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on

Animal Genetic Resources in Asia and Oceania

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ANIMAL GENETIC RESOURCES IN ASIA AND OCEANIA

PROCEEDINGS OF A WORKSHOP

of the

Society for the Advancement of Breeding Researches in Asia and Oceania (SABRAO)

held at

University of Tsukuba,
Tsukuba Science City,

September 3 - 7, 1979

At the 3rd Congress of SABRAO (Society for the Advancement of Breeding Researches in Asia and Oceania), held in Canberra, Australia, in February, 1977, the Farm Animals Section recommended that the SABRAO Board should set up an Expert Committee on Animal Genetic Resources to investigate the collection and collation of data on the breeds, strains and varieties of the economically important domestic animals of the SABRAO region.

Largely due to the efforts of Mr. S. Subramaniam, Secretary-General of SABRAO, the concept of this Workshop was developed. Japan offered to host the meeting and a local organizing committee was established with Dr. H. Shimizu, Vice-President of the Uuiversity of Tsukuba and Professor of Animal Husbandry at the same University as Chairman and Dr. Yukio Yamada, Associate Director of the Tropical Agriculture Research Center as Secretary.

The workshop was held at the University of Tsukuba under the Chairmanship of Dr. J.S.F. Barker, Professor of Animal Science at the University of New England, Australia.

Dr. S. Okabe, Director of the Tropical Agriculture Research Center proposed that the Center be responsible for the publication of the Proceedings of the Workshop.

The objectives of the Workshop were to determine:

(i) What resources are available and where are they?

(ii) How are they adapted to their local environments?

(iii) How best may these resources be identified, documented, evaluated and maintained?

To meet these objectives, one person from each country was invited to prepare a report, these reports to be the working papers and basis for discussion.

Invited participants presented reports for India, Indonesia, Korea, Malaysia, Philippines, Taiwan and Thailand. Reports were presented also for Australia and Japan, while reports were prepared for Bangladesh, Nepal, New Zealand, Papua New Guinea and Sri Lanka although funds were not available to bring their authors to the Workshop.

In addition to the country reports, special lectures were given at the Workshop by Dr. Jan Rendel and by Dr. Ken Nozawa.

As the focus for the Workshop was on documentation, small working groups were set up to prepare draft Data Collection Forms suitable for the tabulation of existing data on each breed, strain or variety of:

(i) Cattle and buffalo,

(ii) Sheep and goats,

(iii) Pigs,

(iv) Poultry and other birds.

Wide ranging discussions during the Workshop identified the major issues relating to animal genetic resources in the SABRAO region, which are summarized in the Workshop Conclusions and Recommendations. In addition, an edited version of the specific discussion that followed each country report and special lecture is given at the end of the paper in these Proceedings.

ACKNOWLEDGMENTS

The members of the Organizing Committee are very much indebted to the Toyota Foundation for covering the travel and living expenses of the delegates from India, Indonesia, Korea, Malaysia, the Philippines, Taiwan and Thailand. They would like to thank the Japan Horse Race Association, the National Federation of Agricultural Cooperatives, the Japanese Cattle Registry Association and the Livestock Industry Promotion Corporation for their generous financial contributions.

They are also indebted to the Australian Development Assistance Bureau for a grant which made possible the participation of Drs. J.S.F. Barker and Helen Newton Turner in the Workshop.

They would like to express their gratitude to Dr. T. Miyazima, President of the University of Tsukuba for allowing the use of the facilities of the University during the Workshop.

Thanks are due to the Secretarial Services Section, University of New England, for typing the final manuscript and covering the cost involved in this work, as well as to the Tropical Agriculture Research Center for bearing the cost of the publication of the Proceedings.

The invaluable help of Dr. J.S.F. Barker and Dr. Helen Newton Turner in editing the Proceedings is gratefully acknowledged.

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1. WORKSHOP CONCLUSIONS

WORKSHOP CONCLUSIONS

1. There is already considerable information on the livestock breeds, strains and varieties of the SABRAO region.

   Nevertheless, it is apparent from the Reports to the Workshop that in many cases, the data are inadequate, being either:

   - incomplete,
   - based on small numbers of animals,
   - based on inadequate definitions of traits.

2. While some attention is being given to exotic breeds and their crosses, the Reports to the Workshop have shown that native strains are often less well identified, documented and evaluated. Because (a) a high proportion of total human food requirements in the SABRAO region are produced by these native strains, (b) they are adapted to village or small farmer conditions, (c) they utilize low quality feeds, crop residues and human waste, and thus have low energy and low economic inputs, (d) they provide an important resource, in terms of sustenance, work and income, to the village and the small farmer, and (e) they are likely to remain important in these ways, it is essential that these native strains be given urgent priority in documentation and evaluation.

3. The water buffalo needs particular attention. Presently there are some 130 million head in the SABRAO region, comprising a large proportion of the world population. They may be divided into the river type of the Indo-Pakistan sub-continent, which supplies milk, meat and work, and the swamp type of eastern Asia which is the major work animal in the area, and also contributes large amounts of meat. There are several breeds and strains within each type, but little is known about their relative merits.

4. A number of breeds, strains or varieties that are rare and in danger of extinction have been identified in the Reports to the Workshop. Such strains should be urgently documented and specifically evaluated, particularly to determine if they possess any unique or special inherited characteristics that would warrant their conservation. Until such evaluation is completed, steps must be taken to ensure preservation of these populations.

5. A number of native breeds, strains or varieties are, or may be in danger of genetic dilution through indiscriminate crossbreeding with exotic breeds.

   Such native breeds should be identified, so that they can be evaluated before this process leads to their essential loss.

6. Some native breeds are in danger of losing genes for high production because high performing animals are withdrawn from breeding populations for use in units of high production and/or subsequent slaughter (*e.g.*, city milk production in India or slaughter animals chosen because of large size).

   Such breeds should be identified and breeding units kept intact.

2. WORKSHOP RECOMMENDATIONS

WORKSHOP RECOMMENDATIONS

1. * That each person who prepared a National Report for the Workshop and persons yet to be nominated from each country for which National Reports were not obtained prepare a list of Organizations, Institutes, Government Departments and University or other Departments that are involved in work on animal genetic resources, animal breeding or livestock studies, with the name of the Head of the Organization, full postal address and a notation as to the nature of the work of each Organization.

   * That these lists be sent to the Chairman, SABRAO Expert Committee on Animal Genetic Resources, who will have them collated, and have the full list sent to each Organization, to each person who prepared the list for each country, to other participants in the Workshop, and to the Commonwealth Bureau of Animal Breeding and Genetics.

2. * That all Reports and publications written in languages other than English should have:

   (i) Title and summary,
   (ii) Table texts and table headings,
   (iii) Figure texts and non-numerical figure information in English as well as the language of publication.

   * That SABRAO should forward this request:

   (i) To Editors of all journals in the SABRAO region which publish papers relating to livestock,
   (ii) To Heads of all Organizations, Institutes, etc. in the list to be compiled (Recommendation 1).

3. * That a Bibliography of published works relating to animal genetic resources in the SABRAO region be developed and maintained.

   * That when circularising the list of Organizations, etc. (Recommendation 1), each Organization be asked to provide to the Chairman, SABRAO Expert Committee on Animal Genetic Resources, a list of publications by members of the Organization, and where available, copies of these publications.

4. * That collation of existing data on the breeds, strains and varieties of domestic livestock in the SABRAO region is essential, so that scientists, administrators and planners may have ready access to available knowledge on identification of such strains and their productive performance.

   * That such data should be collected on standard forms for each species.

   * That the draft Data Collection Forms prepared at the Workshop be given to all participants for consultation with and advice from colleagues in each country, and that all suggestions and comments be forwarded by the end of September to:

   (i) Dr. P.N. Bhat (Cattle and buffalo),
   (ii) Dr. H.N. Turner (Sheep and goats),
   (iii) Dr. S. Watanabe (Pigs),
   (iv) Dr. T.K. Mukherjee (Poultry and other birds),

   who will each prepare a synthesis of proposals and a new draft record form, and forward these to the Expert Committee Chairman for final preparation of the forms, allowing for standardization of format across species.

   * That these final forms be published in the Proceedings of the Workshop, and copies sent to each person who prepared a National Report for the Workshop, and persons yet to be nominated from each country for which National Reports were not obtained.

* That each such person will then take the responsibility for collection of data on each breed, strain or variety within their country.

* That the offer from the Japanese participants to investigate the development of a computer system for the collation of this data be gratefully accepted.

* That the SABRAO Expert Committee on Animal Genetic Resources convene a Specialist Workshop in October, 1980 in New Delhi - this Workshop to finalise the collection and collation system, and to report to the 4th Congress of SABRAO to be held in Kuala Lumpur, May, 1981.

5. * That while Documentation (Recommendation 4) will provide basic information on different genetic groups within each species, there is a vital need for comparative evaluation studies; that is, comparison of the performance of samples of such genetic groups when run together under the same conditions.

* That these conditions under which such evaluation is made must be the normal environment for the industry in which the groups being evaluated would be used. Thus these conditions will often be ones of very low input, but in addition, further evaluation should be done in a potential environment that might be used in the near future, economic and other circumstances permitting. Such conditions might be available on experiment stations or larger commercial enterprises.

* That it should be possible to organize evaluation under conditions of low input by using artificial insemination, even where herds or flocks are small.

* That the genetic groups being compared might consist of various local breeds (or strains) and crosses comprising different proportions of these breeds (or strains) with exotic breeds. However, local breeds which constitute the majority of the population must be included in the evaluation.

* That crosses of a local breed with an exotic breed should always be evaluated against the local breed.

* That evaluation experiments must be carried out to a properly designed and prepared plan.

* That evaluation must be made on total performance, including not only productivity measures but also reproduction rate, mortality and disease incidence. If possible, estimates of economic efficiency should be made.

* That collaboration among countries of the SABRAO region in making these evaluations should be encouraged.

6. * That concerted efforts be made by governments and international organizations to evaluate the various strains and crosses of the water buffalo with regard to the production of milk, meat and work.

* That much of the evaluation of the more important strains within each country can be undertaken by Governmental Institutions and Universities without overburdening costs, and in this work, SABRAO members should participate actively.

* That in order to obtain the crucial information on the comparative productivity of strains and crosses of different national origin, co-operation between countries will be required, and such co-operation will need some outside financial support.

* That regional and international organizations as well as funding institutions engaged in agricultural development in the SABRAO region give urgent attention to the evaluation and genetic development of the water buffalo.

* That in view of the importance of this buffalo evaluation, and the need for international co-operation in carrying it out, the SABRAO Board be requested

to make formal representation to all Governments of the SABRAO region, inviting them to note this above recommendation from the Workshop, and to give their support to the international effort required to have the study expeditiously carried out.

7. * That the SABRAO Expert Committee on Animal Genetic Resources consider the desirability and feasibility of developing for each species, standard recording procedures and forms, that could be used in evaluation experiments and performance recording programs.

   * That the SABRAO Expert Committee on Animal Genetic Resources consider the desirability and feasibility of developing guidelines for experimental procedures to be used in evaluation experiments.

3. OPENING ADDRESS

ANIMAL GENETIC RESOURCES IN ASIA AND OCEANIA - THE PERSPECTIVE

J.S.F. Barker

At the 3rd Congress of SABRAO (Society for the Advancement of Breeding Researches in Asia and Oceania), held in Canberra, Australia, in February, 1977, the Farm Animals Section recommended that the SABRAO Board should set up a Committee on Animal Genetic Resources to investigate the collection and collation of data on the breeds, strains and varieties of the economically important domestic animals of the SABRAO region.

The reasons for this decision were:

(i) There is a widespread tendency to introduce exotic breeds from temperate regions, in an attempt to improve production.

(ii) These introductions are based on the assumption that productivity of the indigenous breeds is very low, yet accurate data often are lacking. Breeds may be small in size, but may have individual desirable attributes. For example, sheep in parts of the region are alleged to lamb twice a year, with a high incidence of multiple births. If this information is correct, these breeds constitute a valuable genetic resource, which should not be dissipated by indiscriminate crossing with introduced breeds.

(iii) Although productivity may appear low, many breeds are adapted to particularly harsh conditions. Their ability to survive and reproduce under these conditions is again valuable and deserves better documentation, so that a genetic resource may be made generally available.

(iv) If a genetic resource is to be available to other areas, figures need not only to be collected, but to be stored in some central data bank from which they can be disseminated.

Subsequently, the SABRAO Board agreed to the formation of this Committee with membership as follows:

Chairman - Professor J.S.F. Barker,
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There is undoubtedly a great deal of information on the distribution, population numbers and production performance of the various breeds, strains and varieties of livestock in the SABRAO region.

However, much of this information is not readily available to research workers or to national and international organizations involved in animal production in the region, in that it is unpublished, or if published, it is only in local or national documents and reports that generally have a very restricted distribution.

It is imperative that this information be collected and collated:

(i) to identify gaps in knowledge, and areas where research effort should be maximized,

(ii) to fully document productivity of local or native strains and to assess their adaptation to specific climatic-management-production systems,

(iii) to ensure that such local or native strains are not displaced by so-called "improved breeds" before their present or potential value is known,

(iv) to allow research workers to know the extent of information in their area of interest, and hence to minimize the chance of repetition of what may be expensive, long-term studies,

(v) to allow planners and administrators to make rational decisions with regard to national and international development programs, and hence overall, to maximize rates of improvement in livestock productivity in the SABRAO region.

Of course, SABRAO is by no means taking a new initiative on this issue, but our action should be seen as a contribution to the growing international efforts relating to biological resources and their conservation. Within Asia and Oceania, SABRAO is not alone in consideration of the problem. In December, 1975, the Animal Production and Health Commission for Asia, the Far East and South-West Pacific (APHCA) was established under Article XIV of the FAO Constitution. In August, 1977, APHCA approved 12 projects for immediate implementation, three of which are particularly relevant to problems of animal genetic resources in our region, namely:

(i) Buffalo research and development.
(ii) Improvement of the data base of livestock resources.
(iii) Goat development in Asia.

The APHCA project on improvement of the data base apparently relates only to numbers of each breed and species. However, production and other information, as I will discuss shortly, also is essential in documenting livestock resources. This is one area where immediate collaboration with APHCA could be established, particularly as APHCA already have agreed that close collaboration should be established with SABRAO. We look forward to this collaboration.

For many years, the Food and Agriculture Organization of the United Nations (FAO) has been concerned with the question of conservation and utilization of animal genetic resources. A series of study group meetings dealing with general aspects and specific questions in cattle, pigs and poultry have been organized (FAO 1966, 1968, 1971, 1973), primarily to make the scientific community and governments aware of the need for action. Conservation of genetic resources (of crop plants, forests, animals and microbes) was considered at the United Nations Conference on the Human Environment, Stockholm (1972), which made a number of recommendations as to action required by member governments and international organizations to safeguard these natural resources. FAO, with support from the UN Environmental Program has surveyed the cattle breed situation in Europe and the Mediterranean basin, with particular emphasis on breeds threatened by extinction (FAO 1975). In the scientific community, the question of the conservation of animal genetic resources was reviewed and discussed at the First World Congress on Genetics Applied to Animal Production (Mason 1974).

This international dialogue has proceeded to the point where there seems general consensus that our genetic resources are important to the present and future needs of mankind; what is needed now is action. In total, a truly international effort is required, involving individual animal scientists, national and international organizations and governments. Clearly the task will not be easy, as the problem lies not just in the collection and collation of information. In determining how to manage our animal genetic resources, both the immediate need for increased productivity to keep up with the expanding human population and the increasing demand for animal proteins (Byerly 1977), and the conservation of resources for unforeseen needs must be considered. Understandably, emphasis in national and international development programs is placed on the immediate needs. While these are not necessarily incompatible with future needs, the latter also must be considered so that potentially useful or interesting genetic material is not lost. Genetic variation is the basic material of the animal breeder. We use it to mould our animal populations to our needs, but once lost, we cannot create it at will.

In opening this Workshop, it is appropriate that I should try to set the scene for our discussions and planning. Clearly it is not possible in this short address to review the whole subject, but I would like to comment briefly on each of the four areas of the study of animal genetic resources, namely documentation, evaluation, conservation and utilization.

Documentation

In considering genetic resources, the basic unit is a breed, strain or variety; that is, a population of animals that is specifically recognised or at least considered to be distinct from other such populations. In addition, crossbreds between such breeds, etc. should be treated as further distinct populations for purposes of documentation and evaluation.

For each breed, strain or variety, documentation should include:

(i) Population statistics - population numbers, herd or flock distribution, geographical distribution.

(ii) Descriptive traits - characters that allow identification of individual animals as members of the breed, such as coat colours and colour patterns, shape of horns, etc. or any unique features, mature weights and sizes, and the main use of or produce from the population (wool, meat, hides, milk, draught, etc., or combinations of these).

(iii) Productive traits - those which relate to a useable or saleable product, such as volume of milk/lactation, number of eggs/year, growth rate, etc.. Preferably the average and normal range of performance should be given, and where appropriate, separately for males and females.

(iv) Reproductive traits - those associated with the ability of the animal to survive and reproduce, such as viability, fertility and prolificacy, which should be reported for each year of age or for defined intervals of the animal's life.

(v) Adaptive traits - those associated with adaptability to specific environments - resistance to environmental stress, disease or parasite resistance.

(vi) Special traits - unique or unusual inherited characteristics, karyotype (chromosome constitution) and blood type and protein gene frequencies.

(vii) Environment - a description of the environmental conditions under which the animals are normally maintained, including climatic conditions, nutrition, disease and parasite incidence, husbandry-management systems, and where specific performance records are available, whether these were collected on government stations, in large privately owned herds, or under village conditions.

Much of this information will not be available for many populations. To have all of it would be ideal, but to have at least some idea of the population statistics, descriptive traits, productive and adaptive traits is essential if we are to determine just what genetic resources are available, and how they should be managed. It is for this reason that this Workshop has focussed on the area of documentation.

Evaluation

If optimum use of available resources is to be attained, it will be necessary to know the relative merits of local breeds, exotic breeds and crosses within and between these two groups. However, even if complete documentation as above were available for two or more breeds, this information would not provide an accurate assessment of their relative productivity if the data had been obtained in different environments. In this case, genetic differences in productivity between the breeds could not be separated from environmental effects.

The relative productivity of different breeds and crossbreds must be determined on data collected under the same conditions, and adequate evaluation will entail careful attention to:

(i) Defining the traits to be measured, together with methods of measurement and of recording of the data collected. As the results of evaluation experiments will feed back into the documentation on the breeds studied, consistency in definitions of productive, reproductive and adaptive traits will facilitate the documentation process, and storage in a central data bank. Ideally, such definitions should be agreed upon and used in the initial documentation. This will not always be possible, but because so little has yet been done for the breeds of the SABRAO region, one of our objects at this Workshop should be to attempt such definitions so that they can be used in documentation of available data, as well as in future evaluation experiments.

(ii) Defining the environment-management system to be used for the evaluation experiments. This should be the normal environment for the industry in which the breeds being evaluated would be used, or a potential environment that might be used in the near future, economic and other circumstances permitting.

(iii) Defining the breeds and crossbreds to be included in the evaluation. It will often not be possible to simultaneously evaluate all potentially useful breeds in all environments, so that an initial choice or grouping of breed types and environments must be made on the basis of available documentation.

(iv) Defining the experimental design to be sure of a high probability of detecting differences of practical or economic magnitude.

For the purposes of documentation of already available information, we may often have to accept inadequate data on inadequately defined traits, or perhaps even information that a particular breed is reputed to exhibit some particular characteristic. Such information may be better than none at all.

On the other hand, where specific records are to be collected for documentation, or when evaluation experiments are to be done, it is imperative that the traits to be measured and recorded are carefully defined and the methods of measurement and recording specified.

Conservation

In the international dialogue regarding animal genetic resources, most attention undoubtedly has been given to this aspect, and it is certainly the most difficult. As pointed out by Rendel (1975), the main problem is how to utilize currently available genetic variation for immediate progress without losing genetic material which could be useful or critically necessary at some future time. Some might argue that breeds or strains that are useful will be preserved, and that therefore there is no need to worry about conservation. Within the last 50-100 years, many breeds or strains have become extinct, having been replaced by other breeds that were considered superior. If these replacements had been based on adequate comparative evaluation, then they could be seen as rational decisions. But it would seem that all too often, breed replacement has been based on quite superficial knowledge of the comparative merits of the breeds. Further, with the emphasis on pure-breeding, replacement of supposedly inferior breeds has meant their total loss, including any genes of special merit.

While probably no-one would argue that all past breed extinctions have been undesirable, some potentially useful genetic variation undoubtedly has been lost, and this should caution us against further such losses. In addition to the complete loss of whole breeds, it is necessary to recognize the possible importance of within-population loss of genetic variation due to selection and genetic drift. As breeding programs are designed to maximize immediate rates of genetic improvement, decay of genetic variability for these reasons may be quite rapid, particularly if the effective population size is small. In one of the inaugural lectures at the first meeting of SABRAO in Tokyo in 1968, I emphasized the tremendous importance of maximizing population size in any breeding program (Barker, 1969). The argument there related to maximizing genetic improvement in both the short-term and the long-term, but it is equally important in the present context of reducing the rate of loss of genetic variability.

The need and the reasons for conserving animal genetic resources have been reviewed by various workers (e.g. Rendel 1975, Miller 1977), but briefly, may be summarized as:

(i) The need to maintain genetic variation to meet immediate requirements for genetic improvement of animal productivity, and to meet future unforeseen requirements resulting from possible changes in environment-husbandry systems of farm animals or possible changes in human demand for types of animal products,

(ii) The need to maintain diversity to allow for utilization of hybrid vigour in meeting immediate or future requirements,

(iii) The need to maintain genetic variability, particularly unique genes or gene combinations, that may be useful in research designed to increase our understanding of the physiology and biochemistry of productive, reproductive and adaptive traits of domestic animals,

(iv) Cultural, educational and historic reasons in maintaining part of man's heritage.

However, there still remains the question of what should be conserved and how this should be done. Miller (1977) has argued strongly that we cannot afford to wait for full evaluation before deciding what breeds should be conserved, and concluded that the only rational criteria are the likelihood of extinction of a breed and the degree to which it possesses unique genes. The former is easy to assess and depends only on documentation of population statistics, and I would agree that breeds in danger of extinction are prime candidates for conservation. But outstanding problems remain. Will we be in a position to conserve all such breeds? For example, of the total number of cattle breeds in Europe and the Mediterranean basin in 1970, 115 indigenous breeds were considered to be threatened by extinction, and only 30 were holding their own (Rendel 1975). Should attempts be made to conserve a breed population or to conserve unique genes and genetic variability in "gene pools"? Even determination of whether a breed does possess unique genes will require some evaluation.

Perhaps we need to consider a step-wise approach to conservation:

(i) Obtain population statistics to identify breeds threatened by extinction,

(ii) Determine whether any of these breeds are reputed to exhibit high levels of resistance to environmental stress, disease or parasite resistance, or any other unique or unusual inherited characteristics that might warrant their conservation,

(iii) Determine blood type and protein gene frequencies in breeds threatened by extinction to specify relationships among them and thus place them into groups,

(iv) Select from within each group candidate breeds for temporary conservation,

(v) Undertake a more complete evaluation of breeds selected in (ii) and (iv), before final decisions are taken on conservation of breed populations or gene pools.

Clearly this would not solve all the inherent problems of conservation, but it would provide a framework for action.

Utilization

Given appropriate and adequate documentation, evaluation and conservation, utilization will depend on application of current genetic knowledge in developing breeding programs to maximize genetic improvement through selection and/or cross-breeding systems to maximize productivity. Particularly in the developing countries where most animals are owned by the small farmer sector, major constraints are likely to be in the development of recording systems and in organizing breeding populations of large effective size.

I have considered documentation, evaluation, conservation and utilization as four areas in the study of animal resources. However, they are not distinct steps to be followed through sequentially as in a carefully designed laboratory study. Even without adequate documentation and evaluation, decisions will be made about utilization of various breeds. These decisions may stimulate the collection of more adequate documentation and the initiation of evaluation experiments, which could in turn lead to pressure to conserve certain breeds. Similarly, recognition that a breed is in danger of extinction should lead to at least temporary conservation, until further documentation and evaluation are obtained.

The National Reports to be presented to this Workshop will provide the first generally available documentation on the livestock breeds and strains of the SABRAO region. I appreciate the difficulties that have been experienced in preparing these Reports, but these exemplify the problems that are to be faced in fulfilling responsibilities to present and future generations in our efforts to ensure optimum use of animal genetic resources. The National Reports will provide the basis for our discussions on:

(i) What information is available,

(ii) How this available documentation is to be collected and collated in a uniform manner, and extended,

(iii) What are the present status and future prospects for conservation and utilization in breeding programs, and improvement of national productivity.

I am pleased to be able to report to you that our Workshop is most timely in that FAO is to hold a Technical Consultation on Animal Genetic Resources in June, 1980, and I have been asked to report at that Consultation on the work of SABRAO.

We have a full program, and as I said earlier, the time for action is now. However, before we proceed to the business of the Workshop, I want to express my gratitude to Professor H. Shimizu, Dr. Y. Yamada and the other members of the Organizing Committee for their efforts in preparing for the Workshop, to the Toyota Foundation for the financial assistance which has paid the expenses of those participants from the developing countries who are to present National Reports, to the following Japanese organizations who have contributed funds for local expenses in relation to the Workshop, namely, the Livestock Improvement Corporation, The Central Horse Racing Association, Chizenkyo, Feed Industries Association, and SABRAO Japan, and to the Australian Development Assistance Bureau for a grant which enabled Dr. H.N. Turner and myself to participate in the Workshop.

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4. SPECIAL LECTURES

PHYLOGENETIC STUDIES ON THE NATIVE DOMESTIC ANIMALS IN EAST AND SOUTHEAST ASIA

Ken Nozawa

I. DOMESTICATION AND GENETIC VARIABILITY

Before entering into discussions on the phylogeny of Asian native domestic animals, I would like to deal with the significance of animal domestication from the viewpoint of genetics.

Domestic animals are defined as the animals whose reproduction is under human control (Nozawa 1975). Domestication can be understood as the process of intensification of such human control. The dichotomy between wild and domestic animals is then unrealistic. We have to look at the animal world as a spectrum which extends from the animals completely free from any human influence at one extreme, to the animals whose reproduction depends completely upon human control at the other. Figure 1 illustrates conceptually the spectrum of the intensity of human control over reproduction of animals, in other words, the grades of domestication of animals. The control over reproduction of animals is motivated by human desire to have animals with such and such characteristics of economic or non-economic value. In an advanced state, the desire would take concrete shape as the breeding objective or breeding goal and the control over reproduction of animals tends to become more and more intensified. Thus, domestication can also be understood as a gradual process of replacement of natural selection pressure with artificial selection pressure to which animal populations are exposed.

Another aspect of animal domestication is the cutting-off of a small number of breeding individuals from the whole species population of wild animals to place their reproduction under human control. Reproductive isolation between domesticated and wild populations would of course be incomplete, at least at its early stage, but it is obvious that an isolating mechanism occurs between them. In other words, an "island population" comes into existence, more or less isolated from the main body of the wild animal population. Under such circumstances, the "island population" cannot represent the whole gene content of the "mainland population". Consequently, genetic variability in a newly-formed domestic population should be less than that of the ancestral wild population because of founder effect. Simultaneously, deleterious genes or genetic load which have been concealed in a wild population could be forced to appear, and selection pressure, either natural or artificial, would eliminate most of them, although some genetic variants which can be beneficial or interesting could be selected and maintained in the domesticated population. The lowered genetic load in a domesticated population compared with the wild one is clearly demonstrated by Sittmann *et al.* (1966), Shinjo *et al.* (1971) and Kawahara (1976) in the Japanese quail (*Coturnix coturnix japonica*), which has been domesticated for the last several hundred years in Japan.

If what has been discussed so far is the whole story in the history of our domestic animals, their phylogeny could be analyzed successfully by using the same method as for wild animal species. A peculiarity of the phylogeny of domestic animals exists in such a situation where the breeds or strains which have once been isolated from each other can often be fused as a result of cultural dispersion or deliberate crossing. So, strictly speaking, the evolutionary history of domestic animals should be depicted not by a phylogenetic tree but by a figure which could be called a "phylogenetic web" (Figure 2). In biological studies aimed at elucidating phylogenetic interrelationships between breeds or populations of domestic animals, we are accustomed to showing the result of analysis by drawing a

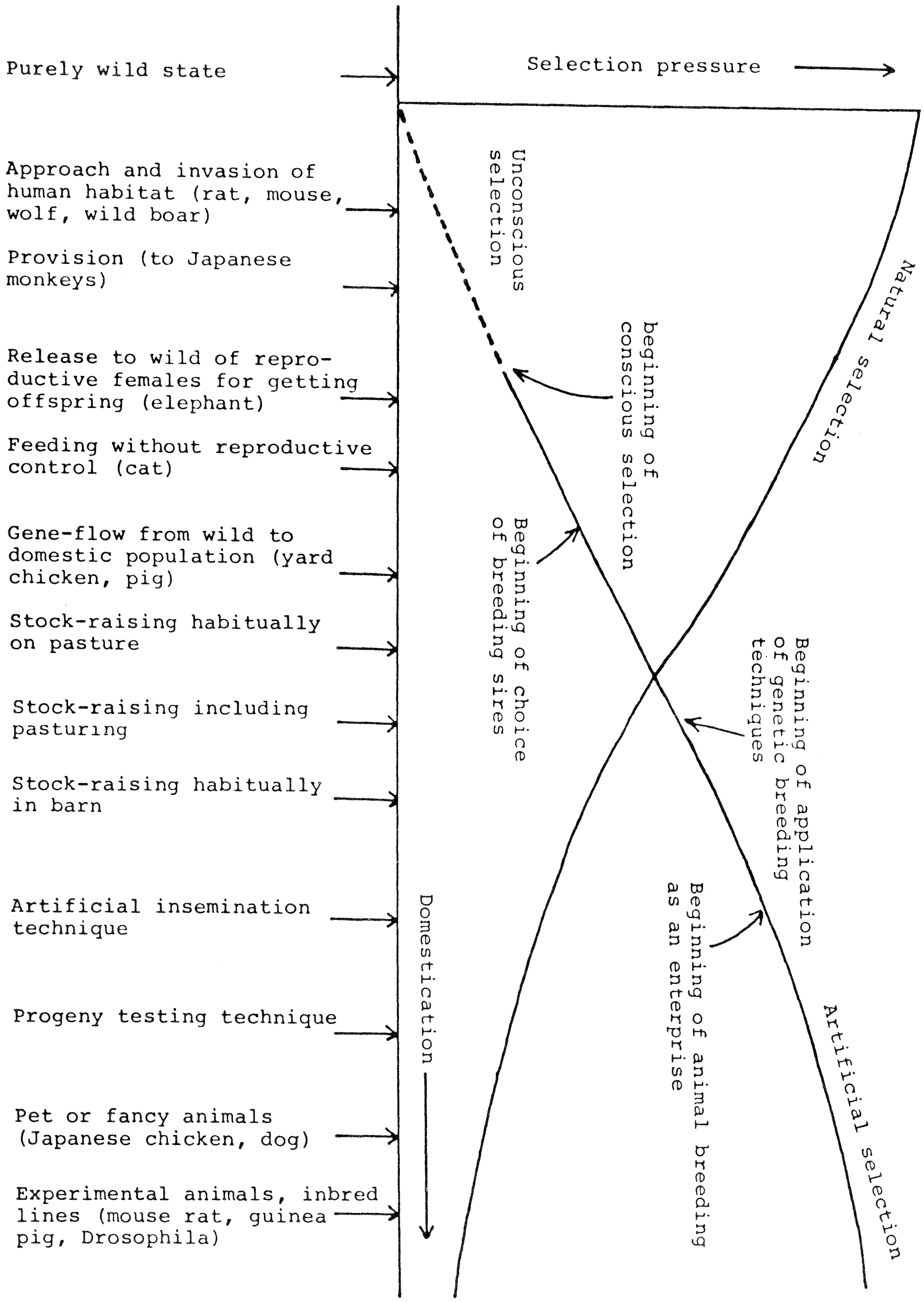

Fig. 1 - Various grades of domestication.

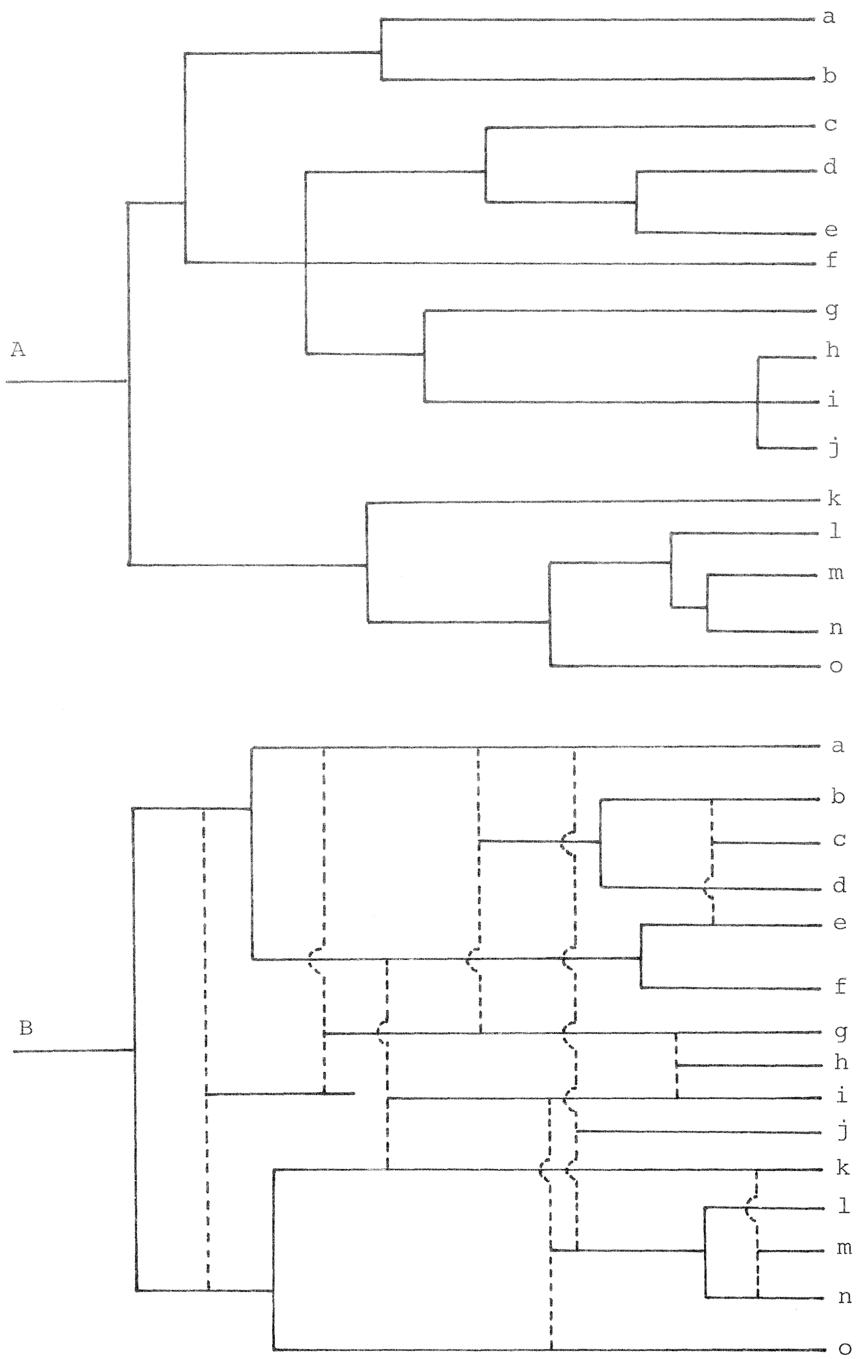

Fig. 2 - Phylogenetic tree (A) and phylogenetic web (B).

dendrogram. Here, we have to remember that in domestic animals a dendrogram shows only similarities and differences in a set of traits between the breeds or populations compared, and that the real phylogeny is to be inferred synthetically by collecting not only biological but also historical and archaeological information.

A population resulting from the fusion of two phylogenetic lines which have once been genetically differentiated would naturally come to have an enlarged genetic variability as compared with its elements. Formation of a phylogenetic web, that is, the process of alternation of fission and fusion of phylogenetic lines, implies that the genetic variability sometimes decreases and sometimes increases in a population, and that the total amount of genetic variation in a domestic animal species as a whole would not be much reduced during its history of domestication. Of course, the pattern of the phylogenetic web would vary from species to species and from breed to breed within a species. Thus, the animals kept by nomadic herders would generally have larger genetic variability than the animals owned by sedentary agriculturists. We can suppose that horses, which have been a powerful biological weapon and as such have experienced long-distance dispersion by military expeditions, would have maintained a high level of genetic variability. The modern breeds, which have been formed by the European breeding scheme consisting of close inbreeding and intense artificial selection, are probably less variable than the Asian indigenous populations of the same species. Further, a population raised by people living at a frontier or periphery of dispersion of an animal husbandry culture would be less variable than a population in its cultural centre. Furthermore, the genetic variability in a breed or population depends also upon the length of its history of domestication, the level of reproductive isolation from its wild progenitor, the multiplicity of elements in its foundation stock, and so on.

Amount of genetic variation in a population can be measured by the proportion of polymorphic loci (P_{poly}) and the average heterozygosity ($\bar{H}$), estimated from electrophoretic screening of blood protein loci sampled randomly from its whole genome. Such multilocus analyses have been carried out in many species of wild animals at diverse taxonomic positions, and the number of reports of such works is extremely large. These reports show that P_{poly} is in the range of 20∿40% and $\bar{H}$ is in the range of 5∿15% generally irrespective of their taxonomic position (cf. Selander *et al.* 1970) though lower values can be observed in the animals with exceptional breeding structures (for instance, Nozawa *et al.* 1975).

Information on genetic variability in domestic animals has been rather scanty up to now, but some data are given in Table 1. From this table we can see that the amount of genetic variation in sheep, horses, dogs and cattle is on about the same level as in most wild animals with the exception of the Tokara pony, a Japanese native breed which has experienced population constriction several times and is now preserved as a small population of about 50 individuals. On the other hand, the genetic variability in goat populations raised in Japan appears remarkably low. Such a low variability might be the result of the fact that Japan is located at the frontier of goat-raising culture in Asia and the dairy goat populations in the Japanese mainland have originated from a small number of founders imported from Europe. Anyway, abundance of genetic variability in sheep, horses, dogs and cattle suggests that these populations have had a history of some phylogenetic fusion since being domesticated.

Next, let us look at the genetic variation between breeds or populations. This can be measured by genetic distance. Although we have many kinds of genetic distance measurements, Nei's (1975) is considered the best, because biological meaning of the measurement is clear, that is, the electrophoretically detectable codon difference per locus between populations compared, and the distance shows a linear relationship with divergence time. The latter property is of much value for phylogenetic studies. Thus, Nei and Roychoudhury (1974) used this distance measurement for estimating the divergence time of the three major races of man, and

Table 1. Proportion of polymorphic loci (P_{poly}) and average heterozygosity per individual ($\bar{H}$) in populations of domestic animals

Species	Breed or populations	No. of populations	No. of samples	No. of loci examined	P_{poly}	$\bar{H}$
Sheep[1]	Merino	1	≦ 189	30	0.23	0.10
	Poll Dorset	1	≦ 106	30	0.16	0.07
Goat[2]	Saanen	7	10~ 69	27	0.11~0.29	0.03~0.05
	Okinawa native	8	9~ 51	27	0.14~0.25	0.02~0.03
	Shiba	3	44~ 61	27	0.03~0.18	0.00~0.01
Horse[3]	Japanese native	4	28~105	21	0.28~0.40	0.10~0.12
	Tokara pony	1	18	21	0.14	0.03
	East Asian native	4	43~103	21	0.38~0.47	0.11~0.16
	European race horses	3	94~100	21	0.33~0.42	0.12~0.15
Dog[4]	Japanese	8	62~236	17~21	0.42~0.57	0.11~0.18
	European	9	17~405	15~20	0.30~0.52	0.08~0.15
Cattle[5]	Japanese Black (Shimane)	1	146	17	0.41	0.12
	Japanese Black (Tajima)	1	212	17	0.52	0.18

References: 1. Manwell and Baker 1977, 2. Nozawa *et al*. 1978, 3. Nozawa *et al*. 1976, 4. Tanabe *et al*. unpubl., 5. Abe *et al*. unpubl.

acceptable results were obtained. Also in our laboratory an estimate of divergence time between the Japanese macaque (Macaca fuscata) and rhesus macaque (M. mulatta) by Nei's method gave about 500,000 years, which was in accordance with the inference from palaeontological data (Nozawa et al. 1977).

On the other hand, when we apply Nei's method to domestic animals, peculiar estimates of the divergence time will be obtained. Manwell and Baker (1977) first pointed out this fact. From the genetic distance over 30 blood protein loci, they calculated the divergence time between two breeds of sheep, Merino and Poll Dorset, and obtained about 70,000 years, whereas sheep are considered to have been domesticated for only about 10,000 years; the ancestors of the two breeds probably have not been separated for more than 2,000 years. Similar, but more incredible, results have been obtained in our laboratory. Figure 3 shows the results on horses and goats by dendrograms, from which we see that the divergence time between East Asian natives and European race horses is more than 100,000 years, and between Okinawa meat goats and the Saanen breed about 30,000 years. We know that horses and goats have been domesticated for only 5,000∿10,000 years. Moreover, Tanabe et al. (unpubl.) analyzed biochemical genetic variation among Japanese and European dog breeds, and the divergence time between Japanese and foreign breeds, estimated by Nei's method, was found to be 140,000 years or more. Certainly, the dog is known as the domestic animal having the longest history as companion of human beings, but the estimates of divergence time appear to be too long.

Manwell and Baker (1977), discussing the reasons for this discrepancy, pointed out the following problems: accuracy of the calculation of the divergence time, influences of population size and breeding structure, genetic correlation between production traits and biochemical markers, and possibility of polyphyletic origin of domestic breeds. Of these factors the most plausible one would be the influences of population size and breeding structure. In early stages of domestication and of breed formation, and also in their breed histories, animal populations would have had many opportunities of passing through a bottle-neck; further, the effective size of domestic animal populations is always markedly reduced as compared with their apparent size, because only a small proportion of males are allowed to breed. Thus, the breeding populations of domestic animals have a special property whereby the bottle-neck effect and random genetic drift combine to accelerate genetic diversification between breeds or populations. A strikingly large genetic distance between the small population of Tokara ponies and other horse breeds (Figure 3) could also be the result of such random processes. In addition, we cannot neglect the possible gene-flow from different sub-species or different species into our livestock populations. Manwell and Baker's hypothesis (1976) on hybrid origins of cattle and sheep based on the presence of haemoglobin polymorphisms with multiple amino-acid substitution is persuasive in this respect.

It would be worth remembering that our domestic animal populations have been diversified genetically with a rate several times faster than in wild animal populations, representing a conscious or unconscious achievement of human control over reproduction of animals.

II. DISTINCTIVE FEATURES OF EAST AND SOUTHEAST ASIAN NATIVE DOMESTIC ANIMALS

Here we have to define the meaning of "native". In the 18th century modern animal breeding took off in Europe, resulting in breed formation by way of inbreeding and rigorous artificial selection for specialized objectives. The centre of this movement was in England, and many superior breeds which have maintained world-wide utility have been established in Europe for 100 years or so in every domestic animal species. Not only the breeds themselves, but also the ideas of

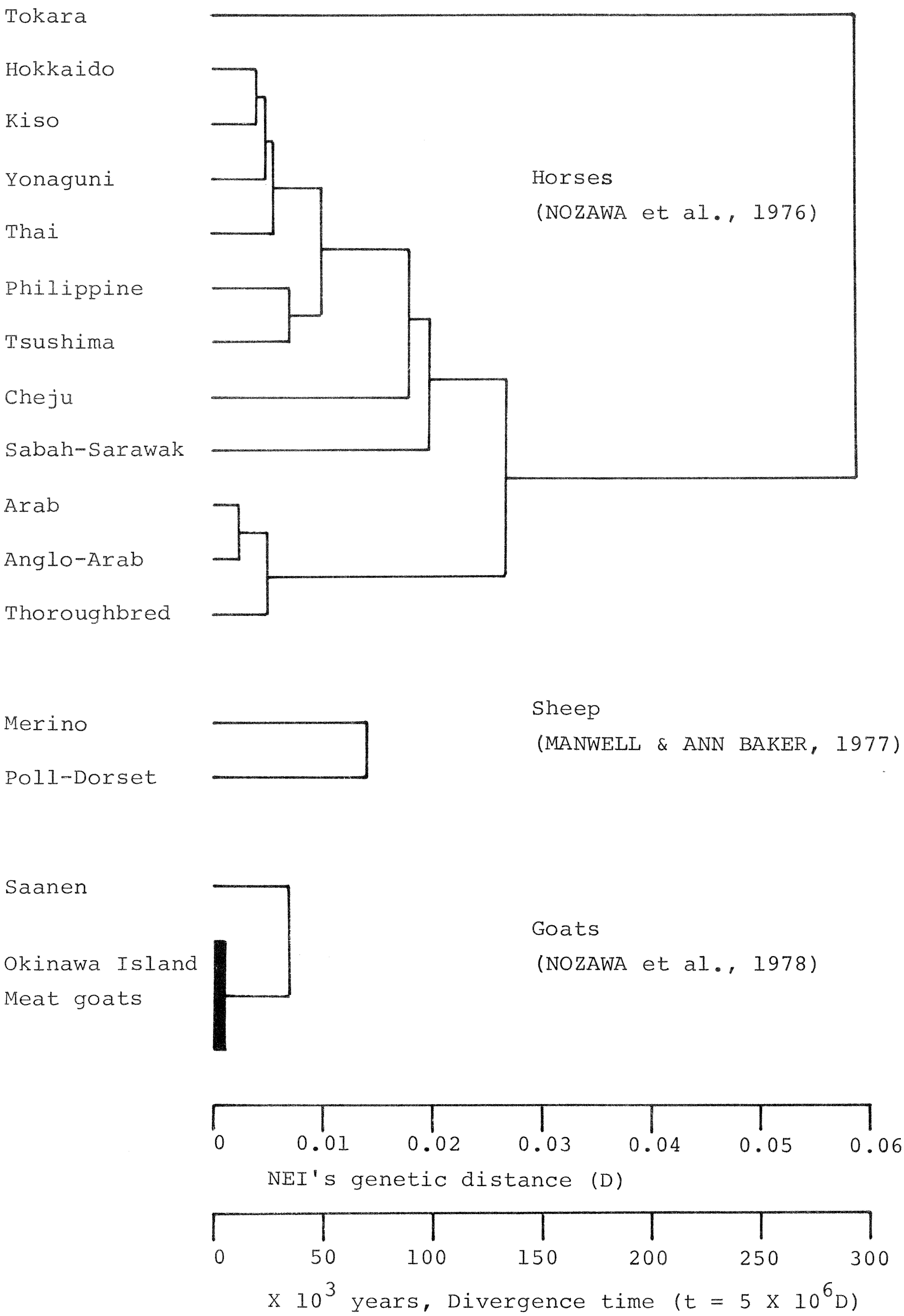

Fig. 3 - Dendrograms from Nei's genetic distance (D) and estimation of divergence time (t).

breed creation, have spread all over the world. Developing countries, one after another, have accepted the European breeds of animals and/or the breeding ideas for modernizing their animal husbandries. The native domestic animals can be defined as the domestic animals which have not been influenced by such European-style animal breeding. Therefore, they are generally characterized by poor breed differentiation. That is particularly so in east and southeast Asia, where the peoples' native culture does not require milk and eggs, but asks only for meat and labour from their domestic animals.

Now, let us consider the distinctive features of east and south-east Asian domestic animals from the viewpoint of genetics.

A. Gene-exchange with ancestral wild animals

It is well known that chickens were domesticated in the forest areas of south-east Asia, and one of the domestication centres of swine is considered to be located in the same area. In addition, Bali cattle have been domesticated from the banteng in Indonesia. In Japan, domestication of the quail also took place. Intensification of human control over the reproduction of animals implies reproductive isolation of domestic populations from their ancestral wild animals. But this is often a slow process, requiring many generations both of men and animals. In south-east Asia, we can observe even now an incomplete reproductive isolation between domestic and wild populations in rural areas of many countries.

Nishida and his associates are carrying out genetic surveys of yard chickens in east and south-east Asian countries, utilizing feather colour pattern and other genetically controlled morphological traits as markers. In northern Thailand in February, 1971, they observed a clear geographical cline in wild-type gene frequencies among the small village populations of yard chickens. The villages were located along the road crossing a hill forest from Lampang to Ngao, both of these towns being surrounded by paddy fields. Figure 4 illustrates the topography of the area studied and the average of normalized wild-type frequencies in the village populations at eight genetic loci or character-pairs controlling the morphological traits of chickens. From this figure we can see that the more distant from the plain area, in other words, the deeper the forest, the more wild-type chickens are encountered. Since the forest is a natural habitat of the red jungle fowl (Gallus gallus), the jungle cocks frequently visit the farm-yard and are able to mate with domestic hens raised there. The farm-yard chicken populations in the forest area are, therefore, considered to be composed of hybrid individuals of every grade between jungle fowl and domestic chicken.

The same situation has been observed by Nishida and his associates in all the south-east Asian countries they visited, that is, Thailand, Malaysia, the Philippines and Indonesia. The gene-flow occurred only in rural areas, however, and a clear geographical cline such as that above could not always be observed, on account of the geographical structure of the economy of the people living there. Further, conscious cross-breeding between domestic and jungle fowls is also practised in some localities in order to get decoys for jungle fowl hunting.

Gene-flow from wild animals to domestic populations can also be observed in swine in south-east Asia, where pig-pens or enclosures in the farmers' gardens are often open, giving an opportunity for wild boars living in neighbouring forests to mate with domestic sows. In Assam in India, the gayal or mithun, a kind of cattle used for flesh, milk and ceremonial purposes, has been reported to mate with its wild ancestor, the gaur (Bos (Bibos) gaurus) (Simoons 1968); and so a certain amount of gene-flow from wild to domestic animals can be observed there.

Surely we can say that such a continuity between domestic and wild populations is an expression of the primitiveness of animal husbandry. However,

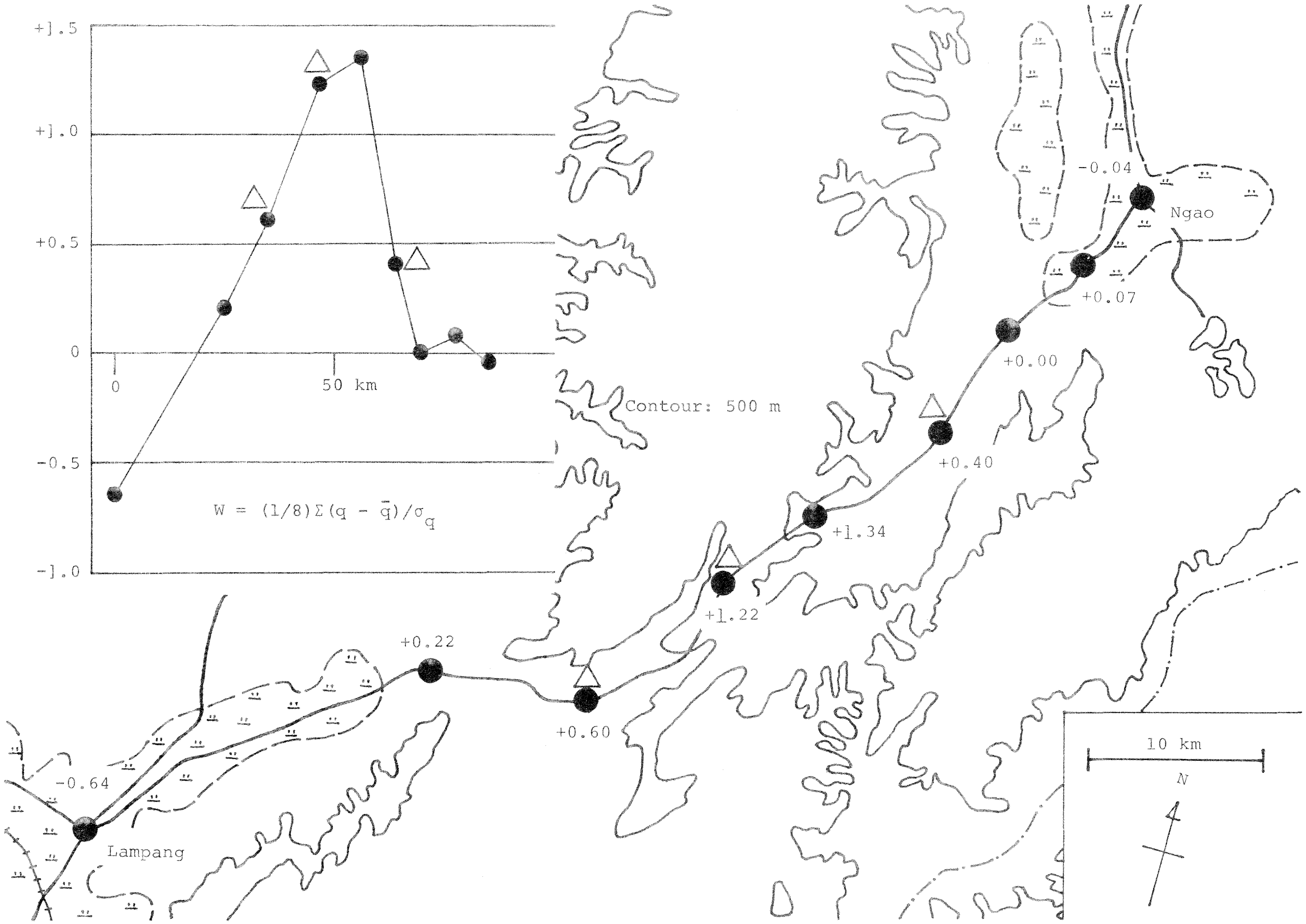

Fig. 4 - Topography of the Lampang-Ngao area, Northern Thailand and graph showing geographical cline in wild-type frequencies at 8 genetic loci or character-pairs. Ordinate is the average of the normalized wild-type frequencies, $W = (1/8)\ \Sigma(q - \bar{q})/\sigma_q$, where q is wild-type frequency and $\bar{q}$ and σ_q are mean and standard deviation of q among 9 village populations at each locus or character-pair.

these facts suggest that locally adapted genes could have been maintained in populations of Asian native domestic animals.

B. Gene-flow from other species

Bali cattle have been known as animals domesticated from the banteng (Bos (Bibos) banteng). According to Namikawa and Widodo's results of haemoglobin analyses (1978), however, the present-day Bali cattle have maintained a proportion of genes originating from the Indian zebu cattle. Another interesting fact is that the ordinary native cattle populations in Indonesia, Malaysia, Thailand, the Philippines and Taiwan have at most 25% haemoglobin-X allele (Namikawa unpubl.), while the frequency of this allele is more than 80% in Bali cattle in Bali Island in Indonesia (Namikawa and Widodo 1978) as shown in Figure 5. This suggests that genes having their origin in the Bali cattle have infiltrated ordinary cattle populations in wide areas of south-east Asia. In other words, we can postulate that a third gene-centre of cattle exists in Bali Island, in addition to the zebu gene-centre in India and the primigenius gene-centre in Europe.

A genetic channel from other species to cattle is thought to exist in north-east India, that is, from the gaur/gayal population to the Indian cattle (Simoons 1968); also, it is known that in China, Mongolia, Tibet and the Himalayan area hybrids between yak and cattle are found and used as pack animals in mountain ranges (Epstein 1969, Keshary and Shrestha 1979). These facts suggest that the range of native genetic resources we can utilize is not limited to a species gene-pool, at least in Asian cattle, although further genetic studies should be made in this respect.

C. Limited influence of pastoralism

Pastoralism is defined as the raising of domestic ungulates with gregarious, nomadic behaviour by utilizing the same behaviour. Cattle, goats, sheep, reindeer, camels, and horses have such a behaviour and so can be objects of pastoralism. Pastoralism is characterized by the utilization of fresh milk or dairy products from these animals, as well as fibre, meat and other products.

Animal husbandry cultures of the east and south-east Asian countries are characterized by the weakness of influence from pastoral peoples. Roughly speaking the native culture of this area has consisted of a mixture of Chinese and Indian influences, stratified dominantly over the primitive tribal culture. These three cultural elements are of settled or shifting agriculturists and not of pastoral nomads. Certainly, the Chinese and Indian cultures themselves have included elements of pastoralism from north Asian steppe dwellers and from Indo-Germanic invaders respectively. But we can see that the Chinese and Indian cultures have affected surrounding areas after absorbing the pastoral elements into their own culture of settled agriculturists. Thus, according to the Simoons survey (1970, 1975), the culture of milking and milk use has not penetrated to the east of the Indo-Burmese boundary; and in mainland China, Korea and Japan, non-milking is traditionally predominant, although it remains to be elucidated whether or not the milking-nonmilking cultural dichotomy is determined biologically by the frequency of genes for adult-type lactase deficiency in the human population as argued by McCracken (1971) and Simoons (1975).

An historically-limited influence of pastoralism would imply that most of the desirable genes for dairy performance involved in the east and south-east Asian native cattle and goats might have been brought into this area from west of the traditional milking-nonmilking borderline, supposedly along with the Hindu and Islam expansion to the east from the Indian subcontinent. While the occurrences of gene-exchange with ancestral wild animals and of the gene-flow from other species stated

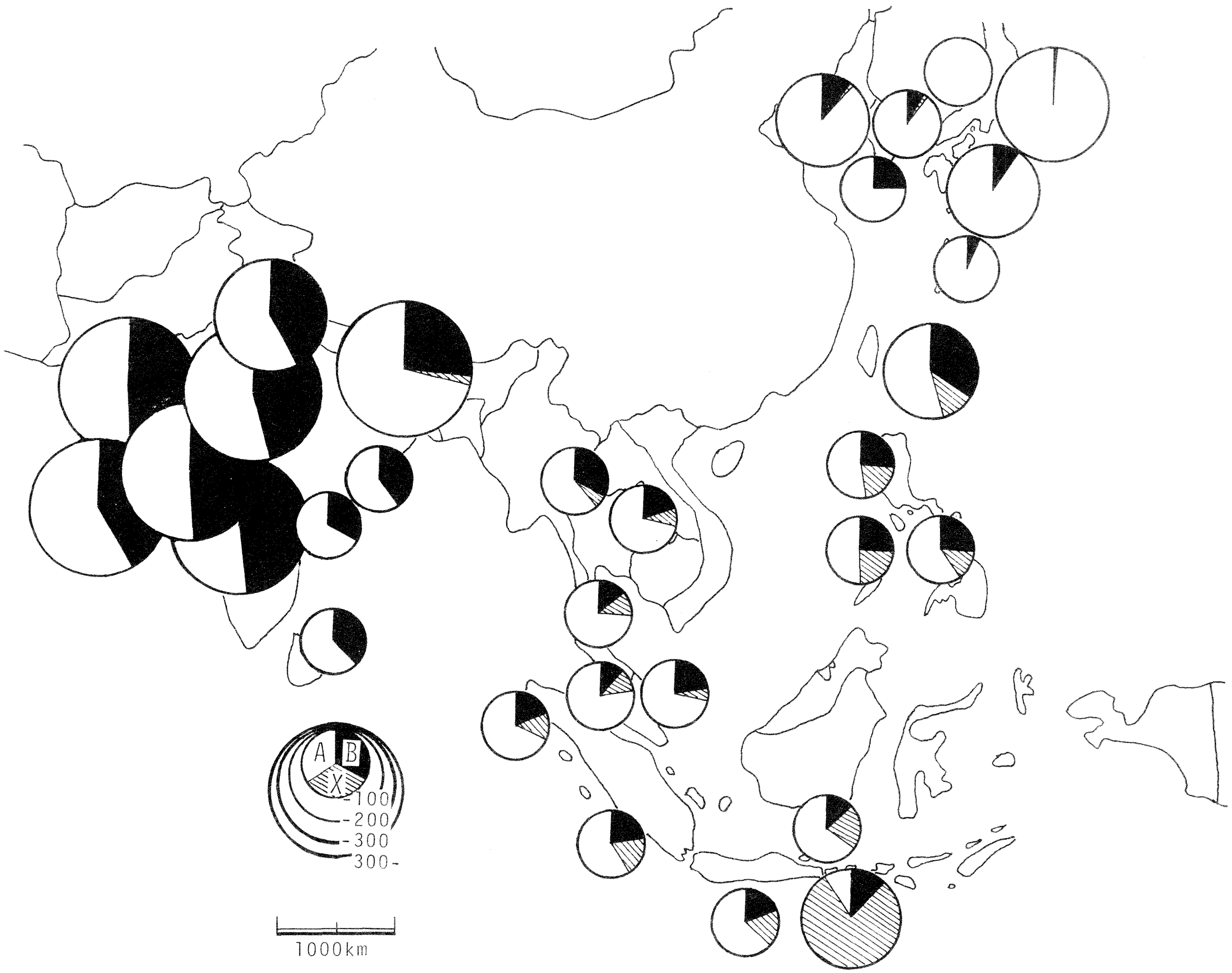

Fig. 5 - Frequencies of the haemoglobin alleles A, B and X in Asian cattle. (Compiled by Namikawa from Buvanendras et al. (1968), Mangalraj et al. (1968), Abe et al. (1968), Naik et al. (1969), Fayed et al. (1970), Singh and Khanna (1973) and Namikawa (unpubl.)).

previously are the factors which would enrich the genetic resources of Asian domestic animals, a minor influence from pastoral cultures is considered as a factor limiting their genetic repertoire.

III. COMPARATIVE GENETIC ANALYSES FOR DEDUCING PHYLOGENY OF EAST AND SOUTH-EAST ASIAN NATIVE DOMESTIC ANIMALS

For inferring the phylogenetic interrelationships between living domestic animal populations we cannot use the economic traits as genetic markers, as these traits have been targets of artificial selection which is liable to bring about genetic changes unrelated to phylogenetic relationship among the populations. For the same reason, morphological traits such as body measurements and coat-colour patterns are not always adequate, although they have long been used as markers for the same purpose. At the present stage of methodological development of biology, we can regard it most advisable to use immunological and biochemical polymorphisms as the basis for phylogenetic inferences, owing to their cryptic nature and selective neutrality (Kimura 1968), the latter property being ascertained by some statistical test procedures. We have to remember, however, that even by utilizing these most adequate genetic markers we can measure only the relative genetic similarities between the populations.

I will now outline the results of the immunological and biochemical comparisons among breeds or populations of Asian domestic animals, which have been carried out by several Japanese workers interested in phylogenetic interrelationships.

1. Cattle

Namikawa and Amano (1974, unpubl.) collated the results of blood-group (9 loci) and electrophoretic (3 loci) screenings in Asian and European cattle breeds which had been performed by themselves and other geneticists. On the basis of the geometrical genetic distance matrix from gene frequency data they constructed a dendrogram as shown in Figure 6.

From this figure we can see that the native cattle in south-east Asia appear to be closely related with each other and with the Indian Zebu cattle, and that the Japanese and Korean cattle have closer genetic similarity with the Holstein breed of Europe than with the south-east Asian cattle. Thus, we can infer that the Korean and Japanese native cattle are of _primigenius_ type and the people there have obtained cattle originally from a broad belt of cattle-raising culture extending from Europe through north-east Asia (Abe _et al_. 1968, Namikawa 1972, Namikawa and Amano 1974). The genetic influence of the Bali cattle on the south-east Asian cattle (Namikawa and Widodo 1978), which has been mentioned in the previous section, manifests itself also in the dendrogram.

Abe _et al_. (1975) conducted a genetic comparison among the Japanese and foreign cattle breeds raised in Japan by electrophoretic screening of milk proteins controlled by five different genetic loci, and revealed that the Japanese breeds had been differentiated markedly from the Indian Zebu, supporting the conclusion based on Namikawa and Amano's dendrogram. Furthermore, a recent immunological and biochemical comparison carried out by Abe _et al_. (1977) shows that, of the four breeds of Japanese beef cattle, the Japanese Polled and Japanese Shorthorn have a very close genetic similarity with the Holstein breed. This suggests that the two breeds have been influenced strongly by European cattle, namely by the Aberdeen Angus and Shorthorn, respectively, which have been used for grading native cattle to establish these breeds.

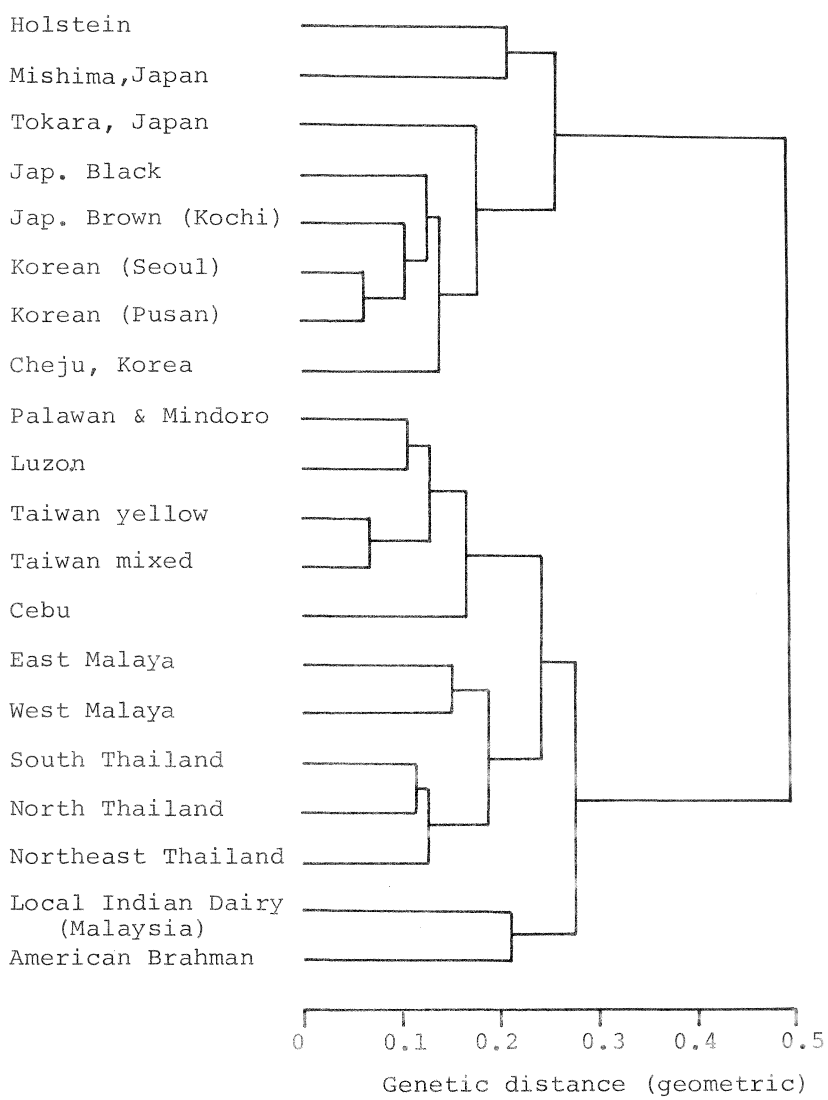

Fig. 6 - Dendrogram from genetic distances among 20 cattle breeds or populations (Namikawa and Amano 1974, unpublished).

2. Horses

On the basis of body measurement data in Asian horses, Hayashida (1958) observed that Asian native horses could be classified into two groups, small-sized horses (110-120 cm in withers height) being raised in southern China and the whole of south-east Asia, and medium-sized horses (130-140 cm) in Mongolia and northern China. He postulated that the small-sized horses were brought into Japan first (1,000-200 BC) from the south and the medium-sized horses later (200 BC - 200 AD) through the Korean peninsula, and that these two groups of horses interbred in Japan. The body-size of the population then increased to the level of medium-sized horses, owing to artificial selection, except in some isolated small islands.

The result of comparative electrophoretic screening for several Asian native horses and European breeds (Nozawa et al. 1976) has already been illustrated in Figure 3. In the data no correlation could be observed between body size and gene constitution of blood proteins; thus, the argument that Japan received immigrations of horses from two different routes could not be supported by our genetic data. Rather, we can argue simply that the small-sized horses remaining in small islands originated from horses from the Japanese mainland, and reduced their body size on account of natural and/or artificial selection on the isolated islands, and that Japan herself received the immigration of horses only through the Korean peninsula, the well-known main route of cultural flow into Japan. Figure 3 shows also that the Asian native breeds have diverged markedly in genetic make-up as compared with European race horses. We have historical evidence showing that Mongolian-type Asian horses had already been differentiated in the 2nd century BC from the Arabian horse, an ancestor of the European race horse.

3. Swine

In Japan and Korea the populations of native swine have been almost extinguished, although it is possible that some of the wild boars found there are descendants of native pigs which escaped human control.

In Taiwan there are two lines of native pigs. One is the "Short-ear" breed which has been raised exclusively by the Taiwan aborigines and is considered to belong to the same lineage as the native pigs in the island areas of Malaysia, Indonesia, Melanesia and Polynesia. The other is a line of Chinese masked pigs introduced mainly from Kwangtung Province of mainland China since the 16th century, which comprise Taoyuan and other local breeds. In Thailand, Malaysia and the Philippines, native pigs are raised by general farmers, although specific breed names have not always been given to them. Tanaka, Oishi and Kurosawa (unpubl.) performed immunological (8 loci) and biochemical (5 loci) comparisons among these Asian pigs and Euro-American breeds. From the genetic distances of geometric scale between every pair of them, they have drawn a dendrogram as presented in Figure 7. This figure shows that there is a marked genetic difference between Asian and Euro-American breeds of swine. It has been considered that the Asian native pig is a domesticated form of the Asian wild boar, Sus scrofa vittatus, and that the Euro-American pig is derived from the European wild boar, Sus scrofa scrofa; the blood type difference is considered to be a reflection of the sub-specific difference between the wild ancestors from which the domesticated forms have originated. As for genetic differences among Asian breeds, there seems to exist some correlation between geographical location and genetic make-up of the populations.

4. Goats

In east and south-east Asia a large number of native goats have been raised exclusively for meat. Their phenotype is coloured coat, with horns and without wattles, and they show a strong resistance to lumbar paralysis, but their body size is much smaller than that of the dairy Saanen breed from Europe (cf. Devendra and Nozawa 1976). It might be expected that a large genetic difference would exist between the Japanese native meat goats and the Saanen breed. The

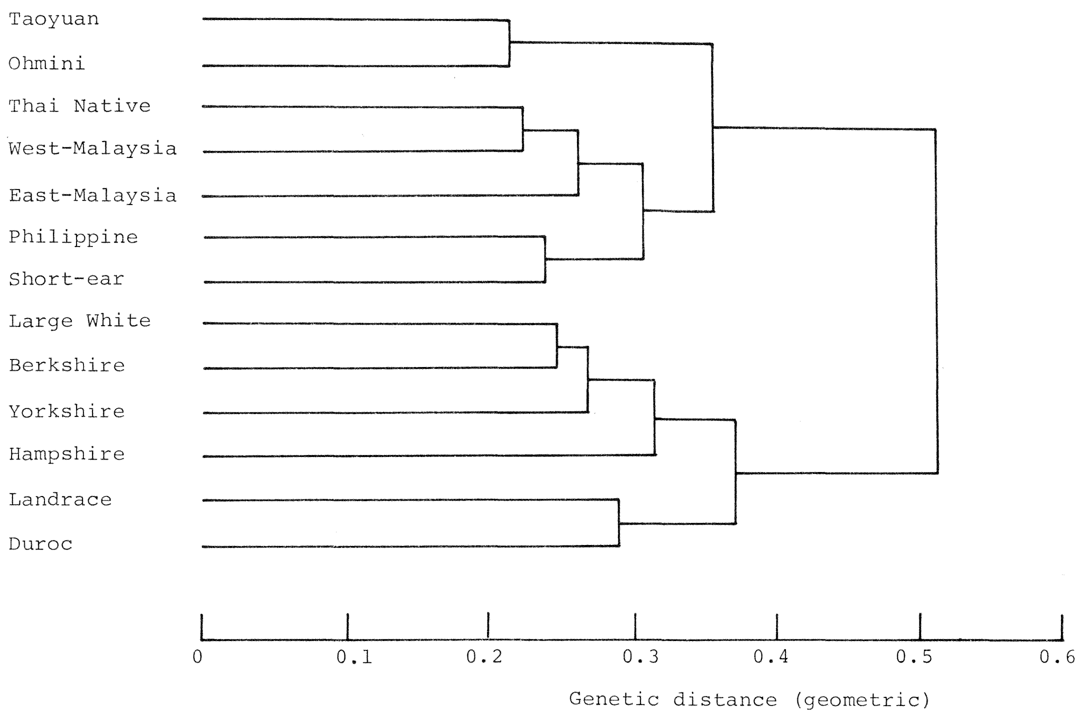

Fig. 7 - Dendrogram from genetic distances among 13 swine breeds or populations (Tanaka, Oishi and Kurosawa, unpublished).

electrophoretic comparison of blood proteins (27 genetic loci) between them, however, gave an unexpectedly small genetic distance value as shown in Figure 3 (Nozawa et al. 1978). On the other hand, it has been observed that the frequency of the B allele at the serum transferrin locus is about 5% or less in Japanese, Korean and Taiwanese native goats and the Saanen breed, 10∿70% in the local goats in Thailand, Malaysia and the Philippines, and 95% in the Indian Jamnapari goats raised in Malaysia (Watanabe and Tsunoda 1974, Shotake et al. 1976, Watanabe 1978). Such findings suggest infiltration of Indian blood into the populations of south-east Asian goats. Multi-locus comparisons between the Indian and south-east Asian goats are now in progress.

5. Dogs

In Japan we have six breeds of native dogs, which are evaluated by the organization for pedigree registration. Tanabe and his associates have carried out extensive genetic comparisons among them and several alien breeds raised in Japan, by using 21 blood protein loci. A dendrogram drawn from the geometrical genetic distance matrix is presented in Figure 8 (Tanabe et al. unpubl.). From this figure we can see that the Japanese dog breeds make a distinct cluster, differentiated from European and other alien breeds except for the local population of Shiba dogs, in which such random processes as founder effect and genetic drift are thought to have occurred frequently. The clustering of the Japanese breeds of dogs can be considered to have resulted from the long geographical isolation of this island country.

6. Chickens

The chicken-raising culture has radiated in three directions from its domestication centre in south-east Asia, namely, west to Europe, east to the southern Pacific and north to China (Nishida 1967). Therefore, when we consider the immigration route of domestic chicken into Japan, we have to pay attention to the route from China through southern Korea to northern Kyushu (Oana 1951). On the other hand, Nishida (1967) has suggested from the morphology of the native chicken in Japan and its neighbouring localities that the Ryukyu island-chain south of Kyushu cannot be neglected as an immigration route. Nishida and his associates have continued to record genetic polymorphisms controlling externally observable characters of the yard chicken populations in east and south-east Asia. These were found to be hybrid populations of every grade between the native chicken and imported modern Euro-American breeds. From the records of gene constitution, Nozawa and Nishida (1970) have estimated statistically the amount of gene-flow from the improved breeds and identified the alleles which were postulated to exist in the original native populations. The result (Figure 9) suggested that the native populations facing the Korean Straits contained the genes i, e, e+, s, b, Id, id, p and P, and those along the Ryukyu island-chain the alleles E and S besides the above nine genes. We know that the alleles E and S have been maintained in the Japanese fancy chickens from olden times, suggesting that the immigration of chickens into Japan occurred not only from the Korean peninsula but also through the Ryukyu island-chain from the south. This conclusion has been supported by Fujio (1972) from the analyses of alleles at the erythrocyte antigen B locus in the native chicken in Japan and surrounding areas.

Electrophoretic and immunological comparisons of chicken blood have been initiated by Okada, Hashiguchi and Tanabe for Japanese fancy chicken breeds on the one hand, and for native yard chicken populations in east and south-east Asia on the other. From this line of work, we are expecting to obtain valuable information for clarifying the phylogeny of domestic chickens in south-east Asia, where domestication of chickens has been achieved and a genetic connection between wild and domestic chickens is still being maintained.

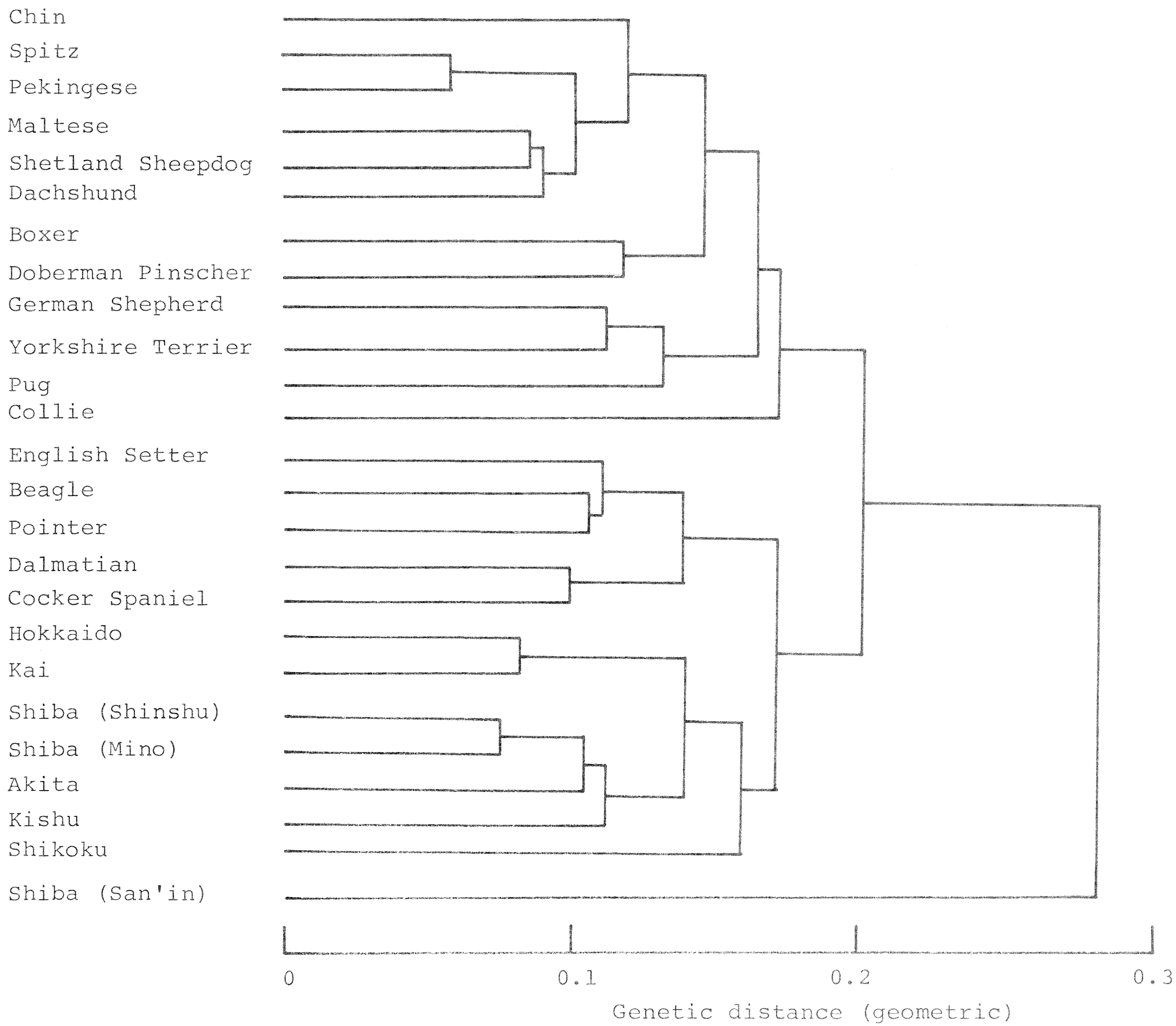

Fig. 8 - Dendrogram from genetic distances among 25 dog breeds or populations (Tanabe et al. unpublished).

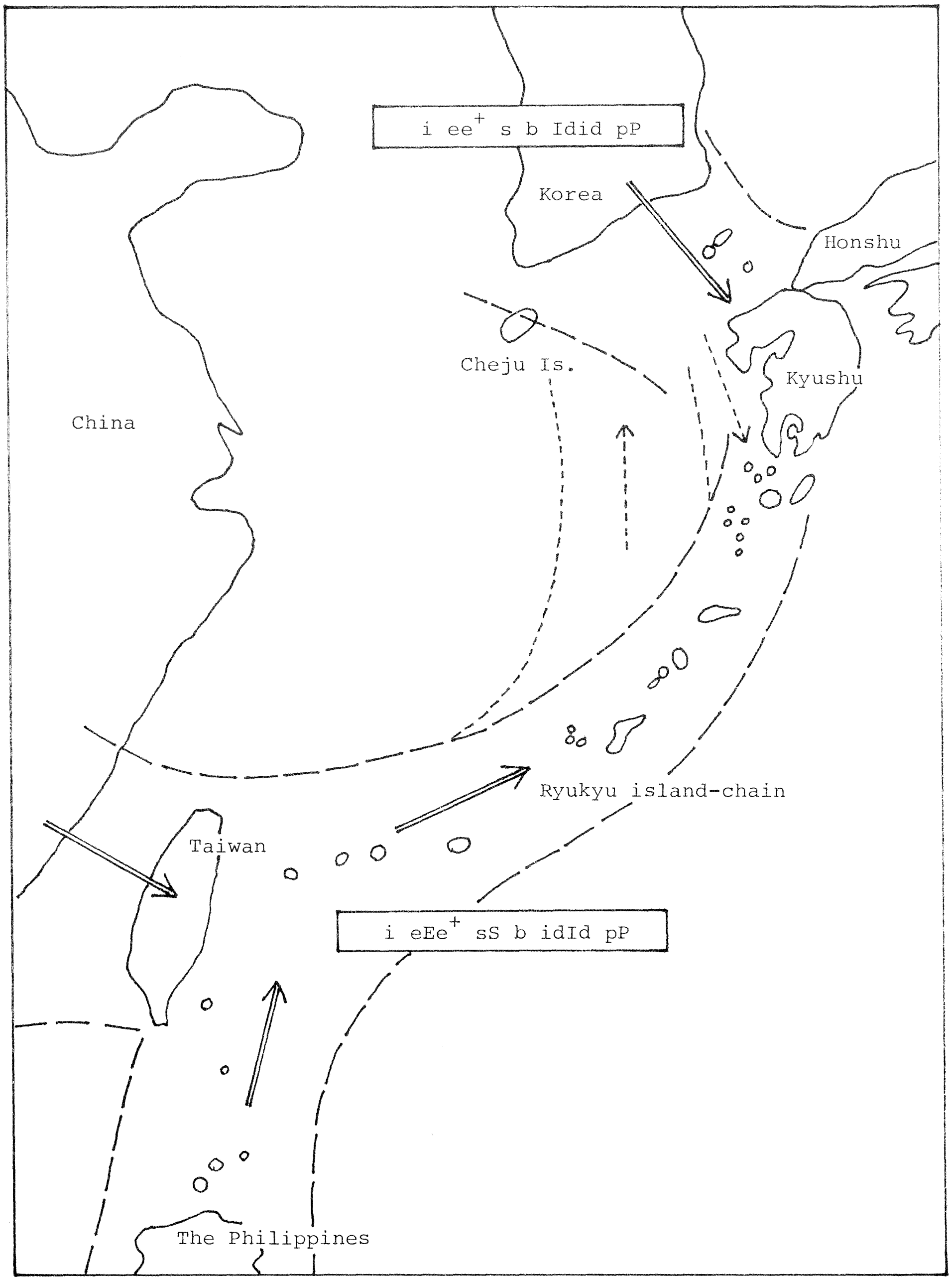

Fig. 9 - Map showing immigration route of native chicken into Japan, and the genes assumed to have been introduced through each route.

IV. ACKNOWLEDGEMENTS

I wish to thank the members of the Japanese Society for Researches on Native Livestock for their cooperation in the research work for clarifying phylogeny of east and south-east Asian native domestic animals. Especially I am indebted to Dr. T. Abe, Dr. Y. Tanabe, Dr. T. Nishida, Dr. K. Tanaka, Dr. T. Oishi, Mr. T. Amano, Mr. T. Namikawa and Mr. Y. Kurosawa for allowing me to cite their unpublished data in this presentation. I also thank Dr. Y. Yamada for his invaluable criticism in reading the manuscript.

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Discussion

Barker: In relation to the poor estimates of divergence time between breeds or strains, where estimated divergence times are much longer than apparently are reasonable, it is important to note that sample sizes are often small, in terms of both the numbers of herds or flocks and the numbers of animals included in the study. This may well lead to poor estimates of divergence time.

Nozawa: I agree that this may be one reason for poor estimates.

Rendel: Did you use both biochemical polymorphisms and red cell antigens in your studies?

Nozawa: Only biochemical polymorphisms.

Rendel: Again in relation to the poor estimates of divergence time in some studies, would you agree that this may be expected where one or both of the breeds has been formed from a very small number of animals, so that genetic drift may have had a strong effect on the genotype of the breed?

Nozawa: I agree that this may be very important.

FAO ACTIVITIES IN THE MANAGEMENT OF ANIMAL GENETIC RESOURCES

Jan Rendel

For the major species of farm animals the domestication process was initiated some 5-10 thousand years ago. Since then these species have undergone gradual changes which have adapted them more and more to the demands set by nature and man. Through natural or intentional selection (generally a combination of both) a wide variety of types and strains have evolved. Breeding in the modern sense with the development of specific breeds, based on external traits and performance characteristics, was initiated some two hundred years ago by Bakewell and others in Britain. The breeds developed there (the thoroughbred horse, Shorthorn cattle, Leicester sheep, etc.) increased fairly rapidly in economic importance within Britain and started soon to spread to other European countries as well as to countries outside Europe. However, the masses of the world's farm animals remained fairly untouched by these developments.

With the foundation of the basic concepts of selection theory during the 1930s and 1940s, the building-up of techniques and organizations for production/performance recording and the development and introduction of artificial insemination in some species, a period of very intensive selection with rapid increases in animal productivity was initiated in the 1950s in the industrialized countries, particularly with poultry, pigs and cattle. Quite naturally the Governments of the Third World countries showed an early interest in improving their livestock populations by using breeding material and techniques developed in the more industrialized countries. The Food and Agriculture Organization (FAO) has often been called upon to assist its member governments in building up the infrastructure and manpower required for livestock improvement as well as in providing breeding animals and semen. For rather obvious reasons the Organization has put major emphasis on activities which could lead to fairly rapid increases in productivity, i.e. improvement of animal health and of husbandry techniques and direct support to the building-up of breeding improvement schemes and artificial insemination. There was, however, an early awareness that care had to be taken to evaluate and inventorize the national animal genetic resources in the developing countries, so as to avoid the loss of potentially useful genetic material through replacement crossings or indiscriminate breeding activities. To this effect FAO published a number of books on livestock breeds, e.g. Zebu Cattle of India and Pakistan (1953) and Types and Breeds of African Cattle (1957). The latest in this series of activities was the Husbandry and Health of the Domestic Buffalo (1974) which helped considerably in bringing attention to the economic importance of the much neglected water buffalo. A series of technical meetings dealing with the utilization and conservation of animal genetic resources in general as well as with specific questions on cattle, pigs and poultry was arranged between 1966 and 1972 (FAO - 1966, 1968, 1971, 1973). The interest in the general questions of animal genetic resource management was, however, limited both in the industrialized and the Third World countries. For some time, it looked as though the recommendations of these FAO meetings and publications had fallen on deaf ears. Genetic resources conservation in general (crop plants, forests, animals and microbes) was, however, considered so important that FAO brought the whole question to the attention of the United Nations Conference on the Human Environment in Stockholm (1972) which made a number of recommendations as to what action was required by member governments and international organizations to safeguard these resources. The Stockholm Conference took place shortly before the first acute signs of a forthcoming energy shortage, which gave additional impetus to the growing interest in resource questions in general. The SABRAO

Fig. 1

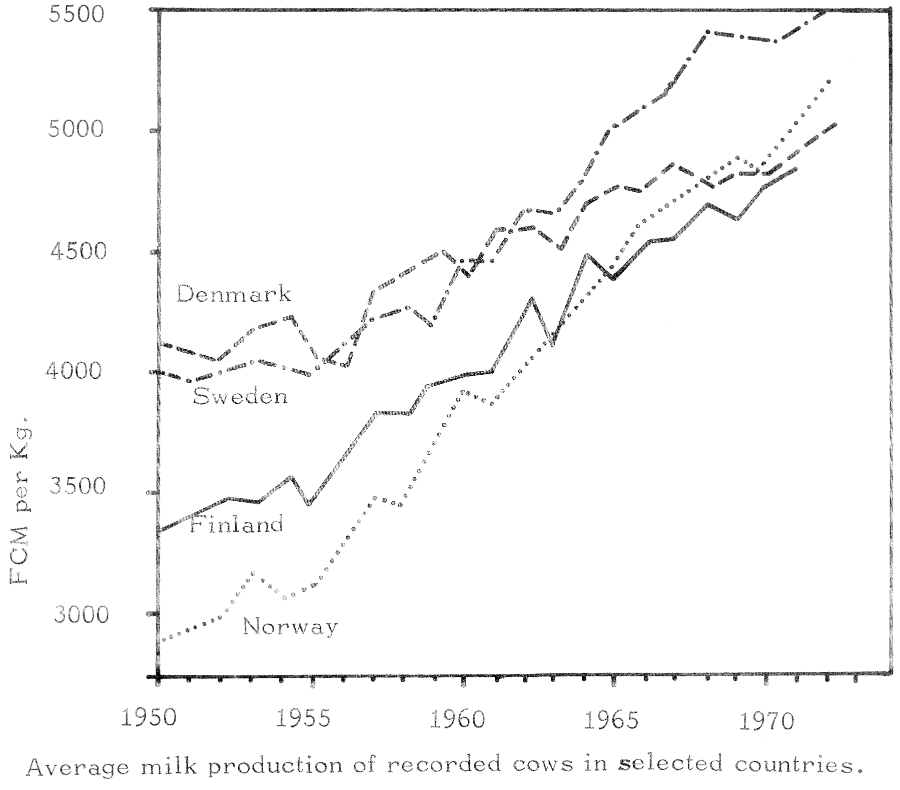


Fig. 1 - Average milk production of recorded cows in Denmark, Finland, Sweden and Norway.

meeting on Animal Genetic Resources we are attending here today is one of many signs of an increased awareness of the need to manage well the genetic resources available to mankind.

KEY ISSUES

Sound breeding policies should aim at rapid immediate genetic improvements and at the same time safeguard against the loss of genetic material which may become important in the future under unforeseen economic and natural conditions. It is not easy to find the right balance between these partly conflicting demands but as the future is unknown, quite naturally there is a tendency among breeders and policy-makers to give major emphasis to the immediate improvements.

The effect of selection (coupled with improvements in feeding and management) has been very spectacular in several species of livestock. In poultry for instance the amount of feed required for the production of one kg of meat has in specialized broiler production gone down towards 1.5 kg, a figure which should be compared to 3-4 kg some 30 years ago. The progress in egg production has also been large. However, the very rapid increase in the productivity of broiler and egg producing strains, which was encountered initially, has slowed down. The opinion is now often voiced by poultry breeders that many strongly selected lines are in a phase of "genetic plateauing" from which it is difficult to come further. In dairy cattle, cow production has shown a marked increase in all industrialized countries since World War II, and national averages of more than 5,000 kg of milk per cow per year are now obtained in several countries. This point is illustrated in Figure 1 for the four Scandinavian countries, where milk recording comprises about 50 percent of all the cows in each country. The average milk production of recorded cows is now well above 5,000 kg in all these countries. This high level has been obtained through intensive breeding work and improvement in management and feeding. The increase has been particularly large in Norway. In 1950 the average annual yield per cow was 2,800 kg, a figure which in 1973 had increased to 5,200 kg, i.e. a rise of 2,400 kg in 23 years, or close to a doubling in productivity. This rapid increase was to a large extent due to a change in the breed composition. In 1950 the cattle population comprised largely a number of local landraces, while in 1973 the great majority of the bulls being used in artificial insemination belonged to the improved Norwegian Red breed.

Norway is not alone in having had a drastic change in the breed composition of its dairy population. The same applies to practically the whole of Europe, as well as to North America. FAO, with support from the UN Environmental Programme (UNEP) and with the assistance of Dr. J.J. Lauvergne of Paris acting as a consultant, recently made a survey of the cattle breed situation in Europe and the Mediterranean basin, with particular emphasis on breeds threatened by extinction (FAO, 1975). To take a few examples: in Denmark the traditional national dairy breed, Red Danish cattle, made up two-thirds of the recorded cows in 1950. In 1973 this breed had decreased quite considerably in popularity and only one quarter of the inseminations were made with semen from Red Danish bulls. Friesian cattle had replaced Red Danish cattle as the most important breed. In Finland, the local Finn cattle breed made up 51 percent of the recorded cows in 1950, while in 1977 only 7 percent of the inseminations were made with semen of this breed. Instead Ayrshire topped the list with 67 percent of the inseminations, and Friesian bulls had entered the scene with no less than 20 percent of the inseminations. The very drastic changes in breed composition in England and Wales are given in Figure 2, showing that Shorthorn, which was the major breed before World War II, has been replaced largely by Friesians for milk and Hereford for beef.

Lauvergne found that of the total number of breeds which existed in 1970 in Europe and the Mediterranean basin, 115 indigenous breeds are threatened by extinction and only 30 are holding their own. To summarize the situation, there has

Fig. 2

CATTLE BREED COMPOSITION IN ENGLAND & WALES, (Licensed Bulls).

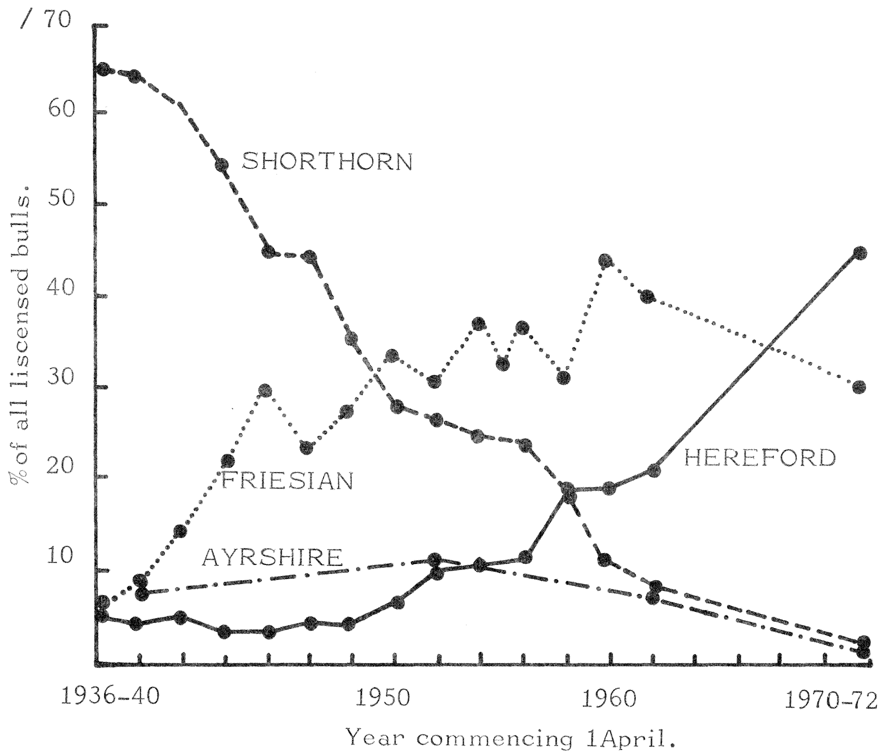


Fig. 2 - Cattle breed composition in England and Wales (based on bulls licensed).

been a change towards Friesian cattle in practically all of the lowland areas of the European continent and the British Isles, and towards Simmental cattle in the moderately elevated areas of central and south-eastern Europe. In Scandinavia, the Red cattle, mainly founded on Ayrshire and Shorthorn crosses, still hold their own although there has been a decline of the Red Danish breed. The Brown cattle of Central Europe, which expanded greatly before and shortly after the last World War, now seem to be somewhat on the retreat.

Presumably not even the strongest conservationist would argue that the changes in breed composition which have taken place recently are all bad or detrimental. Most of the changes have been based on logical efforts to change the cattle population towards more efficient animals. One can say that the selection and changes in husbandry methods have been made mainly as a response to the changes in the economic environment. Concentrates in the industrialized countries are currently relatively cheap. It has therefore paid to "produce" high yielding cows, poultry and swine. For instance, a cow which gives 1,000 kg milk annually will require about 1.5 Scandinavian feed units per kg milk while a cow producing 5,000 kg will need less than half that amount. With good milk prices and low concentrate prices, as compared to the price of roughages, high yielding cows become progressively more economic. In the industrialized world the amount of grains fed to livestock has, as a part of this intensification process, shown a steady increase up to the middle of the 1970s, whereafter the picture became somewhat irregular due to the energy crisis and the general economic stagnation.

The relationship between the <u>per capita</u> income and grain use is indicated in Figure 3, for some selected countries. The figures relate to 1973 but the general pattern still seems to remain. Without going into a detailed discussion, it may be stated that with the limited grain resources which exist in the developing countries, it seems impossible that they could afford the imports necessary to copy the livestock production systems in the industrialized countries. In the developing countries, the intensification process will be (and is) coming first with poultry, pigs and dairy cattle, while on the whole more extensive system will remain for beef and sheep. The available feed resources and the prevailing agricultural system will have to have a decisive influence on the breeding programmes.

Another point should be learned from the experiences in Europe. With the techniques now available the changes in the breed and strain composition of livestock populations can be very fast. Careful monitoring is required so that useful breeding material is not lost before the policymakers even notice that they have a useful national resource available. Increased attention will need to be given to the recording of production and performance characters so that the relative merits of the different local strains of exotic breeds and their crosses can be assessed in the existing natural and economic environment.

CURRENT FAO ACTIVITIES

Being an international organization serving its member countries, particularly the Third World, FAO has to adopt a pragmatic approach to the various issues and questions mentioned above regarding the management of animal genetic resources. The major thrust is in assisting member governments in their efforts to improve livestock productivity by advising on suitable breeding policies and techniques, arranging training of national staff, assisting in improving infrastructures and in providing superior genotypes, particularly semen. At the same time FAO is carrying out or sponsoring resource surveys and studies on a global or regional basis and is arranging policy studies and discussions. Some of these activities will be briefly described.

<u>Genetic improvement</u>

Most of these activities form part of national programmes. For instance,

Fig. 3

SUPPLY & CONSUMPTION OF GRAINS BY PER CAPUT INCOME IN SELECTED COUNTRIES. (FAO,1973-74).

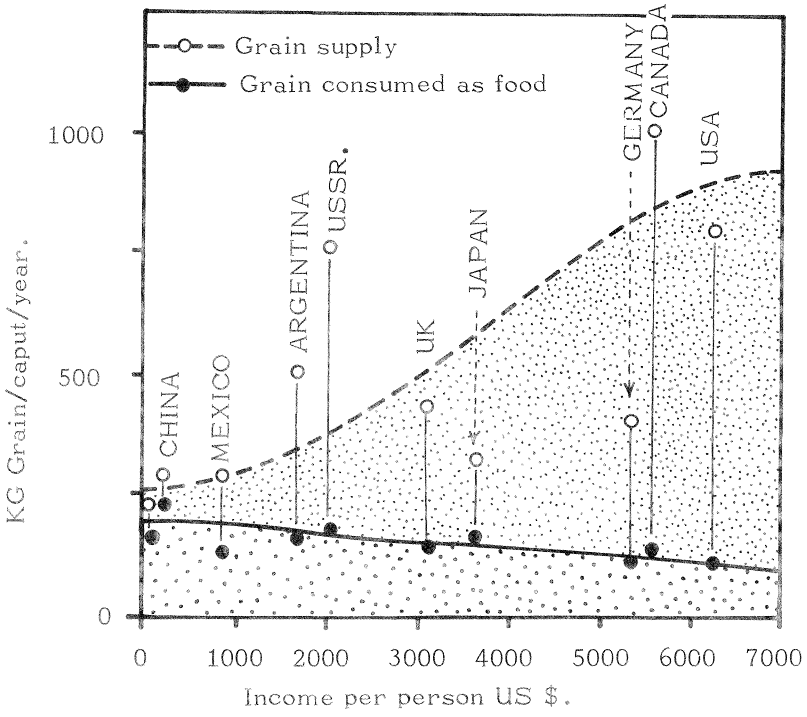


Fig. 3 - Direct and indirect grain consumption by per caput income (Selected countries).

with the support of United Nations Development Program (UNDP) funds, FAO provides expertise in cattle breeding in several countries and fellowships are given to national staff for long or short term studies in animal breeding abroad. Special mention should be given to an artificial insemination project sponsored by the Swedish International Development Authority which makes it possible for FAO to assist member governments in the planning of AI and breeding services and programmes, training staff at various levels and providing frozen semen to their breeding services. Some support can also be given to studies and development of breeds which seem to be of potential use to several countries. This programme has received great interest from member governments. In 1978 a meeting on buffalo reproduction, breeding and AI was arranged in Karnal, India, which took up many issues which are of interest to SABRAO member countries. Donations of bull semen have been made to Burma, India, Malaysia, Nepal, Pakistan, Philippines and Sri Lanka. Similarly planning assistance has been given to several of the SABRAO countries.

Breed evaluation and resource surveys

With funds made available by UNDP, FAO is supporting governmental efforts for breed evaluation in several countries. Often this assistance is directed towards the building up of the infrastructure for evaluating local and imported breeds including the computer facilities and programmes required for the evaluation.

On the global or regional level, special mention should be made of the UNEP-supported survey of trypanotolerant cattle in Africa (ILCA/FAO/UNDP, ILCA = International Livestock Centre for Africa), the survey of prolific sheep and the inventory of rare breeds in special herds and zoological gardens as well as to the FAO International Friesian Strain Comparison Test in Poland and the Red and Red and White Breed Comparison Test in Bulgaria.

Trypanotolerant livestock: Trypanosomiasis is a parasitic disease which occurs in large parts of Africa and forms a major obstacle to livestock production (Figure 4). The disease is transmitted by tsetse flies and is generally fatal if not subject to appropriate treatment. Tsetse occurs in the higher rainfall areas, and thus where the conditions for pasture development and agriculture are relatively good. Certain cattle and small ruminant strains show a remarkable tolerance to trypanosomiasis. A large international campaign has been initiated by FAO to combat trypanosomiasis by a combination of (a) the elimination of the tsetse from areas where this is feasible; (b) by the development and use of chemotherapeutics and (c) the use of trypanotolerant cattle. The prospects for the elimination of the tsetse flies in savannah areas seem reasonably good while in the humid Guinean zone the use of trypanotolerant cattle and/or chemotherapeutics may be the answer. Trypanotolerant cattle, strains which are all of the humpless type, occur in relatively small numbers in the southern parts of West Africa. From a genetic point of view these livestock have been largely neglected, although improvement work has to some extent been made with the N'Dama breed. The nature of their tolerance is only partly known.

Because of the potential usefulness of the trypanotolerant cattle in large parts of Africa, FAO and ILCA initiated a survey of trypanotolerant cattle two years ago. The survey has now been completed and a full report will be published soon. The survey covered 18 countries and concentrated on cattle numbers, breed types, production systems and productivity in different systems and at different levels of tsetse infestation. It also describes the research which has been made or which is under way with cattle and small ruminants in the area. The report ends with proposals for priority research and suggestions of necessary conservation measures.

The trypanotolerant cattle can be divided into two main groups, the N'Dama (with long horns) and the West African Shorthorn. The latter group can be subdivided according to size into Dwarf Shorthorn and Savannah Shorthorn. The N'Dama is the largest group with 3.4 million head or 45 percent of all trypanotolerant

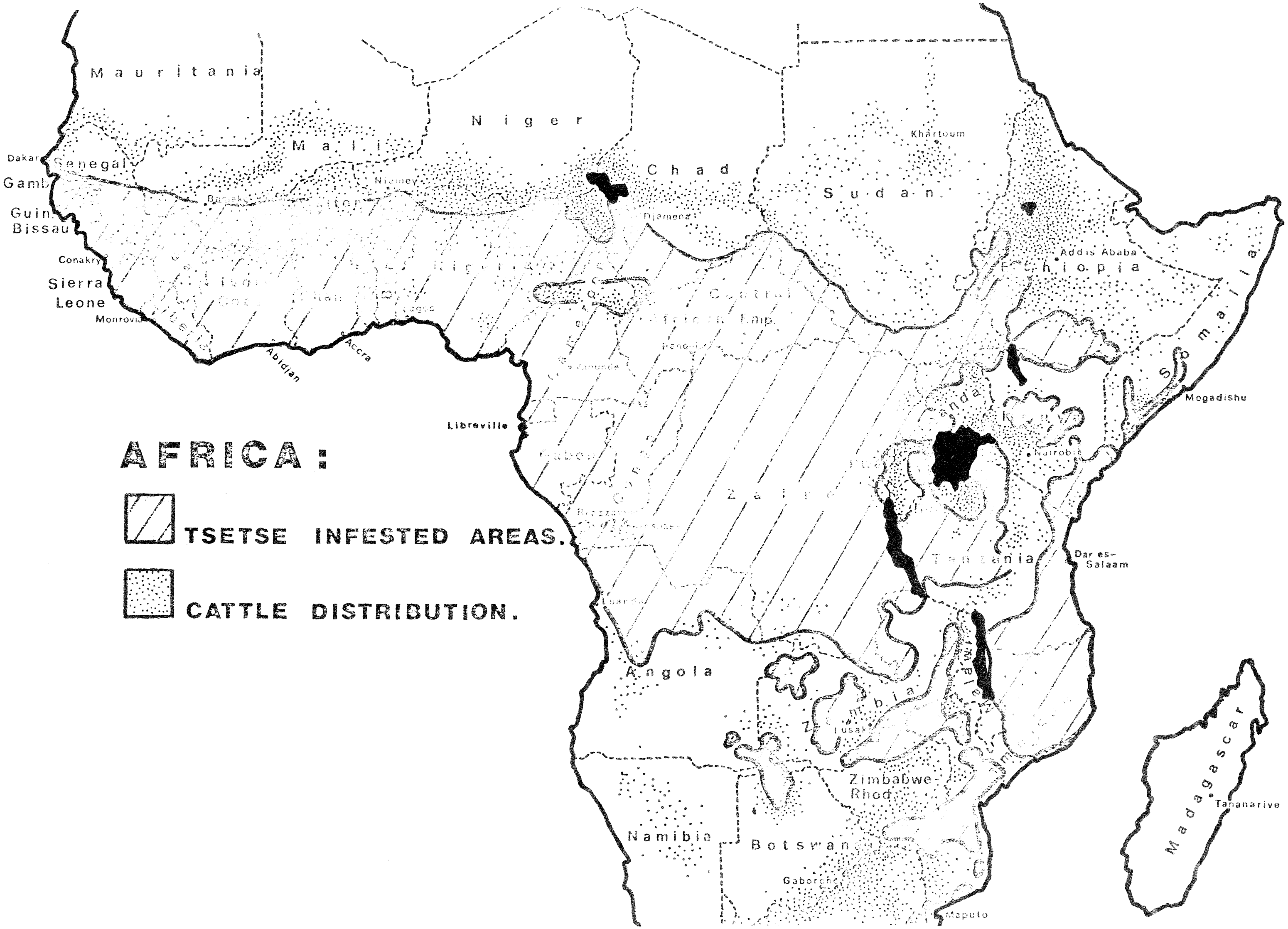


Fig. 4 - Distribution of cattle and tsetse infested areas in Africa.

cattle in West and Central Africa. The West African Shorthorn is next in importance with 1.7 million savannah type and 0.1 million dwarf type or 23 percent of all trypanotolerant cattle. Crossbreds with Zebu make up the rest. The Dwarf Shorthorn which are very small animals with calf weights of about 10 kg, mature weights of about 150-200 kg and wither heights of 85-90 cm, appear to be in danger of extinction or absorption.

The survey went into some considerable detail as to how to measure productivity, particularly as comparisons with Zebu in the tsetse areas are difficult as the latter do not survive. Furthermore the great weight differences between the different types of cattle made direct comparisons of individual productivity meaningless. It was decided to base the comparison on the weight of one-year old calf plus liveweight equivalent of milk produced per 100 kg of cow maintained annually. Least squares analyses of the rather limited amount of data from station and village environments indicated that within stations or villages there were no significant differences in overall productivity between tolerant and non-tolerant livestock, while the differences between the station and village productivities were quite considerable, due to the large differences in management including levels of tsetse challenge (Table 1).

Table 1. Productivity of trypanotolerant and Zebu cattle in three locations under zero, light and medium tsetse challenge

Parameter	Nigeria/ zero challenge/ station management			Ivory Coast/ light challenge/ village management		Central African Empire/medium challenge/village management	
	N'Dama (T)[b]	Shorthorn (T)	Zebu (NT)	Shorthorn (T)	Zebu (NT)	Shorthorn (T)	Zebu (NT)
Cow viability (%)	100	100	100	98	96	96	95
Calving percentage	100	96	91	70	72	68	63
Calf viability to 1 year (%)	97	95	100	55	60	80	65
Calf weight at 1 yr (kg)	131	101	200	75	90	90	120
Annual milked out yield (kg)	-	-	-	70	144	-	71
Productivity index[a] per cow per year (kg)	128	92	181	36.9	55.4	50.0	58.1
Cow weight (kg)	266	183	343	200	270	190	320
Productivity index[a] per 100 kg cow maintained per year (kg)	48.1	50.2	52.8	18.5	20.5	26.3	18.2

a Total weight of one year-old calf plus liveweight equivalent of milk produced
b T = trypanotolerant, NT = non-typanotolerant

Source: ILCA/FAO/UNEP, 1979

Trypanotolerance is not limited to cattle. The small West African sheep found all over West Africa south of the 14^{o} parallel evidently show a high level of tolerance. The same applies to the Dwarf goat occupying the same area. Much more research is required both in cattle and small ruminants on the biological nature of trypanotolerance and on the productivity of different strains under different production systems and varying levels of tsetse challenge. ILCA is taking the lead in trying to get this research under way in cooperation with national institutions and bilateral and international aid organizations. FAO on its side is trying to utilize the information so far obtained in improvement programmes in cooperation with the governmental organization concerned.

Prolific tropical sheep: Prolificacy can be a great advantage in production systems with good availability of feed and possibilities for intensive care of the young lambs. As there have been a rather large number of vague statements of prolificacy in some tropical sheep strains, FAO, with the support of UNEP, recently undertook a survey of sheep prolificacy under the leadership of I.L. Mason. The report is in the final stages of preparation. Several claims of prolificacy could not be substantiated while others were verified. Some information on the prolific breeds identified is given in Table 2 along with data on known prolific breeds in Europe and China. The Barbados Blackbelly sheep is of considerable interest. This breed evidently originates from West Africa where strains of similar sheep exist, although they are not characterized by high prolificacy. Strains of hair sheep of obvious West African type occur in several other places in the Caribbean area, all with ordinary levels of prolificacy. The high prolificacy in the Barbados Blackbelly therefore may well have been developed in the island through selection. Mason points out that there is a common thread linking all the prolific breeds, namely in the way they are kept. All these breeds are kept in small flocks in agricultural areas; none is a range sheep. In Barbados, the flock size is 5-10 sheep; they are usually tethered. In Java each farmer owns 3-5 sheep; they graze by day and are

Table 2. Reproductive performance of prolific breeds - ranges between different flocks, populations and years

Breed	Country	Age at first oestrus (months)	Age at first lambing (months)	Lambing interval (months)	Litter size	
					First lambing	Later lambing
Barbados Blackbelly	Barbados		14-22	6-9	2-2.3	
" "	Elsewhere	5-8		6.5-9	1.5-2.0	
White Virgin Island			13-14	6-8	1-2	
Priangan	Indonesia	6-12		6-9	1.4-2.1	
East Javanese Fat-tailed	"					
D'man	Morocco		12-18	6-7	1.6-2.0	1.8-2.7
Han-yang	China				2	
Hu-yang	"		13-16	6-8	2	
Svanka	U.S.S.R.			6+	2-4	
Chios	Greece		13+	6-12		2.3
Finish Landrace	Finland	7-8		7-12	1.9	2.7
" "	Elsewhere	5-10		7-10	1.5-2.2	2-3.2
Romanov	U.S.S.R.	7-18			2.1-2.7	
Romanov	France	6-8				2.6-3.3

Source: FAO/UNEP, 1980

brought back at night into pens near the houses where they are fed. In Morocco the D'man sheep are found in the pre-Saharan oases where they are kept in small groups of 1-3 ewes which are almost permanently housed; in the rest of the country sheep are herded in large flocks. The two Chinese breeds are in the agricultural areas of the east and well away from the range areas of the north and west. The Hu-yang are kept throughout the year in small sheds attached to the homesteads. In Greece the prolific breeds all originated on islands where they are kept on a family scale. Most of the Skopelos and Kymi sheep are kept in flocks of 2-6; they are grazed by day and brought home at night. Sakiz (Chios) sheep in Turkey are kept in groups of 2-4 animals. During most of the year they are fed in fruit and vegetable gardens; in winter they are kept and fed in simple stalls. In Finland the pasture season is only 4-5 months and for the rest of the year sheep are kept and fed indoors; 85 percent of flocks have only 1-4 adult sheep (Goot, 1973).

It would appear that keeping these sheep in close association with the household has made possible the careful observation which is needed to make selection effective, especially if it is done by eye and memory rather than on the basis of written records. The various aspects of fertility in sheep have a reputation for low heritability. However, Turner and Young (1969) have shown that if the selection is on number of lambs per ewe lambing (rather than overall lambing rate including barren ewes) and if first lambings are considered separately from later lambings, heritability can be considerably higher.

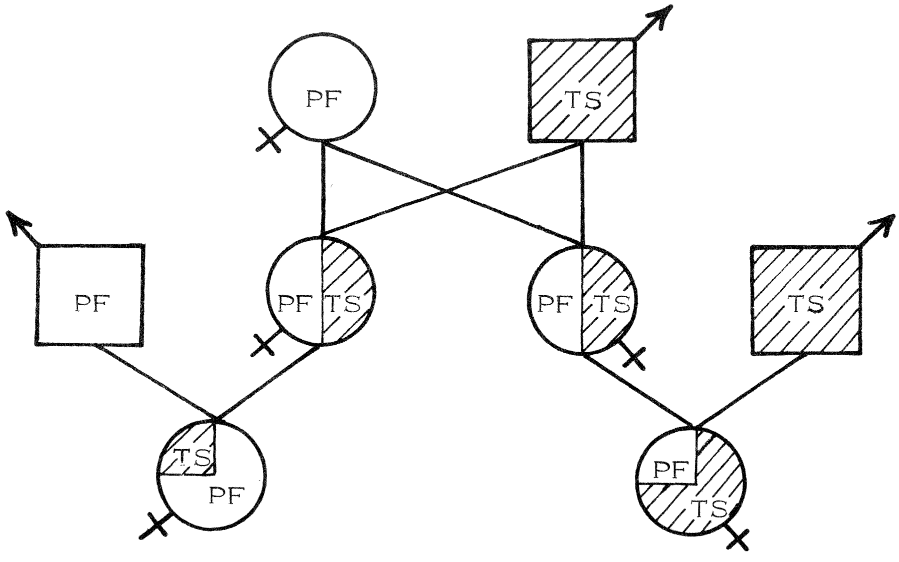
Furthermore high prolificacy seems to be one of a group of related reproductive characters which are shared by the prolific breeds, namely early sexual maturity, absence of lactation anoestrus, high libido in males, high conception rate. The common factor linking them would appear to be high level of gonadotropic hormone or sensitivity to it.

Inventory of special herds and flocks of farm animals: In several countries, particularly in the industrialized ones, it has become more and more common to keep small herds or flocks of farm animals in zoos and parks so as to allow the urban public to have a chance to see farm animals. Often these parks and zoos have concentrated on old local breeds. In some cases special herds or flocks have been established for the mere purpose of conserving historically important or interesting breeds. From a genetic resources point of view these special herds and flocks are of great interest and FAO with UNEP support is currently undertaking an inventory of them under the leadership of I.L. Mason. So far, 34 countries have contributed information of which 6 belong to Asia and Oceania. The inventory, which also covers populations of feral farm animals and of close relatives to farm animals, gives contact addresses in various countries. The report will most likely be sent around to interested people and organizations in mimeographed form with a request to give additional information. In this way it is hoped to build up gradually a more complete register, at the same time making known currently available information which will facilitate direct contacts between people concerned in different countries.

The International Friesian Cattle Strain Comparison Project in Poland: The Friesian cattle is the world's most important dairy breed. It is divided into many country strains some of which have been kept fairly separate and have been subject to different levels of selection and management. Since there is a large demand for Friesian semen, several efforts have been made by countries and professional societies to organize strain comparisons. Through the intervention of Professor H.A. Jasiorowski of Poland, then Director of the Animal Production and Health Division, FAO, it became possible to utilize the large governmental Friesian herds in northern Poland for a Friesian strain comparison test under the auspices of FAO, the direct leadership of the Polish authority concerned and the guidance of a Technical Advisory Committee with specialists from the participating countries. In addition to Polish Friesian, strains from the following countries are included: USA, Canada, Denmark, UK, Sweden, Federal Republic of Germany, Netherlands, Israel and New Zealand. The principle is that each participating country makes available semen from a random sample of the young bulls entering the recognized national AI schemes and that this semen is used on Polish Friesian cows to produce F_1 heifers from each strain and later on for the production of back crosses to the paternal strain and Polish bulls (Figure 5). Contemporary comparisons are made between the

Fig.5

BREEDING PLAN IN THE POLISH FRIESIAN STRAIN COMPARISON.



PF: POLISH FRIESIAN.
TS: TESTED STRAIN.

Fig. 5 - Breeding plan in the Polish Friesian strains comparison.

various crosses and purebred Polish animals. A large number of production characteristics is recorded including growth rate of bull calves up to 450 and 550 kg, milk production of heifers in the ordinary herds and in special stations, viability, fertility and body measurements. The insemination of the foundation cows was completed in 1976 and of the F_1 heifers and F_1 cows in 1978. Each country agreed to send between 225 and 250 doses of semen from 40 bulls, i.e. a total of 9,000-10,000 doses per country or 80-90 thousand doses for the whole project. The total number of pregnancies of Polish cows produced in the project was 26,524 while 6,029 F_1 heifers and cows have been impregnated. The production and performance data are treated according to statistical models worked out by specialists within the Technical Advisory Committee. The first results will be published very soon in FAO's World Animal Review.

A similar project, although on a slightly smaller scale, is under way in Bulgaria for European Red and Red and White cattle with participation from Bulgaria, Denmark, Federal Republic of Germany, Finland, Norway, Sweden, USSR (Estonia) and Canada. The latter country contributes semen from Red Friesian bulls with close relatives in the Polish project thereby linking the two projects together (Hinkowski, Alexiev, Lindhe and Hickman, 1979).

PRIORITIES FOR THE IMMEDIATE FUTURE

In earlier sections of this paper some of the activities of FAO have been mentioned and discussed. It should be clear to everyone that the problems of animal genetic resources management and conservation are manifold and complex and that most of the action will have to be national or possibly regional or sub-regional. Several countries have established national committees or boards to handle the matter; this is, for instance, the case in India where an All-India Animal Genetic Resources Office has been established. Hopefully more activities of this kind will be revealed during the course of this meeting.

In the case of Asia and Oceania, with which this meeting is mainly concerned, there is a pronounced general dearth of information on the animal genetic resources in most of the countries and on species. However, two species come automatically to mind, namely the goat which is a major meat supplier and the water buffalo which is the major farm animal in several countries. The water buffalo is conveniently divided into the river type, of the Indo-Pakistan sub-continent and of areas west thereof, which supplies milk, meat and work, and the swamp buffalo of East Asia, which is the major work animal in the area and also contributes large amounts of meat. There are several strains and breeds within each of the two major types. However, virtually nothing is known about their relative merits.

Dr. P. Mahadevan of FAO, acting as a consultant to the Technical Advisory Committee of the Consultative Group on International Agricultural Research (CGIAR), proposed recently an international buffalo research project which included, among others, as one of the areas for priority research, a comparison of different buffalo dairy strains similar to the Friesian strain comparison referred to earlier. Unfortunately funds for this project have not yet materialized, although there are reasonable prospects that the reproduction and nutrition part of the project will attract donor contributions. The strain comparison part might be something in which SABRAO could get itself actively involved.

Another question which needs priority attention particularly in Asia and Oceania is the place of livestock in general as well as specific species and strains in existing and future feasible agricultural production systems. Due to the human population pressure in many areas, fertile land will continue to be used mainly for the production of human food. Animals adapted to utilizing mainly crop residues and by-products will thus be required. The balance between the feed resource, the animal genetic resource, climate and economic environment has often been neglected in previous research and livestock development.

In order to promote work on animal genetic resources management and conservation, FAO will arrange a technical Consultation on the subject in Rome from 2 to 6 June 1980, which will analyze the major technical and organizational aspects and issues. Hopefully SABRAO and its member countries will take an active part in that Consultation.

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Discussion

Mukherjee: In the buffalo evaluation program, do you not think that there may be problems due to the tremendous environmental variation when semen is collected from sires in different countries whose environments may be quite different?

Rendel: Naturally there will probably be some initial problems, but I do not think that what you mention will be one of them. The point is that while the semen will indeed be collected from bulls in each of the different countries of origin of the strains to be tested, all that semen will then be sent to one place to be used in one herd. Evaluation of the strains will be on the performance of the progeny produced, with all tested in the one environment.

Of course, the relative performance of the strains in that one environment may not indicate their ranking in some other environment. Ideally, then, the comparisons should be done in a number of different environments.

Suntraporn: I consider that we should strongly support a buffalo strain comparison done in a way similar to the black and white cattle evaluation in Poland. The results would be extremely useful to all countries in the SABRAO region.

In Thailand, we would like to test different breeds of milk buffalo, but we could not afford to do so. We have chosen to test only the Murrah in a crossbreeding experiment with our native buffalo.

With regards to testing native livestock, we must explore their characteristics very thoroughly. For example, in our cattle upgrading program, the crossbreds are performing better than the native cattle for weight gains. However, we don't know if they really are better in the low-input environment of the villages. It may still be that the crossbreds are better per animal, but that the native cattle will be better when production is expressed per hectare.

Watanabe: Would you explain the genetic basis of the trypanosome tolerant characteristic?

Rendel: Surprisingly, this is not yet well understood. Some data indicate that trypano-tolerant animals are able to produce antibodies fast enough to keep pace with the continuous changes in the antigenic characteristics of the trypanosome, while the non-tolerant animals are slower antibody producers. This characteristic seems to be genetically controlled, but more research is needed.

Turner: I have heard it said that if trypanosomiasis were to be eliminated from the tse-tse belt in Africa, the result will be over-stocking, over-population and destruction of the environment. Would you care to comment on this?

Rendel: I agree this point has been made, and that it is a potential problem. However, FAO in its tse-tse and trypanosomiasis control program is putting a major effort into area development as a part of the total program. In this way, and particularly as the control program clearly will continue over a number of years, the problem you mention should be minimized.

5. COUNTRY REPORTS

ANIMAL GENETIC RESOURCES IN AUSTRALIA

Helen Newton Turner

I. INTRODUCTION

Australian domestic livestock species have all been introduced from 1788 onwards. They and their main products consist of sheep (wool, meat, skins), cattle (milk, meat, skins), goats (milk, fibre, meat, skins) and poultry (eggs, meat). Horses, once used intensively for draught or for moving sheep and cattle, have been largely replaced by lorries, tractors, motor bicycles and even aircraft, except in northern areas, where they are still used for mustering. Horses are popular now for recreation, including riding and racing, but will not be discussed.

Feral goats, buffalo, pigs, camels and donkeys exist. Goats are harvested for meat, and their value for re-domestication as meat animals is under investigation; they are also used for crossing with Angoras in mohair production, and may provide a source of cashmere. Buffalo are harvested for meat on a small scale, and their value for re-domestication is also being examined. Feral pigs are sometimes consumed privately on individual properties, but are not used commercially. Feral camels and donkeys are not exploited.

Among wild animals, the kangaroo is harvested in some places; its meat is used only for pet food, but skins are an important by-product.

Livestock owners are required to furnish annual returns to the Australian Bureau of Statistics (ABS), which publishes an annual bulletin "Livestock Statistics", based on these census data. The bulletin gives numbers of livestock and total production for the main commodities. Every third year sheep are classified by breed; no such classification is published at present for other species in Australia as a whole, but ABS is planning to collect data on cattle breeds at regular intervals in the future. Details of total numbers for each species at 31/3/78 are in Table 1; the data for 1979 are not yet analysed. Production details are given in the sections for individual species.

The regions from which data are available are listed in the various tables which present the production records. Environmental details for those regions are summarized in Appendix 1.

Production is influenced by both heredity and environment, so that the relative genetic values of breeds, strains or individuals cannot be accurately assessed unless they are run together in the same environment, or compared with some standard genetic group when in the same environment. One might therefore query the value of tabulating production records gathered from a number of areas. The object of this Workshop, however, is to encourage the collection of production records where none exist, and to encourage their collection in some systematic form. Allied to the collection must be a statement of where the data were collected.

This Australian paper does not claim to be a complete survey, but to give an indication of production levels. Ranges are given to indicate how widely figures can vary. The ranges are of reported means, not of individuals, and with sheep and cattle, which in Australia are usually grass-fed, only figures for animals under grazing have been used. Heavily supplemented individual rams, for example, might occasionally produce up to 18-22 kg of greasy wool, but these figures do not appear. In examining the data, the effect of environment and management must always be remembered.

Australia, as much as anyone else, needs more information on the performance of breeds and strains; there are many gaps in our knowledge.

Table 1. Total numbers of livestock in Australia at 31/3/78 ('000)

Species	QLD.	N.S.W.	VIC.	S.A.	W.A.	TAS.	N.T.	A.C.T.	Australia
Sheep	13,438	48,000	22,021	14,073	29,820	3,969	1	119	131,442
Cattle:									
Milk	432	544	1,609	169	134	175	-	-	3,065
Meat	3,568	1,181	584	176	485	106	362	2	6,463
Pigs	463	739	401	311	237	64	3	-	2,219
Poultry:									
Hens:Eggs	2,485	5,917	3,993	1,448	1,271	264	n.p.	150	15,527(a)
:Meat	3,166	12,470	5,695	2,715	2,729	308	n.p.	-	27,084(a)
Ducks	4	129	16	9	3	2	-	-	163
Turkeys	1	298	15	7	1	1	-	-	322
Other	184	23	90	22	5	9	-	-	331

Source: Australian Bureau of Statistics, Livestock Statistics 31/3/78.

n.p. not available separately (a) incomplete

We also need to be reminded of the need for systematizing data collection and reporting. "Feed efficiency", for example, is sometimes reported as production per unit of feed, sometimes as feed per unit of product. The former seems preferable for two reasons: firstly, a higher value indicates better performance (compared with a lower value by the latter method), and secondly, there are no problems about zero in the denominator. In estimating efficiency of feed conversion for beef cattle, what happens with a group which fails to gain weight? Or with a group of hens which produce no eggs? With product/feed, there are no difficulties; with feed/product, there are.

Many Australian colleagues, in State and Commonwealth Departments, Universities and CSIRO, have helped with information. They are too numerous to name, but I thank them all warmly.

II. SPECIES AND BREEDS

A. Sheep

1. Background

Figure 1 outlines the areas of Australia in which sheep are grown. The total numbers of sheep in each local government area or statistical division are published annually by the Australian Bureau of Statistics in a series of bulletins, one for each State.

Table 2 gives the numbers of each breed in Australia in 1965 and 1974, and in each State in 1977. In that year, breed statistics were not collected in Queensland and Northern Territory; two percentages of the total are shown for each breed, one based on totals excluding those States, and the other on the grand total, assuming all sheep in Queensland to be Merino. N.T. contained only 1,000 sheep, and was ignored.

As Table 2 shows, approximately 95% of sheep in Australia are Merino or part Merino.

The Merino breed, however, is not an entity; it consists of a number of genetically different strains, which are broadly classified as fine, medium and strong. Recent writers, such as Hogan et al. (1979) subdivide the fine into those of Saxon and Spanish origin, and identify three different strong wool strains, but the three main classifications are used here, as the literature reviewed does not always make the subdivision.

Until recently the classification into fine, medium and strong was based on number of crimps per inch, but with the advent of sale of wool on measured sample, there is a move towards classification on measured fibre diameter. Table 3 shows the percentage of wool of each micron sold in Australia in the 1977-8 selling season.

There are no statistics available of the numbers of sheep in each strain, but as shown by Table 3, 18.5 percent of Australian wool sold in 1977-8 was of 20 microns or finer, 55.4 percent was of 21-23 microns, and 26.1 percent was of 24 microns or coarser, about 10 percent being over 27 microns.

Table 4 gives a general description of each sheep breed in Australia, listed according to the schedule drawn up before the Workshop.

Products from sheep in Australia are wool, meat and skins, the last being mainly a by-product from the meat industry. No sheep's milk is marketed raw, but a very small quantity of sheep's milk cheese is produced. Sheep's manure is used within one property when animals are grazed on crops or stubble, but there

Fig. 1 - Sheep areas of Australia.

Table 2. Numbers of sheep of each breed in Australia ('000)

Year	Merino	Corriedale	Polwarth	Border Leicester	Dorset Horn	Other	Merino Comeback *	Crossbreds **	Total
1965	129,754	10,641	3,484	2,600	1,130	1,732	4,364	16,917	170,621
1974	110,142	5,845	3,037	1,757	1,152	3,810	3,982	15,450	145,175
1977									
N.S.W.	38,273	1,321	257	742	466	484	742	7,416	49,700
Vic.	11,973	2,419	627	782	390	686	1,031	4,017	21,925
S.A.	13,174	557	120	109	46	119	74	934	15,132
W.A.	27,652	421	84	540	84	1,719	111	538	31,149
Tas.	419	494	1,685	47	26	402	509	433	4,015
A.C.T.	93	-	1	1	1	6	4	18	124
Australia(i)	91,585	5,212	2,774	2,220	1,012	3,415	2,470	13,357	122,045
(ii)									135,350
% Australian									
Total : 1965	76.0	6.2	2.0	1.5	0.7	1.0	2.6	9.9	
1974	75.9	4.0	2.1	1.2	0.8	2.6	2.7	10.6	
1977(a)	75.0	4.3	2.3	1.8	0.8	2.8	2.0	10.9	
(b)	77.5	3.8	2.0	1.6	0.7	2.5	1.8	9.9	

Source: Australian Bureau of Statistics, Livestock Statistics 31/3/77.

* Finer than half-breed ** Including half-breed Merino and coarser

(i) Excluding Queensland and N.T. (ii) All Australia

(a) Percent of Australian total excluding Queensland and Northern Territory

(b) Percent of all Australian total, assuming Queensland all Merino. N.T. had only 1,000 sheep in total, and was ignored.

Table 3. Greasy wool sold at auction in Australia.
Percent of total in each mean micron class 1977-8 selling season

Mean Micron	QLD.	N.S.W.	VIC.	S.A.	W.A.	TAS.	Australia
20 or finer	12.3	22.9	18.2	6.0	26.2	6.4	18.5
21	30.6	21.9	16.6	18.3	31.3	11.2	22.2
22	32.2	20.3	14.5	25.9	21.0	14.3	20.3
23	15.9	12.6	10.1	22.7	9.7	12.9	12.9
24	4.2	4.4	7.0	11.9	3.2	12.4	6.1
25	1.0	1.7	4.8	5.6	1.8	11.7	3.4
26	0.9	2.4	5.2	3.1	0.9	6.0	3.0
27	0.3	2.7	5.6	2.1	0.8	6.5	3.0
28	0.2	3.0	5.1	1.2	0.8	3.8	2.7
29	-	0.3	0.2	-	-	0.3	0.2
30	0.3	4.2	7.6	1.6	0.6	7.8	3.9
33 or coarser	0.1	2.6	3.7	0.7	0.2	4.6	2.0
oddments	2.1	1.0	1.4	1.8	3.5	2.1	1.8
Total	100	100	100	100	100	100	100

Source: Australian Wool Corporation

Table 4. General description of sheep breeds in Australia

Characteristic	Breeds	Description
Coat type	All	Woolled, except for one small flock of Wiltshire Horn, which grows a fleece and sheds it annually. Crosses with it are under investigation (e.g. Pascoe et al. 1976)
Medullation	Merino	Almost completely absent
	Others	Small amounts in some, but no figures- not a problem
	Carpet wool breeds	Small flocks now being grown, based on rams from NZ carpet breeds - fleeces medullated
Colour	Suffolk and Hampshire	Pigmented faces and points; fleece white
	All others	Flocks mostly white, with pigmented lambs occasionally born, which up till recently have been slaughtered. Now there is a fashion for naturally pigmented wool, and 330 small flocks of pigmented sheep have been established. Proceedings of a National Congress on Breeding Coloured Sheep held in February 1979 are available (National Congress 1979)
Tail	All	Medium length, thin (normally docked after lambing)
Horns	Merino	Rams: Some coiled, some polled (hornless) (polled flocks have been developed) Ewes: Some small straight horns, some polled
	Corriedale	Rams: Polled Ewes: Polled
	Polwarth	Rams: Polled Ewes: Polled
	Dorset	Rams: Some flocks with heavy coiled horns, some polled Ewes: Ditto
	Border Leicester	Rams: Polled Ewes: Polled
	Border Leicester x Merino	Rams: Polled Ewes: Polled

is no hiring of sheep to manure fields, and no use of dung for fuel.

The characteristics important for wool production are greasy wool weight per head, percent clean yield, average fibre diameter and staple length. Those important for meat production are number of lambs, amount of lean meat and lamb growth rate. Number of lambs is also important in producing wool, as a higher lambing percentage means greater selection pressure when choosing breeding stock. Further, meat is becoming more important in Australia even on wool-growing properties.

The characteristics whose records will be discussed are therefore:

Greasy and clean fleece weight
Percent clean yield
Average fibre diameter
Lambing percentage (defined as lambs born, marked or weaned per 100 ewes exposed to the ram: called here 'joined')
Body weight : at weaning
at 12-18 months
adult

Because amount of lean meat can only be measured accurately after slaughter, body weight is used in its place; it has been shown to be a good indicator of amount of lean meat (Tallis et al. 1964, Searle and Griffiths 1976).

The schedule of required data drawn up before the Workshop asked for wool production and body weight data for sexes separately, and for reproduction data by age of ewe. It has not been possible to present extensive data for rams as well as ewes, so figures for ewes are given, with subsidiary data on rams where available.

Similarly, it was not always possible to separate reproduction data according to age of ewe, and average figures have been given. The criteria asked for have been slightly modified to suit the figures as published in Australia. Percentage of ewes lambing is given instead of ewes failing to lamb, while average litter sizes at birth and weaning have been changed to number of lambs born and weaned per ewe joined (put to the ram).

Information on variation in the ewe's sexual activity through the year is needed to plan the best mating times, or to decide whether lambing frequency can be increased. Some breeds developed at high latitudes are known to have short, sharply-defined breeding seasons, while there are traditional statements that ewes of breeds from tropical regions are in season all the year. Such statements are sometimes based on the observation that lambs are seen in all months of the year when rams are run continually with the flock. Observations of this kind, however, are not conclusive; more definitive records are needed of the proportions of ewes in oestrus or ovulating throughout the year, or of the performance of individual ewes. For this reason, the source of information on length of breeding season was asked for in the pre-workshop schedule.

Australian information is based on proportions of a flock in oestrus, or ovulating through the year.

2. Overall production data from official statistics

The returns submitted by individual owners each year permit estimates to be made of mean greasy wool weight per head and lambs marked/100 ewes joined for various regions. Lambs in Australia are usually born under extensive conditions, with a minimum of attention, and are first counted at the end of the lambing period, when their tails are docked and ears marked with the owner's sign. The lamb-marking count of course excludes the usually unknown number of lambs which die between birth and marking, but is the only figure widely available (except in experimental work).

Estimates of percent clean yield in different regions are available from wool-selling organizations, so that mean clean wool weights per head can be obtained.

From official statistics, Brown and Williams (1970) produced maps of mean clean fleece weights per head and average lamb-marking percentages in different parts of Australia, for the years 1960-65. These means are over all sheep, and cannot be separated according to breed or strain, but they can be used to demonstrate marked regional differences.

The clean fleece weight map showed a trend in the eastern States (Queensland, N.S.W. and Victoria) and in W.A. from 1.8-2.0 kg in the semi-arid north to 2.7-3.1 kg in the south, with pockets of 3.2 kg or higher in S.A. (home of the large S.A. strong-wool Merino) and a small part of southern W.A.

More recent figures on greasy fleece weights per head and percent clean yields are given in Tables 5 and 6, taken from official statistics and from reports of the Australian Wool Corporation. Table 5 gives the average greasy fleece weight per head in Australia for each of the last 10 years, showing there have been fluctuations but no trend. Table 6 gives average greasy weights per head and yields in the various States for 1977-78. Brown and Williams' map of lamb-marking percentages showed a strong north-south trend, from 20-40 in the north to over 90 percent in the extreme south of Victoria and in Tasmania. Some more recent figures (Table 7) show the same trend, W.A. having always the lowest and Tasmania the highest percentage.

Australia has at present no central performance recording system for sheep which would yield figures similar to those from the Meat and Livestock Corporation in the U.K. or from Sheeplan in N.Z. Production figures have been drawn together from a number of sources, however, and some current or future performance recording schemes are discussed in Appendix 2.

3. Production data for Merinos

(i) General routine: Sheep in Australia are shorn once a year. The time of shearing varies, as the work is done by mobile teams. Lambs are usually shorn first just after weaning, though in some areas this shearing is omitted.

Mating for Merinos is also once a year, the time again varying in different parts of the country. Occasionally there is a second mating six months after the first, if numbers are being re-built after drought losses, but only those ewes which failed to rear a lamb after the first mating are expected to lamb at the second.

The first mating for Merino ewes is usually at 1½ years, though in a few areas it is delayed to 2½ years because of slow growth. Ewes are often cast-for-age after rearing their lambs born at 5 or 6 years of age, but in areas of low lambing percentages are kept longer.

(ii) Wool production: The wool production data given in Table 8 are for ewes aged 15-18 months, before they have entered the breeding flock. Production is of course influenced by age (for review see Turner and Young 1969). Clean wool weight is up to 12 percent higher at 3½ years than at 1½, and then declines, while staple length declines steadily from 1½ years onward. Average fibre diameter increases only very slightly up to 6½ years, and then declines (Turner and Young 1969).

Data for rams are not so extensive. A few figures for rams and the corresponding ewes (that is, born at the same time and run on the same property, but in different paddocks) are in Table 9. Changes with age exist for rams, as well as for ewes. Greasy fleece weight increases with age but percent clean yield falls, while diameter increases steadily with age, rams at 5½ years having an average diameter as much as 15 percent higher than at 1½ years. Length falls steadily from 1½ years (Turner and Young 1969).

Table 5. Average greasy fleece weight per head (kg - Sheep + lambs)

Year	Greasy fleece weight
1969 - 70	4.35
1970 - 71	4.18
1971 - 72	4.23
1972 - 73	4.14
1973 - 74	4.28
1974 - 75	4.48
1975 - 76	4.27
1976 - 77	4.28
1977 - 78	4.22
1978 - 79	4.30
Overall Mean	4.27
Range	4.14-4.48

Source: Australian Bureau of Statistics

Table 6. Average greasy fleece weight per head (kg - Sheep + lambs), and percent clean yield, 1977-78 season

Characteristic	QLD.	N.S.W.	VIC.	S.A.	W.A.	TAS.	Australia
Greasy fleece wt/hd	4.20	4.20	3.88	4.96	4.19	4.00	4.22
Percent clean yield	61.7	64.2	65.0	59.0	59.5	69.4	62.3

Source: Australian Bureau of Statistics and Australian Wool Corporation

Table 7. Percentage of lambs marked to ewes mated (by States)

Year	QLD.	N.S.W.	VIC.	S.A.	W.A.	TAS.	A.C.T.	Australia
1973 - 4	60.1	74.5	82.8	77.2	65.0	88.7	73.9	73.2
1974 - 5	56.1	77.6	83.1	81.4	70.5	89.2	76.3	75.9
1975 - 6	45.5	74.1	80.6	78.2	70.6	90.3	76.9	72.9
1976 - 7	44.9	69.3	68.7	68.2	65.0	84.0	64.6	66.2
1977 - 8	50.0	75.9	79.1	68.7	59.1	91.4	78.6	69.8

Source: Australian Bureau of Statistics, Livestock Statistics 31/3/78

Table 8. Wool production data for Merino strains - Ewes aged 15-18 m (12 months' growth)

Merino strain	Greasy fleece weight (kg)	Percent clean yield (%)	Clean fleece weight (kg)	Average fibre diameter (microns)	Staple length (cm)	Range of environments	Authors *
Fine	2.8-5.1	57-68	2.0-3.4	19.6-20.3	8.1-8.9	QLD : S.W. N.S.W.: N. and S. Tablelands VIC : Western District	3 : 5 : 8 9
Medium	3.5-6.0	58-71	2.5-4.2	20.3-23.0	8.3-10.2	QLD : S.W. N.S.W.: N. Tablelands : South and West VIC : Western District	1 : 2 : 3 6 : 9 : 10 11 : 12
Strong	4.2-6.6	60-75	3.2-4.4	23.1-28.5	8.9-11.9	QLD : S.W. N.S.W.: N. Tablelands : South and West S. Australia	2 : 3 : 4 7 : 12

* Numbers are given separately for each table, and refer to all data for a strain

1. Drinan (1968); 2. Dun and Hayward (1962); 3. Dunlop (1962); 4. Geytenbeek et al. (1962); 5. Kennedy and Kennedy (1968); 6. McGuirk et al. (1978); 7. Mayo et al. (1969); 8. Mullaney (1966); 9. Mullaney et al. (1969); 10. Mullaney and Sanderson (1970); 11. Turner and Jackson (1978); 12. Woolaston and Roberts (1976).

Table 9. Wool production data for Merino strains - Rams and Ewes aged 15 - 16 months (12 months' growth)

Merino strain and sex	Greasy fleece weight (kg)	Percent clean yield (%)	Clean fleece weight (kg)	Average fibre diameter (microns)	Staple length (cm)	Environment	Authors *
Medium: Ewes	3.8	63	2.4	20	8.7	Qld: S.W.	2
: Rams	4.9	57	2.7	20	8.9		
Strong: Ewes	5.5	64	3.5	25	11.7	S. Australia	1
: Rams	6.6	61	4.0	26	11.9		

* Numbers are given separately for each table

1. Mayo et al. (1969); 2. Turner and Young (1969).

(iii) Reproduction rate: The reproduction data in Table 10 are for mixed-aged ewes, because it was not always possible to separate ages in the literature under review. There is a relationship between reproduction rate and age; all aspects of reproduction rise with age from the first lambing at 2 years, and then decline more slowly, the peak being from 5-7 years, for number of lambs weaned. The percentage of multiple births shows very little decline even after 6 years of age (for review see Turner 1969).

No figures in Table 10 were obtained in areas of extreme environments, where productivity is lower. Sheep grazing on oestrogenic pastures, for example, have a lowered reproduction rate. Walker et al. (1979) give figures for strong wool lambs born per 100 ewes joined on Kangaroo Island, S.A., ranging from 36-75, compared with 72-114 in Table 10. Rose (1972) showed that in the hot, dry environment of north-west Queensland medium-wool ewes at their peak age of 6 years bore only 63 lambs per 100 ewes joined, compared with the averages over all ages of 74-115 in Table 10.

Data on length of the breeding season for Australian Merino ewes are in Table 11.

(iv) Body weights: Data for body weights of Merino ewes are in Table 12, and comparable data for rams and ewes in Table 13. The latter are from the flocks whose wool data are in Table 9.

4. Production data for other breeds

(i) General routine: The general routine for other breeds is similar to that for Merinos, except that Dorsets reach puberty earlier and are sometimes mated at about 8 months of age.

(ii) Production data are given in Tables 14-17. There are not as many observations as for Merinos, and some breeds have none. The first-cross Border Leicester x Merino has been included because of its widespread use as a dam in lamb production.

5. Meat production

Table 18 gives the numbers of sheep and lambs slaughtered, and the quantity of mutton and lamb produced, for a series of years. Average carcase weights have been calculated from the total numbers in the official statistics.

Table 10. Reproduction data - Merino strains - Ewes of mixed ages

Strain	Ewes lambing per 100 ewes joined	Ewes with multiple births per 100 ewes joined	Lambs born per 100 ewes joined	Lambs weaned per 100 ewes joined	Range of Environments	Authors *
Fine	89-91	0-10	74-99	53-84	QLD. : S.W. N.S.W.: N. & S. Tablelands : South VIC. : West. District	1 : 4 : 5 9 : 10 : 12
Medium	61-99	11-28	74-115	52-96	QLD. : S.W. N.S.W.: N. Tablelands : S.W. Slopes : West & South TAS.	2 : 3 : 4 5 : 6 : 7 11 : 14
Medium selected (Booroola)	90	71	202-210	102-139	N.S.W.: N. Tablelands	13
Strong	73-93	9-31	72-114	54-101	QLD. : S.W. N.S.W.: N. Tablelands : West & South S.A.	2 : 3 : 4 5 : 8

* Numbers are given separately for each table

1. Barrett (1956); 2. Dun *et al*. (1966); 3. Dun and Hayward (1962); 4. Dunlop (1963); 5. de Haas and Dunlop (1969); 6. Iwan *et al*. (1971); 7. McGuirk and Bourke (1978); 8. Mayo *et al*. (1969); 9. Mullaney (1966); 10. Mullaney and Brown (1970); 11. Pattie and Dun (1968); 12. Stevenson (1968); 13. Turner (1978); 14. Turner and Dolling (1965).

Table 11. Length of breeding season for Merino strains - Ewes of mixed ages

Strain	Method of estimation	Average percent of ewes in oestrus (or ovulating)					Environment	Authors *
		Jan.	Feb. to June	July to Aug.	Sept	Oct. to Dec.		
Fine	Ewe flock teased	0	88	61	4	0	N.S.W.: Badgery's Ck. (nr. Sydney)	2
Medium	Ewe flock teased	41	87	65	26	14	N.S.W.: Badgery's Ck.	2
	Ewes killed at intervals	80	98	83	80	83	N.S.W.: West	1
Strong	Ewe flock teased	62	75	25	7	5	QLD. : S.W.	2
		18	94	85	29	2	N.S.W.: Badgery's Ck.	2
		28	70	58	18	4	Tasmania	2

* Numbers are given separately for each table

1. Dun *et al*. (1960); 2. Kelley and Shaw (1943).

Table 12. Body weight data for ewes of Merino strains

Strain	Body Weight: At weaning: Weight (kg)	Body Weight: At weaning: Age (weeks)	Body Weight: At 15-18 mths (kg)	Body Weight: Adult (kg)	Range of environments	Authors *
Fine	21-23	13-20	27-36	35-40	QLD. : S.W. N.S.W.: N. and S. Tablelands : South VIC. : Western Dist. S.A. : Kangaroo Isl.	5 : 7 : 9 12 : 13
Medium	19-27	11-24	32-44	38-48	QLD. : S.W. N.S.W.: N. Tablelands : West & South	1 : 2 : 3 4 : 5 : 10 11
Strong	16-24	13-20	38-46	47-50	QLD. : S.W. N.S.W.: N. Tablelands : West & South S. Australia	4 : 5 : 6 8 : 13

* Numbers are given separately for each table

1. Ahmed, Dun and Winston (1963); 2. Drinan (1968); 3. Dun and Grewal (1963); 4. Dun and Hayward (1962); 5. Dunlop (1963); 6. Geytenbeek _et al_. (1962); 7. Kennedy and Kennedy (1968); 8. Mayo _et al_. (1969); 9. Mullaney (1966); 10. Pattie (1965a, b); 11. Pattie and Dun (1968); 12. Stevenson (1968); 13. Walker and Fonzoni (1979).

Table 13. Body weight data for rams and ewes of Merino strains

Merino strain and sex	Body weight (kg)		Environment	Authors *
	At weaning (130 days)	At 15-16 m		
Medium: Ewes	21	29	QLD : S.W.	2
: Rams	22	41		
Strong: Ewes	na**	42	S. Australia	1
: Rams	na	57		

* Numbers are given separately for each table

** not available

1. Mayo *et al*. (1969); 2. Turner and Young (1969).

Table 14. Wool production data for breeds other than Merino - Ewes aged 12-18 m (12 months' growth)

Breed	Greasy fleece weight (kg)	Percent clean yield (%)	Clean fleece weight (kg)	Average fibre diameter (microns)	Staple length (cm)	Range of environments	Authors *
Polwarth	3.5-4.9	58-74	2.6-2.9	24.9-25.8	11.7-12.1	N.S.W.: West VIC. : Western District Tasmania	5 : 7 : 10
Corriedale	3.6-5.4	60-73	2.6-3.4	28.2-31.1	10.6-14.3	N.S.W.: N. Tablelands : S.W. Slopes VIC. : Western District	2 : 5 : 6 7 : 8
Romney Marsh	4.6-5.8	72-79	3.3-4.2	29.8-34.4	18.6-19.6	VIC. : South	3
Dorset Horn	2.4	73	1.8	32.5	11.2	N.S.W.: N. Tablelands	2
Border Leicester	3.8	77	3.0	35.9	17.1	N.S.W.: Central West Slopes	4
Border Leicester x Merino	3.6-5.4	68-75	2.5-3.7	27.2-30.5	11.0-12.1	N.S.W.: Central West Slopes : South	1 : 4 : 9 11 : 12

* Numbers are given separately for each table

1. Bourke (1964); 2. Ch'ang (1979); 3. Kennedy (1979); 4. McGuirk _et al_. (1978); 5. McGuirk and Scarlett (1966); 6. McLaughlin (1966); 7. Mullaney _et al_. (1969); 8. Mullaney and Sanderson (1970); 9. Pattie and Smith (1964); 10. Reid (1978); 11. Tyrrell _et al_. (1974); 12. Woolaston and Roberts (1976).

Table 15. Reproduction data for breeds other than Merinos - Ewes of mixed ages

Breed	Ewes lambing per 100 ewes joined	Ewes with multiple births per 100 ewes joined	Lambs born per 100 ewes joined	Lambs weaned per 100 ewes joined	Range of environments	Authors *
Polwarth	55-96	9-38	64-130	31-106	N.S.W.: West VIC. : Western District	10 : 11
Corriedale	60-100	20-48	79-147	48-131	N.S.W.: West : N. Tablelands VIC. : Central; West District Tasmania	2 : 4 : 8 10 : 11: 12
Dorset	74	44	114-137	80	N.S.W.: N. Tablelands : Various	4 : 7
Border Leicester	56-64	46-52	86-93	63-67	N.S.W.: Central West Slopes	6 : 9
Border Leicester x Merino	69-100	7-78	76-180	64-138	N.S.W.: Central West Slopes S. Australia	1 : 3 : 5 9 : 13 : 14

* Numbers are given separately for each table

1. Allden (1956); 2. Baharin and Beilharz (1977); 3. Bourke (1964); 4. Ch'ang (1979); 5. Dunstan (1977); 6. Fogarty *et al*. (1976); 7. Gregory *et al*. (1977); 8. Iwan *et al*. (1971); 9. McGuirk and Bourke (1978); 10. McGuirk and Scarlett (1966); 11. Mullaney and Brown (1969); 12. Mullaney and Brown (1970); 13. Pattie and Smith (1964); 14. Tyrrell *et al*. (1974).

Table 16. Length of breeding season for breeds other than Merinos - Ewes of mixed ages

Breed	Method of estimation	Average percent of ewes in oestrus						Environment	Author
		Jan.	Feb.	Mar.-June	July-Aug.	Sep.	Oct.-Dec.		
Dorset	Ewe flock teased	30	100	93	38	0	0	N.S.W.: Badgery's Ck.	1
Border Leicester	"	0	27	92	33	0	0	"	1
Border Leicester x Merino	"	2	98	100	53	6	0	"	1

1. Kelley and Shaw (1943).

Table 17. Body weights for breeds other than Merino - Ewes of various ages

Breed	Body weights: At weaning Weight (kg)	At weaning Age (weeks)	At 15-16 months (kg)	Range of environments	Authors *
Polwarth	24-28	13-14		N.S.W.	4
Corriedale	20-33	13-16	40	N.S.W.: N. Tablelands : Central West Slopes VIC : West. District S. Australia	1 : 4 : 5 6
Dorset Horn	27-33	21-27	49	N.S.W.: N. Tablelands : Various	1 : 2
Border Leicester	29-32	11-17	50	N.S.W.: Central West Slopes : Various	2 : 3
Border Leicester x Merino	27	11-17	48	N.S.W.: Central West Slopes	3

* Numbers are given separately for each table

1. Ch'ang (1979); 2. Gregory *et al.* (1977); 3. McGuirk *et al.* (1978); 4. McGuirk and Scarlett (1966); 5. McLaughlin (1966); 6. Walker and Ponzoni (1979).

Table 18. Sheep meat production

Year	SHEEP Number slaughtered ('000)	Total carcase weight (tonnes)	Average carcase weight per head (kg)	LAMBS Number slaughtered ('000)	Total carcase weight (tonnes)	Average carcase weight per head (kg)
1974	11,308	231,319	20.4	13,948	236,153	16.9
1976	16,781	325,549	19.4	16,058	262,171	16.3
1978	13,897	263,896	19.0	15,247	251,524	16.5

Source: Australian Bureau of Statistics, Livestock Statistics 31/3/78

There is no information about breeds slaughtered, but all are represented. Lamb comes mainly from crossbred ewes mated to British breed sires, but the Merino and other breeds also contribute to both lamb and mutton.

B. Cattle

1. Background

Breeds of cattle established in Australia can be grouped in 5 classes (Table 19, Meischke and Jones 1975). The table includes both beef and milk cattle. Initially all breeds introduced were *Bos taurus*, but over the last four decades there has been increasing use of *Bos indicus*, particularly in the northern areas.

No census figures for cattle breeds exist in Australia as a whole, but some obtained in 1973 from a survey through beef breed societies are in Figure 2 (adapted from Meischke and Jones 1975). This figure shows the predominance of the Hereford in N.S.W., Victoria and Tasmania and the Shorthorn in the Northern Territory and the north-west of Western Australia. It also demonstrates the great incursion of *Bos indicus* into Queensland and Northern Territory, with slight incursions into N.S.W. and N.W. Western Australia.

During the last few years, there has been considerable introduction of frozen semen from European breeds. Various reports on crossbred progeny have been published, but are not included here as no breed has yet been established from them.

In appearance, the *Bos taurus* breeds resemble their European forebears. Three of the breeds developed in Australia are derived from *Bos taurus*, and in appearance are distinguished chiefly by coat colour, the Illawarra Shorthorn (milk) being mainly red or red and white, and the two Greys (beef), grey.

There are very few pure *Bos indicus*. The breeds developed from them have varying degrees of the characteristic humps and dewlaps. All are beef breeds except the Australian Milking Zebu, and the Australian Friesian Sahiwal.

Although no census figures on cattle breeds are available, total numbers in local government areas or statistical divisions are published annually by the Australian Bureau of Statistics for all States except W.A. As previously mentioned, breed numbers will be available in some future years.

No official census figures for production per head are published. Some estimates of calf-branding percentages obtained from a 1970 survey by the Australian Bureau of Agricultural Economics are in Figure 3; these are calculated as the

Table 19. Cattle breeds in Australia

Class	Breed			
Bos taurus (European)	Angus	Friesian	Hereford	Shorthorn
	Ayrshire	Galloway	Jersey	
	Devon	Guernsey	Red Poll	
Bos indicus (Zebu)	Afrikander	Sahiwal		
	Brahman	Santa Gertrudis	(Zebu cross)	
	Red Sindhi			
Breeds developed in Australia	Australian Illawarra Shorthorn (Shorthorn and Ayrshire)			
	Australian Milking Zebu (Jersey, Sahiwal, Sindhi)			
	Australian Friesian Sahiwal			
	Belmont Red (Afrikander, Hereford and Shorthorn)			
	Braford (Brahman and Angus)			
	Droughtmaster (Brahman and Shorthorn)			
	Murray Grey (Angus and Shorthorn)			
	Tasmanian Grey (Angus and Shorthorn)			
Recently introduced *Bos taurus*	Charolais	Limousin	Simmental	
	Chianina	Maine Anjou		
Crossbreds	Various	*Bos taurus* x *Bos taurus*		
	or	*Bos indicus* x *Bos taurus*		

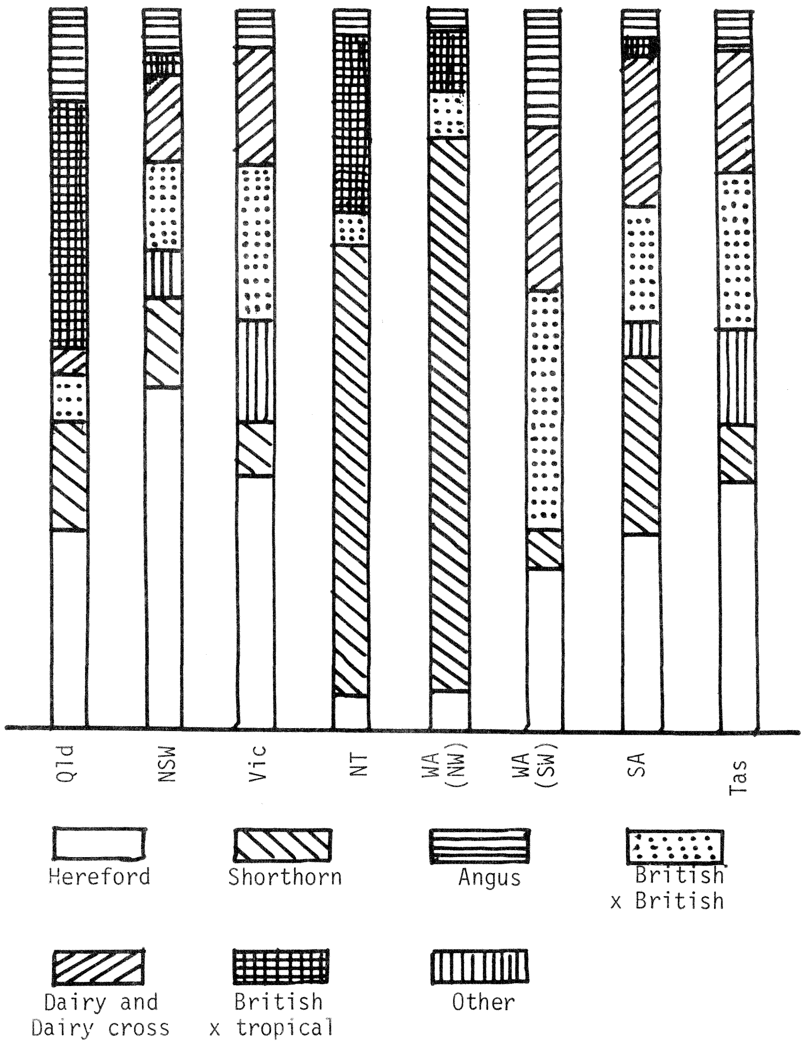

Fig. 2 - Percentage of all cattle in each state which were of each breed in 1973 (After Meische and Jones 1975).

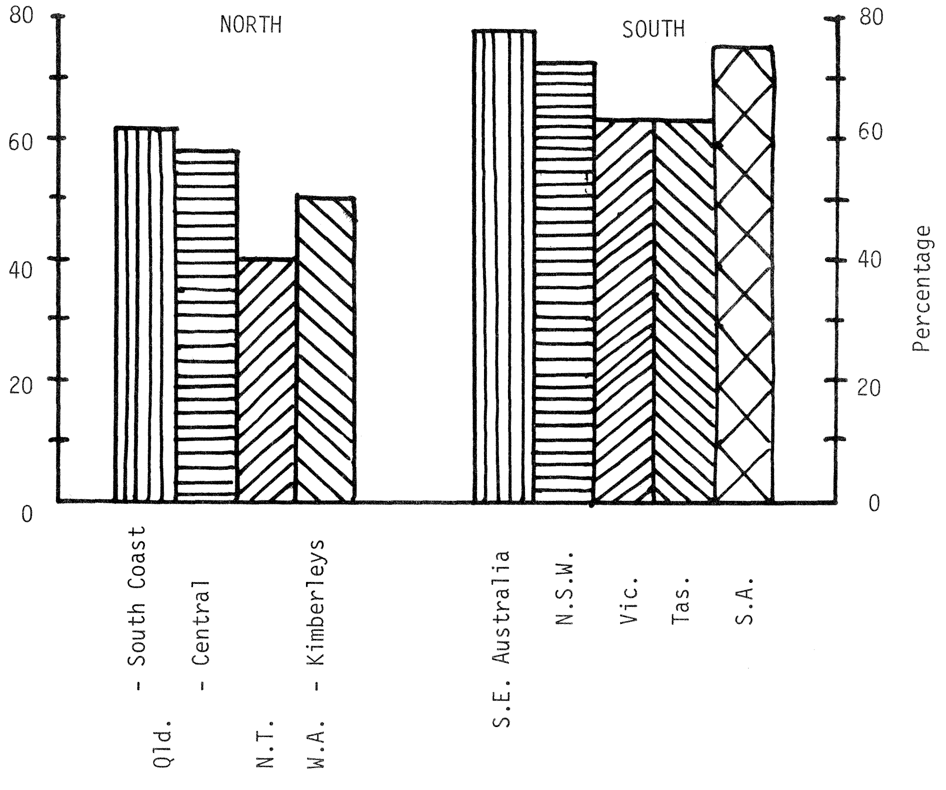

Fig. 3 - Branding percentages for beef cattle in 1970
(Source: Bureau of Agricultural Economics).

number of calves branded on a property during the year, as a percentage of the number of cows aged 1½ years or more in the breeding herd. As with lamb-marking percentages and fleece weights, calf-branding percentages are higher in the temperate south than the tropical north.

Table 20 gives the production of beef and veal in Australia for a series of years, together with average carcase weight, calculated from number slaughtered. The total quantity of milk produced is also given.

Table 20. Production from cattle

Year	Cattle slaughtered		Calves slaughtered		Total milk produced
	No. (thousands)	Average carcase weight (kg)	No. (thousands)	Average carcase weight (kg)	(Million litres)
1974	6,057.8	211.1	1,198.0	35.6	6,718.4
1976	8,532.3	206.1	2,082.8	39.2	6,248.2
1978	10,096.3	200.4	2,461.1	40.5	5,186.3

Source: Australian Bureau of Statistics, Livestock Statistics 31/3/78

2. Beef Cattle

(i) General: The beef cattle industry is based mainly on grazing. Research on lot-feeding has been done, but costs have so far prevented major use of the technique. Data presented are for animals mainly grass-fed, with occasionally some supplementation.

Beef cattle are grown in the north, down the east coast and tablelands, in the dry inland, in the south east and south west. Numbers by States are given in Table 21.

Table 21. Total numbers of beef cattle in each State ('000)

Year	QLD.	N.S.W.	VIC.	S.A.	W.A.	TAS.	N.T.	A.C.T.	Australia
1974	9,767	7,772	3,906	1,482	2,153	664	1,320	17	27,082
1976	10,844	8,507	3,996	1,683	2,487	691	1,602	22	29,833
1978	11,059	6,828	2,963	1,073	2,137	558	1,681	15	26,314

Source: Australian Bureau of Statistics, Livestock Statistics 31/3/78

Characteristics important for beef production are:

Reproduction rate
Growth rate
Body weight
Carcase quality
(back fat and muscle/bone ratio)

Data are by no means as plentiful as for Merino sheep; information on carcase quality, on a breed basis, was so scanty that it has not been included.

In discussing body weights, breeds have been divided into those belonging to Bos taurus and those to which Bos indicus has been introduced. Crossbreds within Bos taurus are not included. If breeds mentioned in Table 19 do not appear in the later tables, it is because no published data were found.

Data on reproduction rate have not been listed as those from Bos taurus and Bos indicus, because in survey reports breeds were often not separated.

(ii) Production data: Body weight data for Bos taurus breeds are in Table 22, and for Bos indicus in Table 23. Figures in the columns for weaning weights and weights at other ages do not necessarily belong to the same groups of animals.

Reproduction data are summarized in Table 24, while some from a Bureau of Agricultural Economics survey, which does not separate breeds but deals with different climatic zones, are in Table 25.

Lack of uniformity in reporting made the task of summarizing these data difficult. "Age-corrected weaning weights" were sometimes given without stating the age; analyses of variance were sometimes presented with no corresponding means. Reproduction rates were quoted in various ways, all of which have been given in Table 24.

An important characteristic in relation to reproduction rate is the calving interval. A few available figures were:

Hereford (mean) 369 days }
Angus (mean) 367 days } Victoria (Baharin and Beilharz 1977)

Various breeds:

range 11-13 months - Queensland (Alexander 1965)

3. Dairy cattle

(i) General: The main dairy cattle breeds in Australia are Bos taurus. One tropical breed incorporating Bos indicus has been developed by CSIRO (the Australian Milking Zebu, or AMZ) while a second (the Australian Friesian Sahiwal, or AFS) is under development by the Queensland Department of Primary Industry.

Dairy cattle are grown in the higher rainfall areas; they are mainly grazed, usually with some supplement as well.

Total numbers of dairy cattle in each State for a series of years are in Table 26; no statistics are available for numbers in each breed.

Characteristics important in dairy production are:

Total amount of milk per lactation
Milk quality (most often available as fat percentage)
Calving percentage
Calving interval.

(ii) Milk production: Herd-recording systems are in operation in all Australian States, and it is from these that most data are available. Analyses from the N.S.W. system are given as an example. Herds are tested at 2 milkings (night and morning) on a monthly or a bi-monthly basis. Summaries are published annually in two sections, one for pure-bred registered cows and one for grade cows. Breed averages for 1977-78 in these two sections are given in Table 27. Management and supplementary feeding would probably be better for the pure-bred than for the grade cows. Only one overall average figure for calving interval was available.

Table 28 gives some published figures from other State herd-recording

Table 22. Body weights for European breeds - *Bos taurus*

Breed & Sex	At weaning			Other			Range of environments	Authors *
	Weight (kg)	Age (days)	Daily gain birth to weaning (kg)	Weight (kg)	Age (days)	Gain/day from weaning		
Hereford								
Cows	184-233	210-283	0.70-0.87	344-425	Mixed	-	QLD. : Central	1 : 3 : 6
Bulls	198-248	210-269	0.72-0.92	-	-	-	N.S.W.: N.E. and S.E.	8 : 9 : 13
Steers	193-208	210	0.77	402-491	586-701	0.51-0.56	VIC. : Western District	16 : 18
Over sexes	160-229	193-240	0.68	-	-	-	: Central	
Shorthorn								
Cows	179-220	210-287	-	-	-	-	QLD. : Central	4 : 5 : 16
Bulls	228-236	254-282	-	-	-	-	N.S.W.: S.E.	18
Steers	197-219	210	-	385-451	587-754	0.41-0.48	S.A.	
Over sexes	224	300	0.81	-	-	-		
Angus								
Cows	189-271	216-300	0.64-0.87	294	365	-	N.S.W.: S.E. : Central West Slopes	1 : 2 : 5 16 : 17 : 18
Bulls	208-226	198-273	0.72-0.90	-	-	-	: Central and S. Tablelands : West	
Steers	202-301	215-300	0.80-0.96	367-454	587-774	0.46-0.47	VIC. : Central	
Over sexes	178-209	196-240	-	-	-	-	S.A.	
Mixed breeds								
Cows	228	365	0.68-0.78	-	-	-	VIC.	9 : 15
Bulls	329	365	0.79-0.91	-	-	-		
Friesian								
Bulls	-	-	-	431	791	-	N.S.W.: S.E. VIC.	7 : 10 : 11 12 : 13 : 14
Steers	-	-	-	424	791	-		
Over sexes	202-290	231-250	0.70-0.74	-	-	-		

* Numbers are given separately for each table

1. Baharin and Beilharz (1975); 2. Barlow *et al*. (1978); 3. Barlow and O'Neill (1978); 4. Dowling (1970); 5. Gifford *et al*. (1976); 6. Hodge *et al*. (1976); 7. Kellaway (1971); 8. Mannetje and Coates (1976); 9. Mason *et al*. (1970); 10. Mickan *et al*. (1978); 11. Mickan *et al*. (1976); 12. Morgan (1977); 13. Morgan *et al*. (1976); 14. Spiker and Hallett (1978); 15. Straw and Jones (1977); 16. Tulloh (1963); 17. Wardrop (1968); 18. Williams and Murphy (1958).

Table 23. Body weights - Bos indicus and crosses

Breed & Sex	At weaning: Weight (kg)	At weaning: Age (days)	At weaning: Daily gain birth to weaning (kg)	Other: Weight (kg)	Other: Age (months)	Other: Gain/day (kg)	Range of environments	Authors *
Belmont Red								
Cows	161-197	275	0.49-0.58	174-224 251-308	13 18	- -	QLD. : coast	7
Bulls	169-202	275	0.51-0.61	-	-	-		
Droughtmaster								
Cows	-	-	-	329-340	24-36	-	QLD. : coast	8 : 12
Bulls	-	-	-	-	-	-		
Steers	-	-	-	240-260	18	-		
Over sexes	168-176	203-224	-	-	-	-		
Bos indicus x Bos taurus								
Cows	162-172	210-220	0.66-0.68	300-417	Mixed ages	0.27-0.43 (wean-12mth)	N.S.W.: N. Coast	1 : 2 3 : 4
Bulls	177-196	210-220	0.70-0.74	-	-	-	QLD. : Dry and wet tropics	5 : 6 9 : 10
Steers	208-219	242-305	-	222-391 297-410	14-18 20-24	0.28-0.46 (wean-12mth) 0.21-0.41 (12-24mth) 0.52-0.63 (18-30mth)	N.T. VIC. : Western District	11 : 13
Over sexes	162-280	179-240	0.39-0.89	321-331	16	-		

* Numbers are given separately for each table

1. Arthur *et al.* (1972); 2. Barlow and O'Neill (1978); 3. Copeman *et al.* (1977); 4. Donaldson and Larkin (1963); 5. Ford (1976); 6. Gartner (1978); 7. Kennedy and Chirchir (1971); 8. Hunter *et al.* (1976); 9. Mellor *et al.* (1973); 10. Morgan *et al.* (1976); 11. Rudder *et al.* (1976a); 12. Siebert (1971); 13. Winks *et al.* (1978 a and b).

Table 24. Reproduction rates of beef cattle - All breeds

Breed	Conception (%)	Pregnancy (%)	Calving (%)	Branding (%)	Cows with live calves (%)	Range of environments	Authors *
Bos taurus							
Hereford	-	75-86	66-100	50	45-77	QLD.: Wet and dry tropics Victoria	1 : 2 : 4 5 : 7 : 10 13
Shorthorn	59-67	55	-	-	25-65	QLD.: Dry tropics	5 : 7 : 9
Angus	-	-	87-94	-	-	Victoria	1
Unspecified	-	50	-	-	49-81	Queensland	5 : 7
Bos indicus							
Belmont Red	-	-	76	-	-	QLD.: Wet tropics	12
Various	-	61-86	80-93	20-81	74-77	QLD.: Wet tropics	7 : 10 : 11
Unspecified	50-86	-	-	20-96	-	Queensland	3 : 4 : 6 8

* Numbers are given separately for each table

1. Baharin and Beilharz (1977); 2. Bewg *et al*. (1969); 3. Churchward (1965); 4. Donaldson (1962); 5. Donaldson *et al*. (1962); 6. Jenkins and Hirst (1966); 7. Lampkin and Kennedy (1965); 8. Osborne (1960); 9. Plasto (1978); 10. Rudder *et al*. (1976 a); 11. Rudder *et al*. (1976 b); 12. Seebeck (1973); 13. Silvey *et al*. (1978).

Table 25. Reproduction rates by zone and State (calving percentage)

Zone	QLD.	N.S.W.	VIC.	S.A.	W.A.	TAS.	All States
Pastoral	74	71	-	87	62	-	72
Wheat-sheep	85	82	97	86	84	-	84
High rainfall	-	82	88	88	82	80	85

Source: Sample properties carrying both sheep and cattle in a Bureau of Agriculture Economics survey (3 year averages) - BAE (1972). The three zones increase in rainfall from pastoral to high rainfall.

Table 26. Total numbers of dairy cattle in each State ('000)

Year	QLD.	N.S.W.	VIC.	S.A.	W.A.	TAS.	N.T.	A.C.T.	Australia
1974	529	685	1,933	210	177	220	1	2	3,757
1976	503	631	1,872	209	168	218	1	1	3,602
1978	432	544	1,609	169	134	175	-	-	3,065

Source: Australian Bureau of Statistics, Livestock Statistics 31/3/78

Table 27. Average milk production per lactation (120-300 days) - 1977-78

Breed	Age (years)	Total milk per lactation (kg)		Total fat per lactation (kg)		Fat %		Calving interval (weeks)
		Pure-bred	Grade	Pure-bred	Grade	Pure-bred	Grade	
Australian Illawarra Shorthorn	2	3651	2884	135	110	3.7	3.8	
	over 9	5284	3743	190	134	3.6	3.6	
	All ages	4553	3548	167	132	3.7	3.7	
Jersey	2	2643	2296	132	111	5.0	4.8	
	over 9	3463	2736	164	121	4.7	4.4	
	All ages	3224	2665	159	123	4.9	4.6	
Guernsey	2	3444	2902	151	126	4.4	4.3	
	over 9	4069	3723	172	148	4.2	4.0	
	All ages	3891	3217	172	135	4.4	4.2	
Ayrshire	2	3600	3062	140	113	3.9	3.7	
	over 9	5060	3846	193	145	3.8	3.8	
	All ages	4170	3211	157	118	3.8	3.7	
Friesian	2	4056	3255	149	122	3.7	3.7	
	over 9	5472	4308	194	155	3.6	3.6	
	All ages	5029	3988	183	147	3.6	3.7	
All breeds	2	3672	3020	143	120	3.9	3.8	
	over 9	5093	3837	189	147	3.7	3.7	
	All ages	4646	3607	176	142	3.8	3.8	56.6

Source: N.S.W. Department of Agriculture

(i) Recording of Pure-bred Registered Dairy Cattle in N.S.W. 1977-78
(ii) Group Herd Recording Statistics 1977-78 (mainly grade cows)

Table 28. Average milk production per lactation over all breeds (from State herd recording data)

Total milk per lactation (kg)	Lactation length (days)	Fat (%)	Calving interval (weeks)	Environment	Authors
891-4594	30-300 (Mode 271-300)	4.0-4.3	40-80 (Mode 50)	Queensland	1
3441-4328	All lactations over 300	3.2-4.3	-	S.A.	2

1. Clark (1969); 2. Munro (1976).

schemes. The lactation lengths included vary from State to State, as indicated in the Tables; and breeds were not separated in the Queensland and South Australian analyses. Some values of lactation length for different breeds in W.A. are in Table 29.

Figures for the Australian Milking Zebu have been given by Franklin et al. (1976). They range from 1228 kg per lactation for 2-year-old cows to 2200 kg for 6-year-old cows. All lactations up to 300 days were included. The fat percentage for 2-year-old cows was 4.7; no figure was given for older cows. The figures were obtained in northern N.S.W., where average daily maximum temperature ranges from 29.3°C to 30.3°C for the three summer months; rain falls in every month, with an average annual total of 1302 mm.

Table 29. Average length of lactation (days)

Breed	Range*		All Regions	
	1977/8	1978/9	1977/8	1978/9
Australian Illawarra Shorthorn	229-267	250-277	262	269
Jersey	237-286	209-284	272	270
Guernsey	208-279	222-283	267	264
Ayrshire	233-237	273	236	273
Friesian	233-272	251-275	266	268
All breeds (including some not itemized above)	232-272	248-276	266	268

* Ranges are over geographic regions in W.A.

Source: Notes from Animal Production Division, West Australian Department of Agriculture

C. Pigs

1. Background

The two main pure breeds of pigs in Australia are Large White and Landrace; the Berkshire, formerly popular, is declining rapidly in importance. The predominant colour of herds is white.

Breed numbers are not published, but total numbers, by States, are in Table 30. Total numbers in local government areas or statistical divisions are published annually for all States except W.A. (A.B.S.). Numbers slaughtered, and average carcase weight, are in Table 31.

The characteristics important for pigs are:

Number of pigs per sow per year (dependent on litter size, survival rate and frequency of litters)

Gain in weight per day (which influences marketable age)

Amount of feed required to produce a marketable pig (depending on feed eaten per unit of gain)

Carcase quality (depth of back fat the main criterion).

Table 30. Numbers of pigs in each State ('000)

Year	QLD.	N.S.W.	VIC.	S.A.	W.A.	TAS.	N.T.	A.C.T.	Australia
1974	441	835	424	385	344	68	8	-	2,505
1976	409	709	393	326	260	70	7	-	2,173
1978	463	739	401	311	237	64	3	-	2,219

Source: Australian Bureau of Statistics, Livestock Statistics 31/3/78

Table 31. Numbers of pigs slaughtered and average carcase weight (Australia)

Year	Number slaughtered ('000)	Average carcase weight (kg)
1974	4169.9	50.6
1976	3295.0	52.8
1978	3657.7	52.9

Source: Australian Bureau of Statistics, Livestock Statistics 31/3/78

2. Production data

Weight gains, efficiency and carcase quality data can be quoted, as an example, from Australia's first pig progeny-testing station, in Brisbane, Queensland. Young boars from Queensland's stud herds enter the station in litter groups of 2, and performance is assessed as they grow from 27 to 90 kg liveweight on an *ad lib* ration of barley and milk powder. At 90 kg, fat measurements are made with an echo-sounder. Results for the years 1970-72 are in Table 32 (ranges are over years).

Table 32. Performance data on growth

Breed	Average daily gain (kg)	Between ages (days) or weights (kg)	Gain per unit of feed (kg)	Back fat thickness (mm)	Range of environments	Authors
Large White (Boars)	0.71-0.74	27-90 kg	0.37-0.38	17.2-22.6	Queensland: Progeny testing Station	1
Landrace (Boars)	0.74-0.76	27-90 kg	0.37-0.40	15.9-20.4	"	1
Duroc (Two sexes)	0.65-0.68	42-154 days	0.33-0.34	-	Victoria	2
Hampshire (Two sexes)	0.57-0.60	42-154 days	0.32	-	"	2

1. McPhee (1974); 2. Mullaney (1976).

Comments on methods of expressing feed efficiency are in the foreword to to this paper.

Some figures quoted by Williams and O'Rourke (1974) in a feeding trial with different rations are given in Table 33 to illustrate sex differences.

Table 33. Performance data on growth - Sex comparison

Breed	Average daily gain Gilts (kg)	Average daily gain Barrows (kg)	Between weights (kg)	Gain/feed Gilts	Gain/feed Barrows	Environment	Author
Berkshire x Large White	0.730-0.731	0.943-0.970	46-85	0.27	0.28	Queensland	1

1. Williams and O'Rourke (1974).

The pigs were crossbred Berkshire x Large White and were fed ad lib on three different diets. The ranges quoted are over diets.

Reproduction rate: Table 34 gives reproduction data. Some figures available on crossbreds have not been included, except for one set of data under "Large White", which was for a herd containing 75% Large White genes.

D. Goats

There are three types of goats in Australia:

Dairy (milk)
Fibre (mohair and cashmere)
Feral (meat)

No official statistics exist for breed or total numbers and few production data are available.

1. Goats for milk

Dairy goats are run in small, mainly "hobby" herds, consisting mainly of high-producing, well-known breeds such as Saanen, Toggenburg and Anglo-Nubian. No milk production figures are at present available, though some cattle herd-recording schemes are now including goats.

2. Goats for fibre

(i) Mohair: Angora goats have been present in Australia for over a century, but until recently were also mainly in the "hobby" class. Interest in them increased during a period of low wool prices in the 1960's, and has been maintained. Some larger herds are now run on commercial lines, and high prices are being paid for Angora bucks.

Important characteristics for these goats are:

Greasy and clean fleece weight
Percent clean yield
Average fibre diameter
Percent medullation (to be low)
Reproduction rate

Table 34. Reproduction rate - Pigs

Breed	Conception rate (%)	No. pigs born per litter (total)	Interval between litters (days)	Litters per sow per year	Pigs sold per sow per year	Range of envirnments	Authors
Large White	72-93	7.9-12.6	155-173	2.2-2.4	-	N.S.W.: S. Tablelands QLD. : Central Victoria	1 : 2 : 3 4
Landrace	68	7.2	-	-	-	Victoria	1
Over breeds					9.4-12.6	Australia	5 : 6

1. Baharin and Beilharz (1977); 2. Entwistle *et al*. (1978); 3. Henry (1969); 4. Holder (1970);
5. Pender and Erwood (1970); 6. Penny *et al*. (1971).

Angoras are shorn twice a year, and production figures quoted in Table 35 are for 6 months' growth.

Table 35. Fleece (Mohair) production data for Angora goats

Age & Sex	Greasy fleece weight (kg) 6 mths	Percent clean yield (%)	Clean fleece weight (kg) 6 mths	Average fibre diameter (microns)	Medullation (%) (Kemp + heterotype)
Kid:					
Does		90-94	0.4	24-33	2-4
Bucks		94		32-39	3-12
Wethers					
Over sexes			1.2		9
Adults:					
Does			1.0-1.3	30-33	3-5
Bucks					
Wethers	0.7-1.0				
Over sexes			1.4		10

Figures all from eastern Australia

Authors: Clarke (1977); Keenan (1974); Stapleton (1976 & 1977)

(ii) Cashmere: Some feral goats have been found to carry an undercoat of high quality cashmere (Smith, Clark and Turner 1973), and experiments are in progress to find ways of harvesting the fibre economically.

3. Goats for meat

Meat is currently produced mainly by harvesting feral goats, and most is exported. In 1975-76, 1.7 million kg of goat's meat were exported from Australia, together with a number of live animals.

Experiments are in progress to study the possibility of breeding re-domesticated feral goats for meat production. The goats vary considerably in appearance, with a wide range of colours and coat lengths; they are a mixture of many breeds.

Some production figures from re-domesticated feral goats are in Table 36.

Table 36. Meat production data for feral goats

Body weight (kg)			Growth/day		
3 months :	Female	15	Birth-3 m:	Female	0.14
	Male	19		Male	0.18
5 months :	Female	22	3-5 m :	Female	0.12
	Male	27		Male	0.13

Kidding percentage: 150-180

Source: Holst and Pym (1977).

E. Poultry

1. Background

Poultry in Australia consist mainly of chickens (for eggs and meat), with some turkeys, ducks and other fowl. Numbers are in Table 37 with annual total production in Table 38.

Table 37. Numbers of chickens (all purposes) in each State ('000)

Year	QLD.	N.S.W.	VIC.	S.A.	W.A.	TAS.	N.T.	A.C.T.	Australia
1974	6,271	18,749	9,618	4,399	4,312	581	66	155	44,151
1976	5,823	19,499	8,747	4,385	3,617	574	140	133	42,917
1978	5,651	18,388	9,689	4,163	4,000	573	183	150	42,795

Source: Australian Bureau of Statistics, Livestock Statistics 31/3/78

Table 38. Number of poultry slaughtered, average carcase weight and total eggs produced

Year	Chickens		Other Fowls & Turkeys		Ducks & Drakes		
	Number (thousands)	Average carcase weight (kg)	Number (thousands)	Average carcase weight (kg)	Number (thousands)	Average carcase weight (kg)	Total number of eggs (thousands of dozens)
1974	139,765	1.22	10,110	2.00	1,195	1.66	198,822
1976	144,202	1.27	9,245	1.98	1,168	1.64	199,525
1978	173,374	1.26	10,606	2.10	1,729	1.65	187,606

Source: Australian Bureau of Statistics, Livestock Statistics 31/3/78

No production data are available except for chickens. On a commercial basis, these are housed and fed, though for home use farmyard poultry are still run.

There are no statistics for breed numbers. Most chickens in commercial egg-producing enterprises are White Leghorn x Australorp, though a White Leghorn Strain cross is showing up well in tests. Commercial chicken meat production is based on a synthetic mix of breeds.

2. Egg production

The important characteristics are:

- Mean age at first egg
- Hen-housed egg production
- Percent mortality
- Average egg-weight
- Efficiency (egg weight/weight of feed)
- Hen-day total egg mass.

Other characteristics which are monitored in large commercial enterprises are:

Egg specific gravity
Albumen quality (Haugh units)
Egg weight

Random sample tests are conducted by the State Departments of Agriculture, and some results from NSW are in Table 39.

Table 39. Average production data from N.S.W. Random Sample Laying Test

Characteristic	Year of Test		
	1975-6 (to 66 weeks)	1976-8 (to 74 weeks)	1977-9 (to 66 weeks)
No. pullets housed per entry	144	144	144
Mean age at 1st egg (days)	127-132	127-155	127-146
Hen-housed egg production	189-221	157-253	189-228
Percent mortality	5.6-20.8	6.3-49.6	3.5-17.4
Hen-day egg production	207-234	220-271	208-236
Average egg weight (g)	57.5-61.8	58.8-63.4	57.3-60.6
Feed efficiency (weight egg / weight feed)	0.32-0.38	0.32-0.38	0.33-0.38
Hen-day total egg mass (kg)	11.9-13.7	13.0-16.1	11.4-13.8

Specific gravity of eggs at 37-41 weeks ranged from 1.071 to 1.081, and at 65 weeks from 1.068 to 1.073. Albumen quality at 37-41 weeks ranged from 64.6 to 80.7 (Haugh units) and at 65 weeks from 56.6 to 70.4.

The data in Table 39 are from White Leghorn x Australorp, except for the top values for egg production, egg mass and feed efficiency, which came from a White Leghorn Strain cross.

3. Meat production

Important characteristics are:
8-week weight
Feed efficiency

The latter is usually quoted as feed/weight, but here has been converted to weight/feed.

Some results from NSW Random Sample Broiler Tests are in Table 40.

Table 40. Meat production - Chickens

Year	8-week weight (kg)	Feed efficiency (weight/feed)
1974	1.74	0.47
1975	1.83	0.48
1976	1.88	0.47
1977	1.97	0.48
1978	2.01	0.50

Source: Best, E.E. (1978) - Proceedings Second Australasian Poultry and Stock Feed Convention, Sydney.

III. DISEASE

Australia has an extremely well organised animal health organisation and quarantine service. It is an active member of the International Office of Epizootics (O.I.E.), the international disease recording agency; of the Animal Health and Production Commission for Asia, S.W. Pacific and Far East (APHCA), which publishes a quarterly regional animal disease record, and fully participates in the production of the FAO/WHO/OIE Animal Health Yearbook, from which source specific details are available. Generally speaking the livestock of Australia enjoy a minimum number of animal diseases compared to the global picture. This has been due to a very strict quarantine system and an efficient and highly organized animal health service.

References

(Note: References are given separately for each species)

A. Sheep

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APPENDIX I

Brief description of environments

Australia is a continent without high mountains. The Great Dividing Range runs close to the coast down the eastern side, and turns west into Victoria, but its highest point, near the border between New South Wales and Victoria, is only just over 2200 m. There are other ranges elsewhere, but all of low altitude.

Parts of the range are suitable for livestock raising; in particular sheep are grown on the North and South Tablelands and the Western Slopes in N.S.W., and in parts of the range in Victoria.

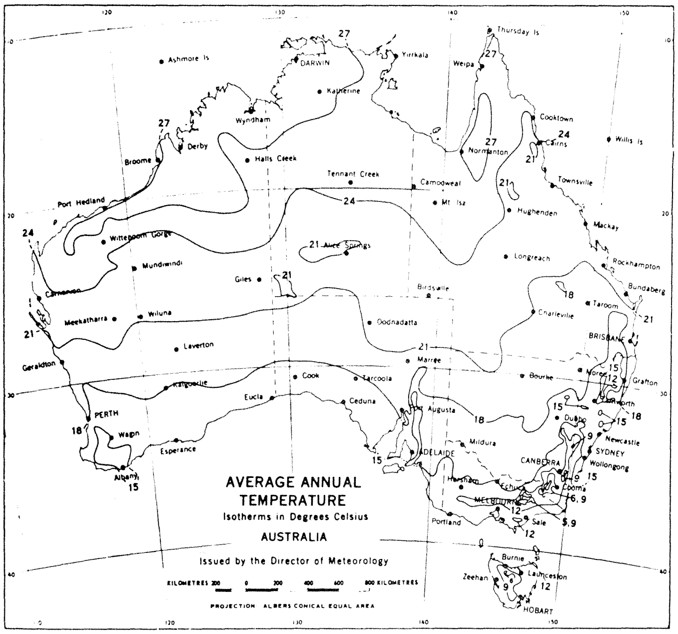
Map 1 shows annual average temperatures, in degrees Celsius (centigrade), while Maps 2 and 3 show median annual rainfall (that is, the figure which has as many values below it as above it) and the variability of rainfall.

Some parts of Australia have seasonal rainfall, while some have rain uniformly through the year. The zones are in Map 4.

The maps all come from Yearbook Australia (1977/8) published by the Australian Bureau of Statistics.

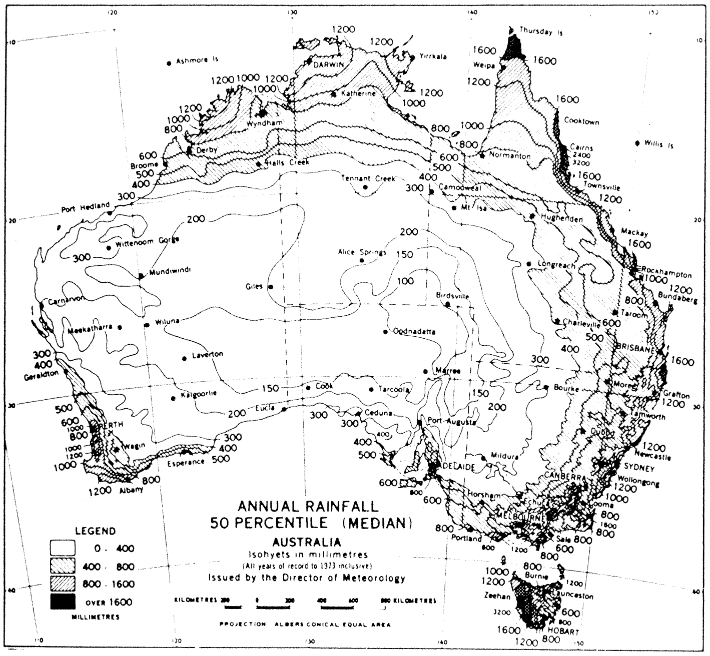
The environments mentioned in the various tables in the text can be related to these maps.

MAP 1



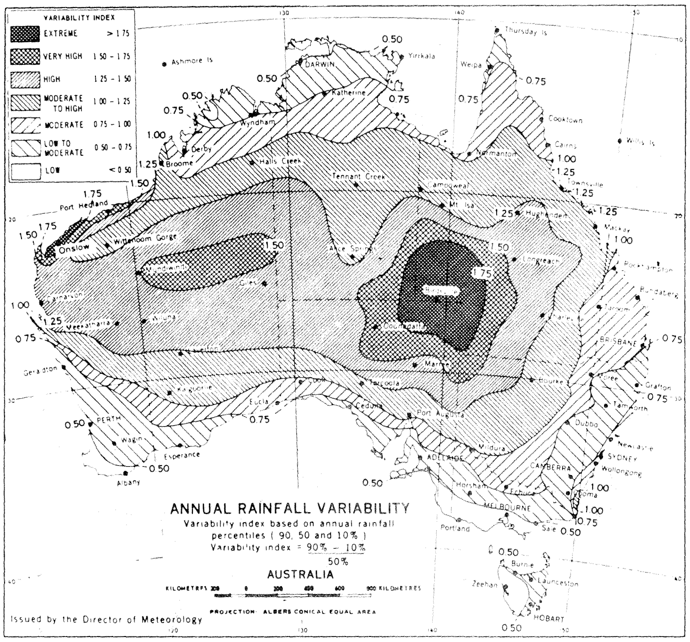
Australia
Average annual temperature
(^{o}Celsius = centigrade)
Source: Australia Yearbook
(Australian Bureau of Statistics)

MAP 2



Australia
Median annual rainfall
(mm)
(i.e. figure which has as many values above it as below it)
Source: Australia Yearbook
(Australian Bureau of Statistics)

MAP 3

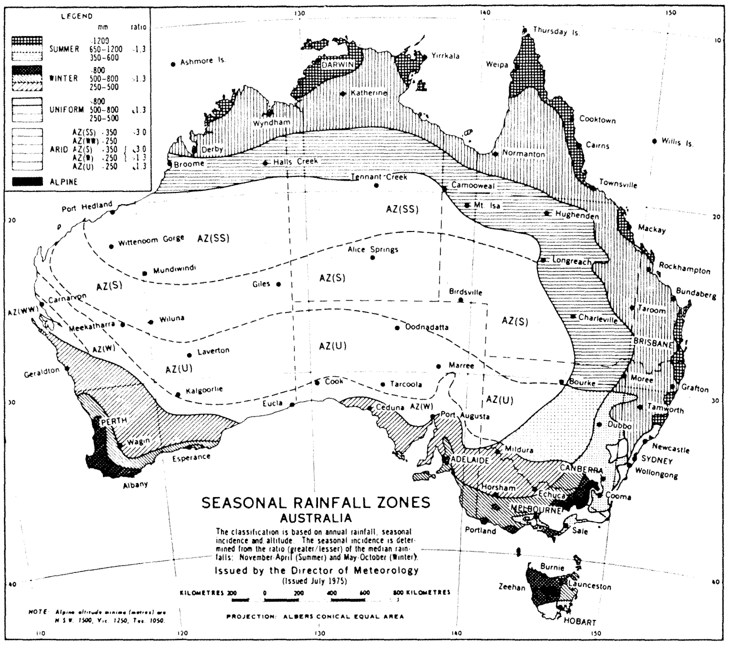


Australia
Annual rainfall variability
Based on annual rainfall percentiles

$$\text{Variability} = \frac{90\% - 10\%}{50\%}$$

(90% percentile means figures which are only exceeded in 10% of years, and so on)
Source: Australia Yearbook
(Australian Bureau of Statistics)

MAP 4



Australia
Seasonal rainfall zones
Source: Australia Yearbook
(Australian Bureau of Statistics)

APPENDIX 2

Australian Performance Recording Schemes

A. Sheep

As in the main body of the paper, a distinction must be drawn between wool-producing sheep (mainly Merino and breeds involving the Merino) and meat-producing breeds. Both flocks and studs of the wool-producing breeds are usually large, and, as they are run under extensive conditions, full pedigrees are usually not kept; often a group of rams is mated to a group of ewes and in such cases neither sire nor dam of the lamb is known.

Lamb and mutton are sold from wool-producing flocks, but for the main meat-production enterprises cross-bred dams are used, mated to meat-breed sires. Sires to produce the cross-bred ewes, and later, the prime lambs, come from small studs, in which full pedigrees are more easily, and more frequently, kept than in the larger wool-producing enterprises.

The performance records required, and feasible, therefore differ in the two types of production.

1. Merinos and other wool-producing breeds

Beginning in the early 1950's, a large extension campaign was mounted to encourage breeders to use measurement as well as visual appraisal in selecting breeding stock. The first impetus to the campaign came from a meeting of sheep and wool research and extension officers, from CSIRO, Universities and State Departments of Agriculture, held in Brisbane in 1951. The meeting was organized jointly by CSIRO and the Sheep and Wool Branch of what was then the Queensland Department of Agriculture (now Primary Industries), with the aim of ensuring the application of research results in the field.

Extension officers took up the promotion of fleece measurement as an aid to selection, and the campaign was consolidated by a Fleece Measurement Conference held in Sydney in 1954 (CSIRO 1954). Measurement laboratories already existed at the Gordon Institute at Geelong (Victoria), the University of N.S.W. (Sydney), the Queensland Department of Agriculture and Roseworthy College, South Australia. Those not previously open to sheep-breeders made their facilities available, and further laboratories were established in other States. Measurements were originally without charge to the grower, but payment must now be made. With the advent of sale of wool by measured sample, Australian Wool Testing Authority laboratories were established to measure wool pre-sale, and these will also measure samples from individual sheep.

Measurements are made of percent clean yield, average fibre diameter and staple length. Originally staple crimp frequency was included, not diameter; it is now often omitted. Fleeces are weighed in the shearing shed and a midside (or shoulder) sample collected after shearing, each sample being sent in an airtight container to the laboratory. Greasy fleece weights and body weights (if taken) also go to the laboratory.

The sheep measured are usually those coming up for their first selection at 15-16 months of age. In the early years, greasy fleece weight was used as an aid to selection even for ewes in some flocks which bought their rams but bred their own ewe replacements. Rising costs, however, have meant that any measurements on ewes are confined to those in a few ram-producing properties, or to those in a cooperative breeding scheme which transfer their top ewes to a central ram-breeding nucleus. Greasy fleece weight, body weight and laboratory measurements are sometimes used in ram selection, the animals measured having already passed visual appraisal.

Measuring laboratories now have access to computers, and results are returned to growers with all information printed out for each animal together with its deviation from the mean for each characteristic. Greasy weights and percent clean yields are combined to give clean fleece weight, and in some cases various of the measurements are combined in an index; there is no index, however, which is universally used, and the method of presentation of results is not uniform.

Use of measurement is entirely voluntary, and the campaign to encourage it met with only limited success until the advent of sale of wool on measured sample. Interest has now increased; although a few ram-producers have been using measurement for decades, their numbers are now increasing, and more buyers are asking for performance records when purchasing rams. The N.S.W. Department of Agriculture has recently established a scheme to encourage the use of measured diameter in selecting flock (as distinct from stud) rams.

Because of the difficulty of identifying lambs with their dams at birth in large wool-producing flocks and studs run under extensive conditions, performance recording for such properties has not so far included reproduction rate.

2. Other breeds

A panel was appointed by the Animal Production Committee of the Standing Committee on Agriculture (a Commonwealth Government body) to recommend characteristics of importance in selecting meat sheep, and its report was published (APC, 1970). The characteristics recommended as important were number of lambs per birth, body weight at weaning (with adjustments for age of lamb, type of birth and age of dam), body weight at a later age (e.g. 15-16 months), which may also require adjustment to avoid selecting against twins, and fleece weight with 8-12 months' growth at 15-16 months of age.

Various pilot schemes for recording meat sheep have been tried, but the only full flock-recording scheme is one established by the Victorian Department of Agriculture in 1973. This incorporates reproduction rate, growth rate and wool production. Two forms are completed by the grower, one giving the lamb's eartag number, with that of its dam and sire, its sex, birth date, birth type (single or multiple), survival time, weaning weight and date. The second (optional) form records yearling body weight (taken at from 7-18 months of age) and data on the first adult fleece (10-12 months' growth following a weaner shearing), including greasy weight, average diameter and wool classer's appraisal.

From the records on the first form, the grower receives a print-out giving weaning weight adjusted to the mean age of the group, and corrected for birth-type and age of dam. A summary of performance for progeny of each sire is also given. A list of ewes failing to lamb must be kept; from this and Form 1, each year the ewe's reproduction index is compiled (number of lambs/number of opportunities).

The Victorian Department's scheme is the most comprehensive; South Australia has established a service providing adjusted weaning weight, while Tasmania is in the process of doing so. S.A. plans to extend its scheme to include ewe's reproductive performance (Stafford 1979).

3. National scheme

So far performance recording schemes for sheep are run on a State basis, but the possibility of a national scheme is currently under discussion.

B. Cattle

1. Beef cattle

Selection of beef cattle on recorded body weight, rather than solely on visual appraisal, has been encouraged in Australia for some decades. Performance recording on an integrated basis followed the 1967 Report of an Expert Panel on "Selection of Beef Cattle Breeding Stock", appointed by the Animal Production

Committee of the Standing Committee on Agriculture (later published - APC, 1968). The characters considered important were weight of calf produced; rate of growth post weaning; finish; percent of muscle in a fat-free carcase; fertility in males and females; adaptability; polledness, good temperament and absence of deformities.

The Beef Cattle Records Committee was appointed as a result of the Report, to co-ordinate work concerned with the application of performance in industry, and from its discussions were developed the basic specifications for a uniform national recording scheme. The Agricultural Business Research Institute of the University of New England at Armidale, N.S.W., was contracted to provide all data processing.

The National Beef Recording Scheme (NBRS) was finally launched in August 1972 (AMLC, 1979). At that stage, data were collected on mating details (dams and sires); results of mating (live calves, dead calves, failure to calve); growth to weaning and growth post-weaning. Reports returned to the breeder gave information on individual growth performance pre- and post-weaning, sire performance in relation to both, and dam performance on calf growth rate, including lifetime performance.

In 1974, desirable objectives were again reviewed, and it was concluded that major emphasis should be placed on fertility, maternal ability and growth, with measurement of growth altered from post-weaning gain to final weight and total lifetime weight gain.

A major appraisal of NBRS operations in 1975-6 led to the establishment of a two-stage system, which evaluates performance initially at 200 days, then at one of "final weight" ages (365, 420 or 550 days). Visual grade, eye-muscle area and fat depth can also be recorded at the second stage.

A third stage is being evaluated, which will give an assessment of reproductive performance and mortality.

The data accumulated by NBRS are being analysed to provide Australian estimates of adjustments for age of dam, sex and so on.

As with sheep recording, participation in NBRS is entirely voluntary.

2. Dairy cattle

Herd recording schemes are conducted by State Departments of Agriculture, participation again being voluntary.

Testing is done by measuring amount of milk at each of two milkings, either on a monthly or a bi-monthly basis, samples being taken for estimation of fat and protein content. Measuring and sample collection may be done by a Departmental herd recorder, by the farmer himself, or by a contractor. Estimations of fat and protein content are done in a central laboratory, usually run by the Department.

Some States report production in litres, some in kg.

C. Pigs

Various State Departments of Agriculture have been, or are, associated with on-farm performance recording of pigs. Measurements made include gain per day (to bacon weight, 63-110 kg) and back-fat measurements, made either with a back-fat probe or an ultra-sonic tester (Treacy 1976).

D. Goats

Performance recording for goats is becoming allied to established systems for other species. Milk recording for goats is being done by the organizations responsible for recording dairy cattle production, while fleece testing for Angoras is being incorporated into sheep performance recording.

E. Poultry

Random sample tests are conducted by some State Departments of Agriculture. Participating growers contribute eggs (taken at random) which are hatched at a central station, female birds then being reared under standard conditions, with performance recorded for a period of 50 weeks after the beginning of lay. Records are kept of number of eggs laid, feed consumed, egg weight and quality, body weight (at beginning and end of the 50-week laying period), age to reach 50% lay. A control line is included in each test.

Random sample tests have been discontinued in some States (e.g. Queensland) because of low level of participation and inadequate facilities, and other States are currently re-assessing their continuation. Some on-farm sample surveys have been conducted (e.g. Geysen 1976-7; Evans 1977-8; Dark et al. 1978) which give performance information of value to producers at various levels of the poultry industry : producers of fertile eggs, hatcheries, growers of broilers, egg producers.

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Discussion

Bhat: How popular is the National Beef Recording Scheme? Since the farmer has to pay for the recording of his animals, what does he get in terms of nett economic benefit by being a member of the scheme?

Barker: In total, some 9000 herds are members of NBRS, and 18 beef cattle breed societies operate pedigree/performance recording programs through the scheme.

An individual breeder pays A$40.00 to join the scheme, and 70¢ per calf recorded, and he has to weigh his own animals. His records are then processed - to adjust for age of calf at weighing, age of dam, etc. so that adjusted records may be used for selection decisions. Lifetime performance of cows and average progeny records of sires are estimated, and the data may be used for management as well as breeding decisions.

The economic benefit to the breeder depends on his use of the records for these purposes. In early 1979, it was estimated that if members were using their records efficiently in breeding decisions, the average extra gross value of beef produced per herd would be of the order of A$10,000.

Rendel: I believe Dr. Bhat has touched on a very important question, namely how to get farmers to participate in a recording scheme. Obviously the farmer needs to be convinced that he will benefit. While Australian cattle breeders with large herds may be convinced, the situation may be very different in many other countries.

In these countries, the recording program may need to be part of an extension program giving advice on feeding and management. Should this not be sufficient, the recording scheme may need to be subsidized by the industry as a whole, which obviously will benefit from it.

Turner: I would agree with Dr. Rendel's comment, and should point out that even in Australia, acceptance of recording schemes by breeders is not always easy. Fleece weight is the most important single characteristic in Merino sheep breeding, and in the early days of urging performance recording for sheep some 30 years ago, we showed that estimation of fleece weight by eye was only 40% efficient, as compared with fleece weighing. Even so, interest in performance recording programs has developed only recently, and then largely because the wool is now being sold on the basis of measured characteristics.

Subramaniam: In recording schemes in Australia, do you record the frequency of occurrence of specific diseases?

Turner: Not in the recording schemes. The Commonwealth Bureau of Animal Health, in association with State Departments of Agriculture, has a comprehensive scheme of disease recording. Of course, Australia is free of most of the major animal diseases such as foot and mouth, rinderpest, etc.

Bhat: While Australia may be free of those diseases, with the increasing movement of people by air, I believe some of these diseases may spread more easily. In the future, we may then have to pay much more attention to inherited disease resistance, and breeding strains that are more resistant. Considerations of disease resistance or susceptibility are a very important aspect in evaluating our animal genetic resources.

ANIMAL GENETIC RESOURCES IN INDIA

P.N. Bhat, Pran P. Bhat, B.U. Khan, O.B. Goswami
and B. Singh

I. INTRODUCTION

Discussion on animal genetic resources over the last few decades has crystallized around the need for four steps: Identification, documentation and evaluation, conservation and utilization. Mason (1974) gave three main reasons for conservation:

Agricultural - reduction in genetic variation through current improvement schemes removes flexibility for future improvement. In particular, removal of local hardy breeds, especially sheep and goats, may mean loss of species suitable for low input agriculture.

Scientific - animals adapted to specific conditions are needed to study the basic nature of the adaptations.

Cultural - diversity is part of our natural heritage.

Identification and documentation/evaluation are needed before final decisions can be taken about what to conserve. In India, new breeds are being identified, such as Siri cattle in Sikkim and Kashmir Black in the Kashmir Valley, as well as a third cattle breed in Kerala. Some of these thrive on forest grazing.

A source of loss other than extinction has also been recognized in India. Cows and buffaloes with the highest milk yield have been moved to urban centres and have been slaughtered after completing lactation; high-producing genotypes are thus being removed from the breeding tracts, leaving inferior genotypes for breeding.

Problems of evaluation and conservation are not easy to solve. A possible approach for some countries is to tie all livestock development programmes into the problem of evaluating and conserving genetic resources. As a first step, local populations for all breeds of livestock should be maintained in nucleus herds under government or private ownership. Funding should be by the government, from money allocated for livestock improvement programmes.

A. Steps taken in India

In India the need for conservation of animal genetic resources has become clear, and the lack of necessary documentation and evaluation has been recognized. A National Bureau of Animal Genetic Resources has been established, which will have the following functions:

(i) To evaluate the various breeds of cattle, buffaloes, goats, sheep and other species.

(ii) To stimulate programmes for improvement in the various breeds and give adequate support.

(iii) To take steps for the preservation of germplasm both as live animals and by setting up frozen semen banks for storage of a certain number of minimum doses of semen of sires under evaluation at various centres of research.

(iv) To undertake surveys for the evaluation of merits or attributes of breeds threatened with extinction.

(v) To undertake systematic cataloguing of animal germplasm and to establish a data bank and information service on animal genetic resources.

In particular, it is now recognized that existing performance data are scanty, and past evaluations have used inadequate experimental design. Further, no evaluation in the usual environment is available except for cattle.

Besides the National Bureau, national research centres have been established to investigate rare species economically important for various regions, such as mithun (*Bos frontalis*) and yak (*Bos phoephagus graunieus Linn.*).

A major effort is also underway to identify genotypes suitable for low input agriculture, as suggested by Bhat (1978).

B. Outline of present paper

The paper is divided into five sections, discussing various species of livestock and birds, including their economic value.

II. CATTLE, BUFFALOES, MITHUN AND YAK

A. Cattle and buffaloes

1. General

Cattle and buffaloes are the most important livestock in India and play a pivotal role in the agrarian economy. Information on them is available both under government farm and field conditions, except in the case of new and rare breeds. Examples of these latter are frequently being found, and attempts are being made to describe both the breeds and their habitats.

Bullocks are still the main source of motive power, and milk the main source of animal protein in the Indian diet. Cattle are used for ploughing, harrowing, harvesting, threshing and transport; they replenish the fields with organic manure. India is one of the largest suppliers of hides and skins in the international market, while horns, hoofs and bones are utilized in many industries and in the preparation of bone-meal.

Indian cattle, on account of their draught qualities and resistance to major cattle plagues and parasitic diseases, have been exported to Western countries for cross-breeding to combine the productivity of the European breeds with the hardiness of the Indian.

The indigenous humped cattle, *Bos indicus*, differ from the *B. taurus* of Europe and North Asia in body conformation, colouration and habits. Their origin is unknown, but they are thought to have descended from *B. nomadicus* in South Central Asia. No ancestral form has yet been found among Indian fossil bovines.

Tending of cattle is considered an honourable profession, and milk products such as milk, butter, cheese and ghee are consumed by all classes of the population. However, genetic improvement is hampered by the fact that cattle are sacred and slaughter is frowned on.

2. Distribution

The average density of cattle population per 100 ha of grass-cropped areas is 116, ranging from 61 in Punjab to 283 in Maharashtra and Gujrat; West Bengal and Orissa densities lie in between, at 188 and 162 respectively.

The Indian cattle population varies in appearance in different parts of the country, possibly to suit different climatic conditions (see Figure 1). The most productive breeds are found in Punjab, Rajasthan, Saurashtra, part of Maharashtra, Madras, Mysore and Andra Pradesh. In the eastern and coastal areas (e.g. Assam, West Bengal, Orissa and Kerala) the animals are nondescript and are poor milkers; poor quality animals are also found in hilly areas with high rainfall.

The numbers of cattle and buffaloes in each State are given in Table 1, while the well-defined breeding tracts are given in Figures 2 and 3.

3. Description

India has 26 breeds of cattle and 7 of buffaloes, together with a number of nondescripts, small in size and of low productivity.

Indian cattle breeds are classified as milch, draught and general purpose. Joshi and Phillips (1953) gave very detailed descriptions of them, which need not be repeated here. They classified the breeds into 5 main groups, with the following broad descriptions:

Group I : Lyre-horned, grey colour; wide forehead, thin face with flat or dished-in profile.

Group II : Short-horned, white or light grey colour; long, coffin-shaped skull, face slightly convex in profile.

Group III: Ponderous in build, with pendulous dewlap and sheath, prominent forehead, lateral and often curled horns. Solid red, dun or brown colour, or spotted red and white.

Group IV : Medium-sized, compact. Forehead prominent; horns emerge from top of poll in upward and backward direction and are very pointed. Grey colour.

Group V : Heterogeneous mixture of strains. Small; horns short or lyre. Black, red or dun, often with white markings.

The body dimensions and body weights for adults of the main cattle breeds are in Table 2. The group to which each breed was allotted by Joshi and Phillips is included. Breeds are listed alphabetically within each category of main use.

Descriptions and dimensions of buffalo breeds are in Table 3.

4. Environment, management, feeding and disease

(i) Environment: The environment in India varies considerably. The annual rainfall ranges from 380 mm to 3,800 mm, falling mainly from July to September, while temperatures range from extreme heat (dry or humid) to heavy snowfalls in the mountain areas.

The country has been divided into five climatic regions, four of which are shown in Figure 1, the fifth being a further subdivision of the wet region. The five regions are:

Temperate Himalayan (Region 1): Rainfall is heavy; snow and frost occur. Crops are mainly paddy, wheat and horticultural. Alpine pastures are common, and there are dense forests in some parts. Most animals are moved between summer and winter pastures.

Dry northern and central (Region 2): Rainfall is low and vegetation scanty, most cultivation being by irrigation.

Eastern (north part of Region 3): Rainfall is heavy, and rice is cultivated.

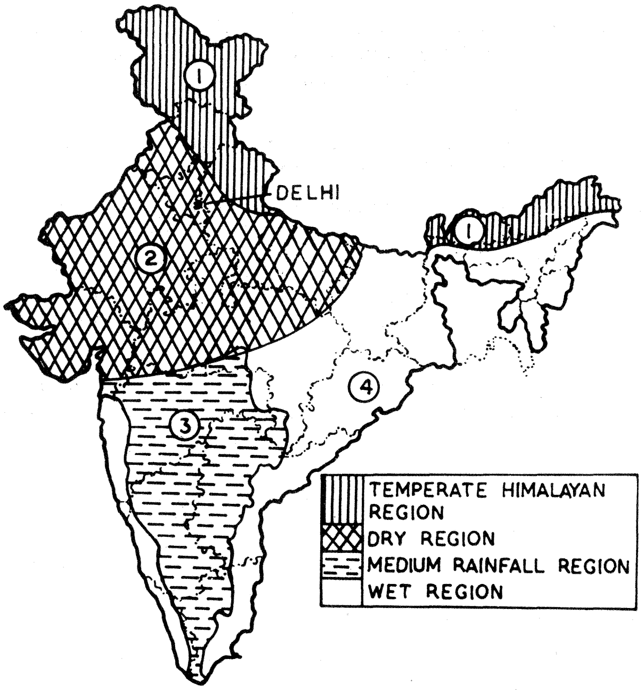

FIG.1_A CLIMATIC REGIONS OF INDIA

Fig. 1 - Climatic regions of India.

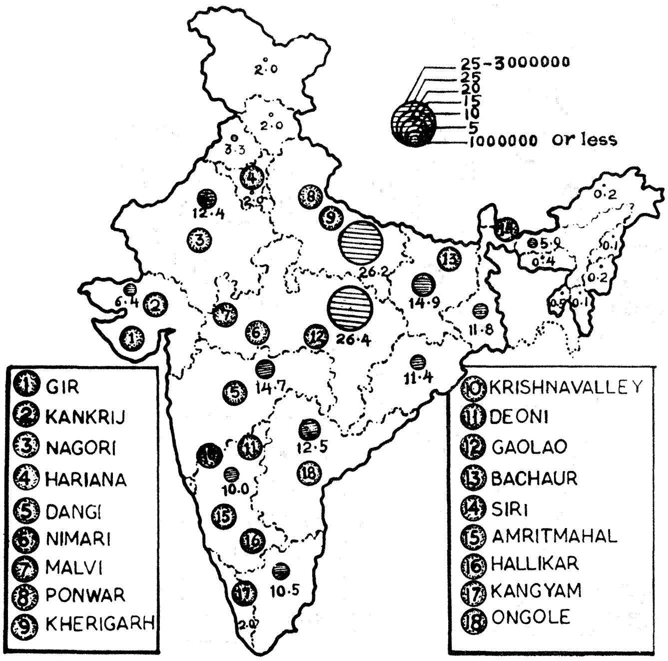

FIG. 2 _ IMPORTANT CATTLE BREEDS AND CATTLE POPULATION IN INDIA

Fig. 2 - Important cattle breeds and populations in India.

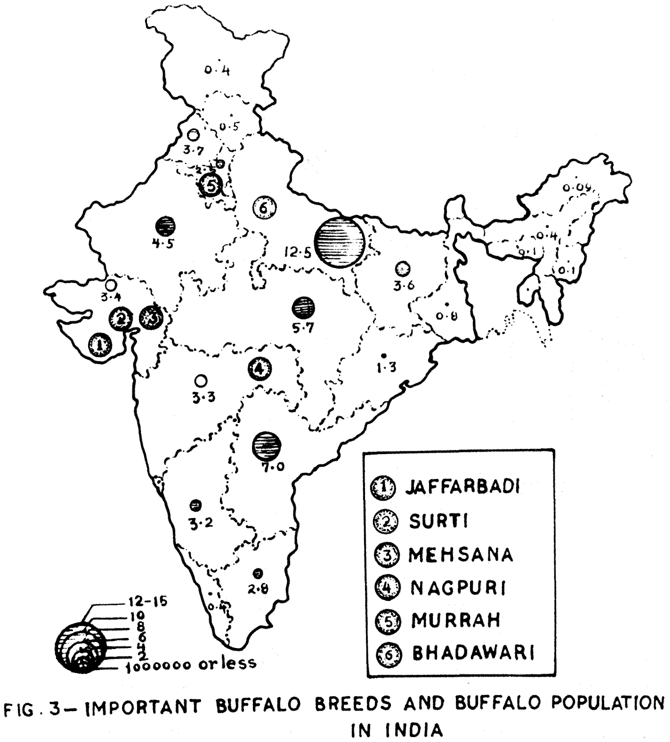

Fig. 3 - Important buffalo breeds and populations in India (1972).

Table 1. Statewise distribution of cattle, buffaloes and yaks (in thousands) (1972 census)

State	Cattle	Buffalo	Yak
Andhra Pradesh	12507	7057	-
Assam	5796	489	1
Bihar	14911	3679	-
Gujrat	6457	3468	-
Haryana	2451	2518	-
Himachal Pradesh	2176	544	4
Jammu & Kashmir	2057	493	12
Karnataka	10019	3216	-
Kerala	2856	472	-
Madhya Pradesh	26461	5795	-
Maharashtra	14705	3301	-
Manipur	294	52	8
Meghalaya	468	46	-
Nagaland	89	9	17
Orissa	11496	1399	-
Punjab	3390	3795	-
Rajasthan	12469	4593	-
Tamil Nadu	10573	2853	-
Tripura	525	20	-
Uttar Pradesh	26217	12592	1
West Bengal	11878	824	-
Andaman & Nicobar Islands	19	8	-
Arunachal Pradesh	174	9	-
Chandigarh	5	11	-
Dadra & Nagar Hawali	40	3	-
Delhi	68	128	-
Goa, Daman & Diu	124	38	-
Laksya Deep	1	-	-
Mizoram	25	2	-
Pondicherry	90	12	-
India	178348*	57426	43

* The total for India and the sum of numbers given for each state do not tally due to reorganization of states.

Table 2. Body dimensions and body weights of adults of Indian cattle breeds

Main use	Breed	Group (Joshi and Phillips)	Sex	Average body dimensions (m)			Body weight (kg)
				Height	Length	Girth	
Milch	Deoni	III	M	1.5	1.7	2.0	590
			F	1.3	1.5	1.7	340
	Gir	III	M	1.4	1.5	1.8	544
			F	1.3	1.7	1.7	386
	Red Sindhi	III	M	1.3	1.4	1.8	454
			F	1.2	1.4	1.4	317
	Sahiwal	III	M	1.7	1.5	1.9	544
			F	1.3	1.4	1.7	408
Draught	Amrit Mahal	IV	M	1.3	1.5	1.9	499
			F	1.3	1.3	1.7	318
	Bachaur	II	M	1.4	1.2	1.8	386
			F	1.0	1.2	1.7	318
	Bargur	IV	M	1.2	1.4	1.8	340
			F	1.0	1.3	1.7	295
	Hallikar	IV	M	1.4	1.5	1.9	454
			F	1.2	1.3	1.7	318
	Kangayam	IV	M	1.4	1.6	1.9	545
			F	1.4	1.4	1.7	386
	Kenkatha	I	M	1.3	1.2	1.8	344
			F	1.0	1.2	1.7	295
	Kherigarh	I	M	1.3	1.2	1.8	476
			F	1.3	1.3	1.5	318
	Khillari	IV	M	1.4	1.4	2.0	499
			F	1.3	1.1	1.7	340
	Malvi	I	M	1.4	1.5	2.0	499
			F	1.3	1.4	1.7	340
	Nagori	II	M	1.5	1.5	2.0	408
			F	1.4	1.3	1.9	340
	Ponwar	V	M	1.4	1.4	1.6	318
			F	1.3	1.3	1.6	295
	Siri	V	M	1.3	1.5	1.9	454
			F	1.2	1.3	1.8	363
General purpose	Dangi	III	M	1.3	1.4	1.5	363
			F	1.2	1.3	1.5	295
	Gaolao	II	M	1.5	1.2	1.9	431
			F	1.3	1.3	1.7	340

Continued

Table 2 continued

Main use	Breed	Group (Joshi and Phillips)	Sex	Average body dimensions (m)			Body weight (kg)
				Height	Length	Girth	
	Hariana	II	M	1.4	1.5	2.0	499
			F	1.3	1.4	1.7	354
	Kankrej	I	M	1.6	1.6	2.0	590
			F	1.3	1.4	1.8	431
	Krishna Valley	II	M	1.5	1.5	1.9	499
			F	1.2	1.3	1.5	340
	Mewati (Kosi)	II	M	1.6	1.8	1.9	386
			F	1.2	1.3	1.6	327
	Nimari	III	M	1.6	1.8	1.8	390
			F	1.4	1.3	1.6	318
	Ongole	II	M	1.5	1.6	2.0	568
			F	1.3	1.1	1.8	431
	Rath	II	M	1.5	1.5	2.0	386
			F	1.2	1.4	1.5	318
	Tharparkar	I	M	1.3	1.4	1.9	544
			F	1.3	1.4	1.7	386

Table 3. Descriptions, body dimensions and body weights of adults of Indian buffalo breeds

Breed	Description	Colour	Sex	Body dimensions (m)			Body weight (kg)
				Height	Length	Girth	
Bhadawari	Body medium sized, wedge shaped; head comparatively small; legs short and stout, hoofs, black; hind quarters heavier and higher than forequarters; hair scant on the body; tail long, thin and flexible, with black and white or pure white switch reaching to hocks.	Copper	M F	1.3 1.3	1.4 1.4	1.9 1.8	476 385
Jaffarabadi	Long body but not compact; dewlap in female somewhat loose; head and neck massive; forehead very prominent, horns heavy, inclined to droop on each side of neck, less tightly curved than in Murrah; udder well developed.	Usually black	M F	1.5 1.4	1.7 1.7	1.9 1.9	590 454
Mehsana	Body longer than in Murrah; lighter limbs; head longer and heavier; horns usually less curved at the end but longer; well shaped udder.	Black or fawn grey with white markings on face, legs or tail tip	M F	1.5 1.4	1.8 1.6	2.1 2.1	567 431
Murrah	Body massive; head comparatively light; horns short and tightly curved; well developed udder, hips broad; fore and hind quarters drooping; tail long, reaching to fetlocks.	Jet black with white markings on tail, face and extremities	M F	1.5 1.4	1.5 1.5	2.3 2.2	567 431
Nagpuri or Ellichpuri	Long horns, flat and curved; face long and thin, neck somewhat long, limbs lighter, tail comparatively short, reaching little below hocks.	Usually black, some times white patches on face, legs and tail tip	M F	1.4 1.3	1.8 1.5	2.1 2.0	522 408

Continued

Table 3 Continued

Breed	Description	Colour	Sex	Body dimensions (m) Height	Length	Girth	Body weight (kg)
Nili Ravi	Head elongated, bulging at the top, depressed between eyes, muzzle fine; frame medium sized; horns small, coiled lightly; neck long, thin and fine; udder well developed; tail long, almost touching ground.	Usually black with white markings on forehead, face, muzzle and legs	M F	1.4 1.4	1.6 1.5	2.3 2.3	567 454
Surti	Body well shaped, medium sized wedgeshaped barrel; head long and broad, rounded between horns; back straight; eyes prominent; horns sickle-shaped, moderately long and flat; tail fairly long, ending in a white tuft.	Black or brown, two white collars, one round the jaw and the other at brisket	M F	1.3 1.3	1.4 1.4	1.9 1.8	499 408

Southern (Region 4): Rainfall is uncertain, and millet the main crop.

Coastal (south part of Region 3): Rainfall is very heavy, and rice the main crop.

(ii) Management: Animal husbandry in India is mainly carried out by small farmers, cattle raising being a subsidiary occupation. The average size of holding is 3 ha, with 2-3 cattle, some sheep and goats and a few birds.

Grazing is poor except during the monsoon, when fresh vegetation is available. Other available feeds are not adequate to sustain the existing cattle population. Marketing facilities for milk and milk products are meagre, the farmers having either to depend on intermediary agents, who take away most of the profits, or to dispose of their surplus milk in the form of ghee, which is the least remunerative of all the milk products. As a result cattle are neglected, their growth is slow, and they mature much later than cattle in other countries. The interval between calvings is prolonged and losses due to starvation and diseases are high. Milk production, on the whole, is low.

(iii) Feeding: India has 227 million cattle and buffaloes, which cannot be properly and adequately fed from available resources. In countries with highly developed dairying industries, such as New Zealand, only one female calf out of six or eight produced by a cow is reared to maturity, to replace the cow when she becomes old, and the rest are slaughtered. Thus the total number of animals in the country is kept under control. Most of the Indian population is sentimentally opposed to beef eating, and is thus faced with the problem of feeding unproductive as well as productive cattle.

Indian standards (IS: 2052-1962) have been laid down for preparing several balanced feed mixtures of roughages and concentrates for cattle of different ages. Roughages include fodder and forage crops, and the concentrates include cereals and oil-seeds, as well as cereal and animal by-products.

In addition to the fodder and forage crops obtained in cultivated areas, other roughage is obtained from grazing, either of public lands in villages, Government land or forest areas (which include roadside verges).

(iv) Disease: Most Zebu cattle breeds are resistant to diseases such as rinderpest (cattle plague), foot-and-mouth and many others of bacterial or viral origin. There is a general belief that this resistance is partly genetic, partly due to immunity acquired in the environment, but there is no clear-cut evidence on the matter. In surveys it has been observed that pure exotic breeds and Zebu x *B. taurus* crosses are more susceptible to these diseases than are pure Zebus, but the observations are not based on contemporary comparisons.

Genetic resistance to endo- and ecto-parasites by Zebu and Zebu x *B. taurus* crosses is well established. Experiments are needed to locate alleles or genetic complexes responsible for this resistance.

Vaccination against most of these diseases is practised, though mainly in highly productive herds. Rinderpest has been controlled through a major programme which supposedly has covered the entire cattle and buffalo population; no case has been reported for many years.

5. Reproduction

Cattle breed all the year round, but for buffaloes there is marked seasonality in calving. One suggestion is that this is caused by temporary summer sterility in the bulls; the hypothesis is supported by the fact that in areas where summer stress is minimal, seasonality of calving has not been observed. There is no general agreement, however, on the cause of the phenomenon.

The proportion of cows and female buffaloes failing to produce offspring, even though mated, is high. This may be partly due to the fact that there is virtually no culling for infertility or reproductive disorders.

Mortality of female calves does not exceed 10 percent, while adult mortality does not exceed 5-8 percent annually. Among dairy breeds in cities and urban areas, however, many male calves are allowed to starve to death before weaning.

Data related to reproduction in cattle and buffaloes are given in Tables 5 and 6 (in Performance section)

6. Breeding

There are at present twenty six breeds of cattle and seven breeds of buffaloes in the country. The improved and specialized breeds are generally found in the north-western and western dry areas. Only a very small proportion of the cattle and the buffalo stock is, however, pure-bred; seventy-five per cent of the total cattle population do not belong to any distinct breed and are classed as nondescript.

Selection over centuries to meet the special requirements of agricultural power has resulted in excellent draught animals. Some dual-purpose and a few milch breeds of cattle also have been developed. In India the emphasis so far has been mainly on producing bullocks capable of supplying the motive power for agricultural operations, but the demand for milk has been increasing during recent years with the increasing human population. Agricultural operations were slowly becoming mechanized in the country and the requirement of bullocks for agricultural purposes seemed likely to go down. With the prevailing energy shortage, however, it appears that bullocks will continue to be the main source of motive power for agriculture for a long time to come.

Herd books for dairy breeds were introduced in 1941. These herd books serve as an authoritative guide on the standard breeds and their respective milk yield. The breeds, with their required minimum milk yield qualifications (in kg), so far included in the herd books are: Buffalo - Murrah (1,362); cattle - Sahiwal (1,362), Red Sindhi (1,135), Tharparkar (1,135), Hariana (908), Gir (908), Kankrej (681), Ongole (681) and Kangayam (454).

In the villages, good pedigreed bulls are used for breeding, selected on conformation, aptitude for draught, and, in some dairy breeds, milk production of their dams. About 2-3 males from each village are retained entire, the rest being castrated. Mating is at random, males grazing with the females.

Artificial insemination is in vogue for both cattle and buffaloes; in some states about 60 percent of females are mated by AI. For improvement of milk yield in cattle, crossbreeding with Holstein, Brown Swiss, Jersey, Red Danish and other European breeds has been adopted. So far, two new strains, both based on Brown Swiss, have been developed, viz. Karnswiss and Sunandine.

7. Performance

Data for body weights of cattle and buffalo at different ages are in Table 4. Reproduction and milk production figures for purebred cattle are in Table 5, and for buffaloes in Table 6. Corresponding data for crossbred cattle are in Table 7.

The records in Tables 4-7 were made under standard conditions on Government of India or State Government farms, military establishments, University or commercial farms. The animals were housed and stall-fed according to NRC standards. Milking was twice daily (2.30 a.m. and 2.30 p.m.); all pure-bred and some cross-bred cows were hand-milked, the remainder machine-milked.

Records have been adjusted for year, season and lactation effects wherever possible.

Table 4. Average body weights (kg) of different pure-breds and their crosses for Indian cattle and buffalo breeds

Breed	Body weight						Maximum average daily gain (kg) (12-26 wks)
	Birth	6 months	12 months	18 months	24 months	30 months	
CATTLE							
Gir	20.30±0.16**	113.27±3.56	166.14±2.03	203.52±2.42	245.48±4.31	285.78±3.92	0.540
Hariana	18.70±0.23	113.93±0.96	178.73±5.59	238.35±3.72	277.24±4.05	334.49±8.36	0.566
Red Sindhi	17.27±0.19	97.81±1.67	174.20±4.26	222.08±3.86	267.28±3.41	305.41±3.23	0.464
Sahiwal	19.63±0.13	104.63±0.69	176.34±1.59	235.87±1.76	281.49±2.05	328.88±2.47	0.568
Tharparkar	19.53±0.34	96.72±1.98	168.82±4.15	217.03±4.05	263.84±4.22	305.39±3.98	0.448
G X F*	22.07±0.23	131.63±1.22	223.23±3.36	263.96±3.88	310.54±4.58	358.53±6.47	0.653
H X F	23.88±0.24	139.85±1.38	222.64±2.77	270.27±4.46	333.17±3.53	390.27±3.84	0.689
R X F	19.78±0.41	131.63±1.22	209.05±4.47	277.71±3.92	347.74±4.92	308.90±14.07	0.668
S X F	23.92±0.30	135.36±2.28	213.93±3.39	273.02±3.90	326.82±4.39	365.07±6.41	0.684
T X F	22.08±0.34	126.26±3.14	209.53±7.92	267.64±5.91	326.97±4.90	372.56±5.49	0.621
BUFFALOES							
Murrah	29.25±0.21	118.57±1.42	212.12±2.68	263.97±2.93	324.50±2.98	376.91±3.39	
Murrah Grades	29.32±0.09	118.58±0.68	211.83±1.50	265.91±1.46	325.67±1.46	382.94±1.66	
Nili	30.52±0.17	133.92±1.52	218.84±3.14	288.93±3.28	355.78±3.49	423.92±4.00	
Nili Grades	29.88±0.11	123.47±0.99	205.78±1.94	267.91±1.77	339.65±1.07	400.85±2.09	

*F = Friesian ** Standard error of mean

Table 5. Reproduction and production data of Indian cattle breeds

Breed	Age at first calving (months)	Service period (days)	Calving interval (months)	Lactation yield (kg)	Lactation length (days)	Dry period (days)	Milk yield per day of calving interval (kg)
Deoni	52.9±1.0*	163.6±6.5	14.8±0.3	879.2±23.6	270.0± 4.6	172.6± 7.4	2.0
Gir	47.0±0.8	160.6±4.4	15.7±0.5	1403.0±31.1	257.4± 4.6	213.6± 5.1	2.9
Red Sindhi	41.7±0.6	146.8±5.1	14.7±0.3	1605.0±24.7	284.0± 2.4	146.8± 5.1	3.7
Sahiwal	40.2±0.2	156.0±3.2	15.0±0.6	1718.7±36.0	283.5± 1.8	156.0± 3.2	3.8
Hallikar	45.1±1.5	298.3±7.5	19.7±0.9	541.9±61.1	285.1±10.1	302.0±28.5	0.9
Kangayam	44.1±0.4	225.0±5.9	16.7±0.3	643.6±10.5	212.0±30.0	242.0± 6.9	1.3
Khilari	51.5±1.1	175.0±4.0	15.2±0.2	214.7±12.2	255.0± 3.1	242.7± 6.7	1.0
Umblachery	45.6±1.1	202.0±8.9	16.1±0.5	323.9±18.5	233.7± 9.1	277.9±15.8	0.7
Dangi	53.6±2.0	229.0±6.9	17.0±0.6	615.9±34.9	292.5±11.5	221.3±16.8	1.2
Deogir	46.9±2.1	181.0±9.0	15.4±0.4	1423.1±60.5	313.2± 8.7	157.0± 8.4	3.1
Gaolao	46.2±0.4	188.3±4.8	15.6±0.3	534.5±15.2	295.2± 5.2	185.2± 7.6	1.3
Hariana	58.7±0.4	166.9±0.5	19.5±0.5	1136.7±34.0	232.5± 4.3	166.9± 8.0	1.9
Kankrej	47.4±0.8	212.0±6.1	16.2±0.4	1850.0±51.4	351.0± 8.0	141.0± 9.2	3.8
Ongole	39.9±0.4	229.3±5.2	17.0±0.6	613.1±60.5	217.0± 8.9	366.2±23.7	1.2
Rath	40.1±0.4	256.1±8.3	19.3±0.7	1931.0±53.0	331.0± 4.2	243.0± 6.2	3.3
Tharparkar	49.4±0.4	145.5±8.3	14.8±0.8	1659.2±53.3	280.1± 6.0	145.5± 8.3	3.7
Non-descript (Coastal region)	59.0±2.5	280.0±8.6	18.7±1.0	534.7±14.3	303.0± 6.2	264.0±20.3	0.9
Non-descript (Eastern region)	54.0±2.0	295.2±9.2	19.6±0.9	492.3±11.6	268.6± 4.0	300.8±26.1	0.9

* Standard error of mean
Source: Bhat, P.N. (1977)

Table 6. Reproduction and production traits of Indian buffalo breeds

Breed	Age at first calving (months)	Calving interval (days)	Lactation yield (kg)	Lactation length (days)
Bhadwari	50.7±0.8*	453.6±10.2	1111.0± 12.9	276.0±2.2
Murrah	41.3±1.4	495.1±12.2	1744.0± 10.5	279.0±6.5
Murrah**	42.4±0.1	479.5± 2.4	1597.3± 8.0	295.9±1.0
Marathwada	55.2±0.9	429.9± 7.4	960.0± 38.0	270.0±6.5
Nili	53.2±0.6	461.6±18.8	1855.2±106.3	316.0±8.5
Surti	44.5±2.0	461.1±15.3	1772.0± 10.3	350.1±5.4
Non-descript	49.5±0.8	481.0±18.4	541.0± 39.9	272.0±8.5

* Standard error of mean

** Data from a different location

Table 7. Reproduction and production data of Indian cross-bred cattle (*B. indicus* ♀ x *B. taurus* ♂)

Breed	Age at first calving (months)	Service period (days)	Calving interval (months)	Lactation yield (kg)	Lactation length (days)	Dry period (days)	Milk yield per day of calving interval (kg)
G X F*	34.9±0.5 **	113.3±11.6	13.2±0.3	2254.5± 97.5	288.2± 6.0	105.9±16.3	5.7
G X J	24.9±1.8	101.0±10.8	12.7±0.9	2713.0±225.5	324.0± 6.2	57.0± 6.3	7.1
H X BS	29.0±0.9	134.0±12.0	14.1±0.6	2785.5±163.2	336.0±24.5	115.0±23.2	6.6
H X F	33.0±1.1	173.0±15.3	15.3±0.8	3195.5±205.0	340.0± 5.1	85.0±15.4	7.0
H X J	32.9±1.2	134.0±10.7	13.5±0.4	2868.0±215.5	308.0± 4.2	98.0± 5.2	7.1
J X BS	34.5±5.1	147.2±77.3	14.4±2.9	2188.0±697.0	292.0±12.9	141.3±18.8	5.0
L X J	31.0±3.5	218.2±17.9	17.7±0.8	1151.0± 45.0	328.6± 4.0	109.3±23.2	3.7
R X J	31.3±1.2	104.0±11.2	12.6±0.5	2801.6± 96.4	321.0± 8.4	60.0±11.9	7.4
RS X F	29.2±0.6	90.0±10.8	12.2±0.4	2326.2± 94.3	283.8± 8.3	84.1±18.2	6.3
RS X J	29.0±0.9	109.6± 9.9	13.6±0.5	1501.7± 82.3	305.8± 7.2	98.4±12.8	3.7
RS X RD	28.3±1.2	71.0±10.3	11.7±0.3	2213.8±115.5	267.0± 9.4	85.0±17.0	6.2
S X F	34.7±0.8	133.6±11.5	13.7±0.4	2356.8± 20.0	294.6± 5.1	121.8±12.4	5.7
S X J	32.6±0.6	120.0±15.4	13.3±0.6	2659.7± 29.0	314.0±16.8	92.0± 6.3	6.7
T X F	33.6±0.6	119.8±12.4	13.2±0.4	2600.0± 49.5	311.1±17.8	96.2±17.7	6.6

*H = Hariana, S = Sahiwal, RS = Red Sindhi, G = Gir, T = Tharparkar, L = Non-descript, R = Rathi, F = Friesian, BS = Brown Swiss, RD = Red Dane and J = Jersey.
** Standard error of mean
Source: Bhat, P.N. (1977)

B. Mithun

Apart from humped Zebu cattle, there are in the north-eastern region a number of wild, semi-wild and domesticated humpless cattle. Economically the most important is the Mithun (Bos frontalis), raised primarily for meat and sacrifice, and also used for bride price, two mithuns being presented to the bride's family at the time of a wedding.

Prater (1971) believes the Mithun has arisen from the cross of Gaur, the wild cattle of the Indo-Malaysian region, with domestic cows.

1. Distribution

The Mithun lives in semi-wild conditions, living on forest produce and is seldom given concentrates, only salt licks being provided. The animals are usually found at an altitude of 600-1500 m.

At the last census (1972) the total population was 121,000, spread over Arunachal Pradesh (76,000), Nagaland (17,000), Tripura (13,000) and Manipur.

A national centre for studies on the Mithun has been started in Arunachal Pradesh.

2. Description

The Mithun is slightly smaller than the Gaur with heavy fore-quarters, and a muscular ridge along its shoulders which slopes down to the middle of the back and ends in an abrupt dip. The face is narrow, ears are erect and small to medium in size; the dewlap is distinct and tail comparatively short. The coat colour is predominantly black, with white patches.

The adult male Mithun weighs 400-500 kg, with body length 1.2 m, height 1.4 m and girth 1.6 m. Females have body measurements 8-20 cm less than males.

C. Yak

1. Distribution

The yak, or grunting ox (Bos poephagus graunieus Linn.) is a native of Tibet and surrounding countries in central Asia. In the wild it inhabits the coldest and most desolate tracts of the Himalayas, being found at elevations of 4000-6000 m. In India, it is found in the valleys of Ladakh, Pangi, Chini, Lahul, Spiti, Garhwal and Sikkim.

The distribution over states is given in Table 1. Hybrids with cattle are now twice the purebreds in number. Since there has been no organized effort to preserve this useful animal, its population has declined by almost 25 percent over the last 10 years.

2. Description

The wild yak is dark brown to almost black in colour, except for the head and neck, which are often grey. Domesticated yaks are variable in colour, being often pure white to piebald.

The domesticated yak is also relatively smaller in size than the wild form, but is still a massively built animal; an adult bull stands about 1.7 m at the shoulder, and may reach 1.83 m. It weighs about 544 kg. Good horns measure 6.4-7.4 cm in diameter.

The yak has a drooping head, high humped shoulders, a straight back and short, sturdy limbs. Shaggy hair covers the chest, shoulders, thighs and the lower half of the tail, forming a bushy tuft between the horns and a great mane on the neck.

The mating season is limited to late autumn, and young are born in April, when tender grass ensures adequate food supply. In summer yaks eat small shrubs, and also eat and drink melting snow.

The average annual yield of milk is about 385.5 kg, with a 6 percent fat content.

3. Uses

The yak supplies milk, meat, hides and fibre, as well as transport for man and merchandise, and draught power for ploughing. Without the yak, travel and trade in desolate trans-Himalayan regions would be extremely difficult.

Yak skins are used for making loose robes by local people at high altitudes, while the long hair is woven into a rough cloth for tents, and is made into ropes and fly whisks. Bones, horns and hoofs are used for manure.

4. Hybrids

The yak has for centuries past been interbreeding with domestic cattle in the Himalayan heights. Two kinds of hybrids, one horned (Zo) and the other hornless (Zum), are known; both breed true. Yaks are kept for breeding purposes in the plateau areas of Spiti and Pangi, and also in the northern parts of the valleys. Yak bulls are mostly used for cross-breeding hill cows. Yak cows are also, of late, being used for crossing.

The yak interbreeds with several other members of the genus Bos, such as bison, banteng, gayal, zebu and European cattle. No interbreeding with buffaloes has, however, been recorded so far in India.

Hybrids are intermediate in body size, and surpass both parents in many ways when bulls of improved native stock are used on yak females. They have good beef conformation particularly when castrated, and the quality of meat and hides is superior to that of the yak. The hybrids are hardier than the yak and are capable of bearing heavier loads, but are inferior in staying power. Their hoofs are softer and are, in fact, more adapted for a warmer climate. In milk production they surpass the yak cow and sometimes native domestic cattle. The milk of hybrids has a higher fat percentage than that of domestic cattle.

III. SHEEP AND GOATS

A. Sheep

1. General

Not much is known about the origin of sheep in the Indian sub-continent. According to Allchin (1969), excavations at Adamgarh in Hoshangabad district have revealed a number of domestic animal species on these sites, which include a candid, a pig (Subcristatus), buffalo, sheep and goat. In parts of Baluchistan and adjacent areas, bones of cattle, sheep and goats have been excavated dating back to the first stage of settlement. Chronologically next to the Baluchistan finds, the earliest information has come from Utnur, in South India, where a largely pastoral people kept cattle, sheep and goats during the last quarter of the third millennium B.C.

The history of domestication in the Indian sub-continent is, therefore, likely to involve the relationship of two separate groups of people: the late Stone Age hunting and collecting groups, widely scattered over the whole sub-continent, who perhaps independently domesticated certain species, and the groups of largely nomadic pastoralists who spread from the West, probably as a result of population expansion in the earlier centres of West Asia. These people brought with them herds of animals, and were obvious targets for the "hunting" activities of the earlier inhabitants whom they encountered. As a result of this interaction between two essentially diverse lines of domestication, present sheep breeds are supposed to have evolved.

In the opinion of Grzimek (1972) the sheep in the Indian sub-continent are perhaps influenced by tahr, from the Himalayan and Nilgiri regions, and urials (Ovis ammon-orientalis Gamlin) which were predominant in Punjab and adjoining areas of the north-west.

The current Indian sheep population, projected on the basis of the 1972 census, is approximately 40.4 million (Table 8), producing approximately 32.6 thousand tonnes of wool, 158.8 thousand tonnes of meat (with bones) and 15.5 thousand sheep skins (1961 census).

2. Distribution

There are sheep in all four of the climatic zones of Figure 1, but the types of sheep vary greatly (Table 8). Their distribution by numbers is shown in Figure 4.

3. Description

Descriptions of sheep breeds are given in Table 8. Broadly, medium wool is produced in the Himalayan temperate region (Region 1 in Figure 1), from a total of approximately 3 million sheep. Good quality carpet wool or medium wool comes from a total of approximately 13 million sheep in the dry north-western Region 2. Of approximately 21 million sheep in the Southern Peninsula (Region 4), all produce meat, and about half coarse, poor quality, mainly pigmented, carpet wool, the remainder growing hair but no wool. Meat is the main product from about 3 million sheep in the eastern Region 3.

Many of the sheep listed in Table 8 were described in detail by Lall (1956), and the description has not been repeated.

Three breeds shown on Figure 4 as "types" are not included in Table 8 (Dhamda, Ganjam and Godawari). They are all hair sheep, grown for meat and producing no wool.

4. Environment, management and feeding

(i) Environment: Environments are described briefly in Figure 1 and Table 8.

(ii) Management and feeding: Although sheep-raising is a major occupation in some areas, most people engaged in it possess no land or very small holdings. Further, unlike the situation with cattle, sheep-growers are near the bottom of the social scale.

The husbandry is essentially an extensive one, based on grazing, with some variation according to season. In many areas there is no specific pasture-land, grazing being on stubble, road or canal verges, under trees or on waste lands. There are usually no fences, sheep being continually shepherded, groups belonging to several owners often being banded into one flock for grazing.

Flocks are classified as "stationary" or "migratory", the latter being further sub-divided into "partially migratory" (having a permanent headquarters to which they return for part of each year) or "completely migratory" (fully nomadic, with no headquarters). The proportion of migratory sheep varies from 5-10 percent in the south to 100 percent in parts of the west and north.

Flocks vary in size, stationary ones ranging approximately from 4 to 70 head,

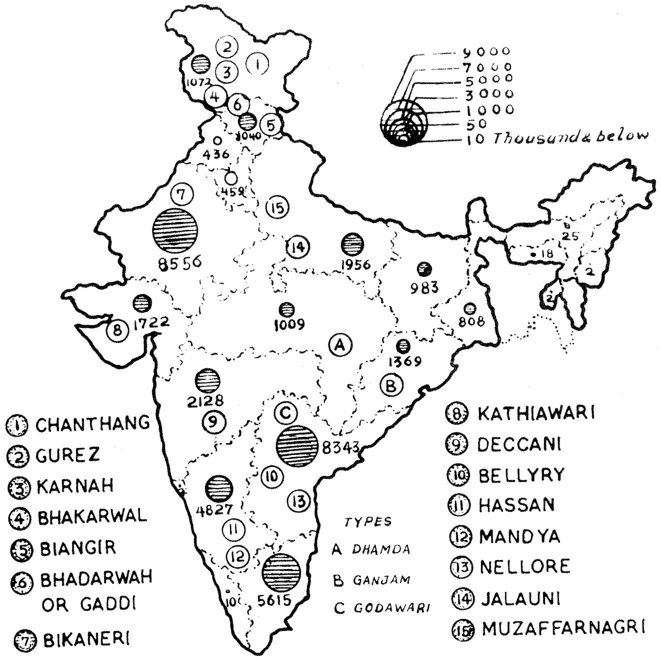

FIG.4 _ SHEEP BREEDS& TYPES AND SHEEP POPULATION IN INDIA

Fig. 4 - Sheep breeds, types and populations in India.

Table 8. Numbers (in each State) and descriptions of Indian sheep breeds

Climatic Zone State	Sheep numbers '000	Breeds	Main products	Colour	Description
1: Himalayan Temperate					
Himachal Pradesh	1,040	Gaddi (Bhadarwah)	Coarse wool: fine undercoat may be used for shawls	White: pigmented face	Lall*
		Rampur-Bushair	Coarse wool: fine undercoat may be used for shawls	White: tan markings	Lall
		Biangir	Coarse wool: pack animal		
Jammu Kashmir	1,072	Bhakarwal	Coarse wool: undercoat may be used for shawls	White or pigmented	Lall
		Gaddi	As above		
		Gurez	Medium wool	Mainly white	Lall
		Karnah	Medium wool	White	Lall
		Kashmir Valley	Medium wool	White or pigmented	Small size
		Poonch	Medium wool	White	Large size; polled; tail short
Arunachal Pradesh	no information				
Sikkim	"				
Uttar Pradesh -Hill areas	not given (approx. 1,000)	Rampur-Bushair	As above		
2: North-west and central (dry)					
Uttar Pradesh -Plains	1,956 (State total)	Muzaffarnagri	Mutton, coarse carpet fleece	White: sometimes pigmented patches	Polled, with long drooping ears and long tail
		Bikaneri strains	Superior carpet wool	White: some pigmented faces	Lall ("Bikaneri" now separated into Chokla, Jaisalmeri, Magra, Malpura)

Continued

Table 8 Continued

Climatic Zone State	Sheep numbers '000	Breeds	Main products	Colour	Description
		Jalauni	Poor carpet wool, mutton	Generally white	Lall
Rajasthan	8,556	Chokla (Shekhawate)	Superior carpet wool or medium wool	White, brown	Medium size; ears medium, tail medium length
		Jaisalmeri	Medium wool or carpet wool	White	Large frame; ears long and drooping, tail medium
		Lohi	Medium wool, mutton, milk	White, some-times pigmented spots	Lall
		Magra	Medium wool or carpet wool	White brown patchy face	Large; ears medium size; tail short to medium
		Malpura	Coarse carpet wool	White, brown face	
		Marwari (Kathiawari)	Carpet wool	White, black or brown face	Lall
		Nali	Medium wool or carpet wool	Light yellowish	Large; ears large and leafy; tail long and tapering
		Pugal	Medium grade carpet wool	White	Medium size; ears short; tail short to medium
		Sonadi	Mutton, poor carpet wool, milk	White; brown head and neck	Long body; ears large and drooping; long bare legs and tail
Punjab	436	Bagir	Coarse wool	White, brown or black head	
		Lohi	As above		
		Nali	As above		
Haryana	459	Lohi	As above		
		Nali	As above		

Continued

Table 8 Continued

Climatic Zone State	Sheep numbers '000	Breeds	Main products	Colour	Description
Gujarat	1,722	Patanwadi (Desi or Kutchi)	Medium wool	Yellowish-white, brown face and points	Ears drooping, medium size; tail short
		Marwari	As above		
Chandigarh Delhi	1 4 }	no information			
Madhya Pradesh (part)	1,009 (total)	Bikaneri strains	As above		
3: Southern (Medium rainfall) humid					
Madhya Pradesh (part)	no separate figure	no information			
Andra Pradesh	8,343	Deccani (Bellary)	Coarse, highly medullated wool	Mainly pigmented	Lall (gives them as two breeds)
		Hassan	Coarse, highly medullated wool, fine undercoat	Some white, some pigmented	Lall
		Nellore	Meat, no wool	White or pigmented (different strains)	Lall
Karnataka	4,827	Deccani	As above		
		Mandya Bannur (small strain Mandya) }	Meat, no wool	White or pigmented (reddish)	Lall
		Nellore	As above		
Kerala	10	no information			

Continued

Table 8 Continued

Climatic Zone State	Sheep numbers '000	Breeds	Main products	Colour	Description
Maharashtra	2,128	Deccani	As above		
		Nellore	As above		
Tamil Nadu	5,615	Nilgiri	Medium wool	White	Small. Derived from local breeds, Cape Merino, Southdown and Cheviot
		Mandya	As above		
		Coimbatore	Meat, no wool	White: pigmented patches on head	no information
		Madras Red (South Madras)	Meat, no wool	Reddish-brown	no information
		Macheri	Meat, no wool	Pigmented	Strain of Madras Red
		Kelakarisal	Meat, no wool	no information	
		Ramnad	Meat, no wool	no information	
		Trichi Black	Meat, no wool	Black body, white face	Small, short tail
4: Eastern (hot wet)					
Assam	25	Bonapala	no information		
Bihar	983	Shahabadi	Coarse, highly medullated wool	White, pigmented face	Medium size, long tail
		Chotanagpuri	Coarse wool	Dirty white to light tan	Small, ears rudimentary, very short tail
Orissa	1,369	no information			
Tripura	2	no information			
West Bengal	808	no information			

* See Lall (1956)

while migratory ones are much larger, and when sheep belonging to different owners are combined may number thousands.

Stationary sheep are taken out for grazing during the day, returning to the village in the evening.

Migratory sheep in the temperate Himalayan region are taken to high alpine pastures in April and brought down in October. They are housed from November to March and fed on tree leaves, dry fodder and grains for fattening. The houses are of stone or mud bricks, often with a roof of tree trunks and mud; humans live on the top floor, with the animals underneath.

Each migratory flock follows a well defined and socially acceptable path, overlapping of routes being unknown. Most of the upland pastures have a great potential for development.

Some flocks in Rajasthan are completely nomadic, again with well-defined routes; some routes traverse neighbouring states.

Pastures on the north-west plains and in the south are very poor, the main species being Cenchrus, Lesiurus, Dicanthium and Panicum. Supplementary feeding is adopted only during drought. In May and June, when temperatures are very high, the sheep are grazed during the night and early hours of the morning; during the day they are sheltered under trees.

Castration is practised before weaning for fat lamb production, using the open method (removal of testes by operation).

Ewes are kept to 7 years of age in flocks producing medium wool or carpet wool. Males are sold at around one year of age.

Sheep are usually shorn twice, and sometimes 3 times a year. In the northern areas "canary stain" is a major problem during the wet season; shearing twice gives one yellow and one white clip for white-fleeced sheep.

(iii) Disease: The sheep are supposed to be generally resistant to external and internal parasites.

Sheep-pox is generally common, and most deaths are due to bronchial infection in lambs and Johne's disease in adults.

Mortality in lambs before weaning is around 28%, another 10% being lost before maturity (Arora *et al*. 1975). The annual mortality in adults is 8-10 percent.

5. Reproduction

On the evidence of presence of lambs and/or oestrus observations, it seems that most Indian sheep will breed all the year round.

Raising two crops of lambs a year is common practice in the temperate zone while in the north-western and southern regions only one crop is raised.

The most widely practised system of mating is to run rams with ewes during the mating seasons in March-April and September-October, with 1 ram to 19 ewes. Most breeders of migratory flocks, however, run the rams with the ewes all the year round, and in many cases tie one end of a string round the prepuce, the other end round the ram's neck. The string effectively stops breeding, and is removed during the mating season. Matings are generally at random.

Artificial insemination and hand matings are practised both in some commercial flocks and in some under Government or University control.

Rams are generally first used as yearlings, then used extensively from 2½ to 7 years of age.

6. Breeding

Most indigenous rams are homebred. There is also a practice of exchanging rams between breeders, while various State farms have schemes for breeding and distributing rams.

For improving wool production, there have been introductions of Merinos from the USSR and Australia, Rambouillets from USA and Corriedales from Australia. Dorsets and Suffolks have also been introduced for meat production. The Government of India and various State governments are involved in schemes for introducing genes from exotic breeds into village flocks, sometimes through cross-bred rams, sometimes, as in Rajasthan, through AI.

Various sheep improvement plans have been drawn up and implemented by the Government of India during its series of Five-Year Plans. In these, recommendations have been made that some breeds, such as those in Rajasthan which produce superior carpet wool, should be improved by selection, while others should be crossed with exotic breeds, but with a limit to the level of exotic genes (Government of India 1970).

7. Performance

Table 9 gives some available breed data for body weights at different ages, dressing percentages, lambing percentages and lamb survival rates, while Table 10 gives some body dimensions.

Some figures for fleece weight and fleece characteristics are in Table 11.

Work on haemoglobin and transferrin polymorphisms in Indian sheep breeds has revealed few important associations with production characteristics.

8. Present status and problems of evaluation

No systematic effort has been made even to catalogue the various Indian sheep breeds. The information presented in this paper comes from observations made without systematic planning. There is not even agreement between various workers as to what constitutes the different breeds or strains; confusion exists even in the most valuable sheep areas of the dry north-west. Haphazard methods have been used to classify breeds, without resort to blood groups, biochemical polymorphisms or karyotype analyses.

All the information available for documentation has been collected on State or Central Government farms, where higher standards of nutrition and management prevail than in the areas where sheep run commercially. In fact, evaluation studies have come primarily from improvement programmes, taken up erratically using crossing with exotic breeds.

It is imperative that serious efforts be made to evaluate production, reproduction, adaptation and disease resistance for different genetic groups in their natural environments, as well as in better ones. The necessity for such evaluation cannot be exaggerated.

Five main points should be considered in planning evaluation:

(i) Comparison of breeds or crosses must be made in the present environment of an industry, and also in any planned future environment,

(ii) Using an environment completely different from that in which a breed was developed usually results in poor overall performance,

(iii) Evaluation of crossbreds is not complete unless purebreds are included (e.g. a cross between a local and exotic breed must be compared with the local),

(iv) Final evaluation must be based on the ratio of outputs (products) to inputs (feed, labour, costs),

Table 9. Body weights (pooled sexes), dressing percentages (for males at 6 months of age), lambing percentages (as number of lambs born/number of ewes mated) and lamb survival rates of Indian sheep breeds (Data from Government farms)

Breed	Body weight (kg) at:					Dressing percentage	Lambing percentage	Survival to weaning(%)	Authors*
	Birth	Weaning	6 months	1 year	Adult				
Gaddi	2.1	10.2	14.2	-	-	-	-	-	9
Rampur Bushair	3.4	-	17.3	-	-	-	75	83	1, 9
Muzaffarnagri	2.7	10.2	16.0	27.9	-	50	-	-	9
Chokla	2.4	9.6	10.8	20.9	26.9	41	63	71	1, 9
Jaisalmeri	-	-	-	-	-	-	-	68	1
Lohi	2.8	11.0	14.3	19.6	-	-	81	75	1, 9
Magra	3.0	12.1	20.6	30.1	-	53	74	93	1, 9
Malpura	3.1	11.6	-	-	33.1	50	54	83	1, 9
Marwari	2.5	8.2	9.4	14.6	-	-	81	40	1, 9
Nali	2.8	10.8	13.3	18.3	24.5	-	75	82	7, 9
Sonadi	2.7	12.4	-	-	23.0	50	-	-	7, 9
Bikaneri (unspecified)	3.2	12.1	17.6	21.9	28.1	45	-	-	1, 9
Deccani	2.8	10.1	11.8	12.9	-	-	79	88	1, 9
Nellore	2.4	9.5	-	18.7	-	-	-	-	9
Mandya	2.4	11.2	13.8	21.3	-	-	-	-	9
Bannur	1.9	8.1	15.0	16.5	-	-	60	-	9
Madras Red	2.8	13.6	16.6	-	-	-	-	-	9
Macheri	-	9.4	-	16.3	-	-	75	-	1
Ramnad	-	9.7	-	16.0	-	-	-	-	1

* Numbers refer to bibliography, which has a separate section for each species

Table 10. Body measurements (cm) of Indian sheep breeds

Breed	Length	Height	Heart girth	Paunch girth	Head length	Distance between eyes	Ear length	Tail length	Author
Muzaffarnagri	77.2	75.4	85.5	-	-	-	16.1	47.1	11
Chokla	72.0	62.5	68.3	69.5	24.3	15.7	7.5	24.6	7
Malpura	64.5	64.1	70.1	72.0	26.3	14.6	6.3	23.6	7
Nali	-	64.8	85.8	91.8	-	-	11.7	17.2	7
Sonadi	60.4	61.2	67.9	72.0	-	9.4	17.3	30.3	8

Table 11. Fleece characteristics of Indian sheep breeds

Breed	Greasy fleece weight (6 months) (kg)	Fibre diameter (μm)	Staple length (6 months) (cm)	Medullation (%)	Authors
Rampur Bushair	0.55	35.6	9.2	23	9
Kashmir Valley	-	27.6	8.2	24	9
Muzaffarnagri	0.64	44.4	4.2	73	9,10
Chokla	1.23	29.9	5.0	42	9
Jaisalmeri	0.64	31.2	8.8	50	9
Lohi	0.77	35.0	6.6	29	9
Magra	0.78	38.6	7.2	16	9
Malpura	0.62	38.3	4.2	75	9
Marwari	1.13	39.6	10.5	30	9
Nali	1.95	33.5	9.0	32	9
Pugal	1.54	35.0	6.2	62	9
Sonadi	-	51.5	5.1	86	8
Deccani	0.74	34.1	7.0	21	9
Shahabadi	0.56	47.9	4.8	92	9

(v) The number of animals included must be adequate to demonstrate differences in characteristics involved in the conversion of feed to the final product.

A possible approach to the problem of evaluating sheep breeds can be handled in two parts:

(i) As a first major step, a nucleus flock of each breed should be maintained as part of all development programmes. Evaluation of these flocks should be done under the auspices of the Bureau of Animal Genetic Resources.

(ii) Evaluation and conservation should be an integral part of development programmes. After about 25 years, a clearer picture should emerge about the available genetic material. Since there has already been considerable cross-breeding, crossbreds should be included in the evaluation.

9. Conservation

Many authors have written on the problems associated with conservation of animal genetic resources. What should be emphasized here is the need for evaluation and conservation to go hand-in-hand. With the screening which would come with systematic evaluation, valuable genotypes could be identified and maintained, and others discarded.

This takes time; hence the need for urging the immediate establishment of nucleus flocks of all breeds, to ensure that valuable ones do not disappear. Two steps can be suggested:

(i) That all universities, educational institutions, religious trusts and organizations associated or having interest in historical preservation should be aided by the government and encouraged to maintain small flocks of sheep in their natural habitat or intended management systems. These flocks or herds should be under a uniform recording system, which should be in a computer readable format, the evaluation being conducted by the National Bureau of Animal Genetic Resources. The Bureau should provide identification material like blood group antigens, cytomorphological methods of analysis, etc. along with a computer readable recording system. The actual evaluation, analysis and documentation should be done by the Bureau.

(ii) All the development programmes undertaken by State governments should have a mandatory pre-requisite that breeds being used for crossbreeding or grading up should be maintained in nucleus flocks in their natural habitat and subjected to continuous evaluation as described under item (i).

B. Goats

1. General

Goats have proved very useful to man throughout the ages, largely because of their adaptability to varying environmental conditions. They have tremendous ability to survive, and often thrive on sparse vegetation unsuitable for feeding of other livestock.

Goats provide a considerable source of income and occupation to a sizeable rural population, especially the economically and socially backward classes in India. The goat is an important meat animal here and perhaps the most misunderstood species of livestock. In spite of regular attempts by soil conservationists to exterminate this animal, its population has increased 12% during the past decade. According to the 1972 census, the total Indian goat population was 67.5 million, producing approximately 275 thousand tonnes of meat and 708 thousand tonnes of milk annually. This constitutes 35% of the total meat produced from livestock (excluding poultry) and 2.7% of the total milk produced in the country. Annually 7,020 tonnes of goat skins are produced in India, most being exported. Pashmina goats contribute about 40,000 kg of Pashmina (cashmere), while all goats contribute 34 million quintals of manure, casings and offals, etc. The total contribution of the goat to the gross national product is about Rs. 3,500 million.

The origin of the Indian goat breeds is not clearly known. They are believed to have been derived from wild goats which inhabited the Asian Mountains in antiquity, and to have been domesticated around the 7th century B.C., much earlier than cattle. There are at present about 17 distinct goat breeds in India, of which several are economically useful, with distinct characteristics of productivity and adapted to the various agro-climatic regions. The Jamnapari breed of the Chambal Ravines in Etah district (U.P.) has been extensively used for improvement of native breeds in several countries. The famous Anglo-Nubian breed is based on a cross of the Jamnapari. The dwarf goat breeds, such as Black Bengal, Barbari, Malabari and Assam Hill, are famous for high prolificacy (multiple births) and early sexual maturity, and generally give two kid crops in a period of 14 months. The Pashmina goats of Ladakh produce the finest quality of Pashmina fibre (cashmere) in the world, which has no substitute so far.

Because of the importance of goats to Indian agriculture, the Government of India has set up a National Institute of Research for Goats at Makdoom, Mathura District, U.P. One objective is evaluation of goat breeds at the Institute and in various locations around the country. The newly-sanctioned National Bureau of Animal Genetic Resources is likely to be functioning shortly, and will conserve resources by providing assistance for establishing farms for indigenous goats around the country, which will document information.

2. Distribution

India has a total of 67.6 million goats, about 20 percent of which are in Rajasthan, while Bihar, Madhya Pradesh, Maharashtra, Uttar Pradesh and West Bengal each have a population 8-11 percent of the national total. Figure 5 and Table 12 give the distribution in detail.

3. Description

Descriptions are in Table 12. Goats provide mainly meat, plus milk in some areas and fibre in others; skins are a by-product.

4. Environment, management and feeding

The environmental regions are those of Figure 1.

(i) Management systems: There are three systems:

(a) Extensive: There are two types, one followed in the plains, the other in the hills.

Plains: Most of the country's goats are in rural areas, where they are raised by the socio-economically weaker sections of the population, who are either landless labourers or marginal/sub-marginal farmers. Most flocks contain 2-15 goats, which are grazed on marginal lands and fed agricultural by-products, as well as garden and kitchen waste. No special feeding is done, and maintenance costs are low.

Hills: Goats move from the lower valleys in winter to the alpine pastures in summer. In the valleys they run in flocks of 100-500, but as they move to the hills a shepherd's family can handle 1000 animals belonging to lowland communities, who pay the family wages for care of the animals. Sheep and goats usually graze together; they move to the hills in April and begin their descent again in September. These flocks receive marginal supplementary feeding during winter.

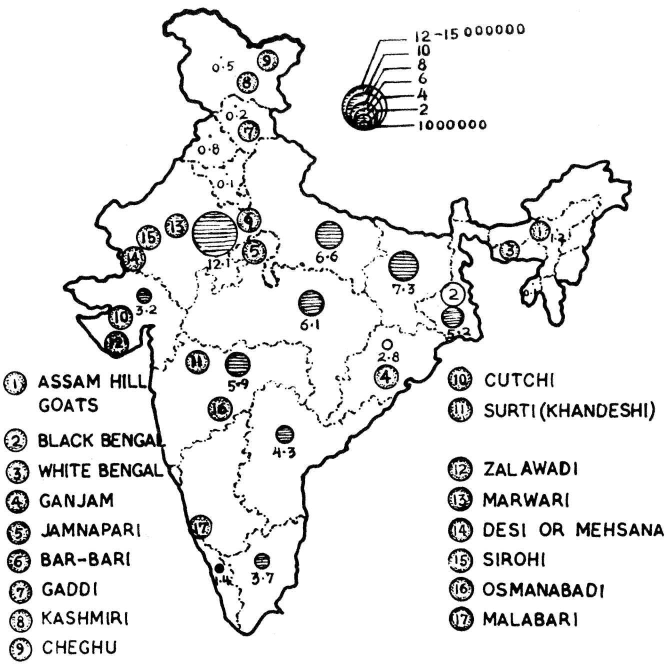

FIG. 5 - GOAT BREEDS & TYPES AND GOAT POPULATION IN INDIA

Fig. 5 - Goat breeds, types and populations in India.

Table 12. Numbers and descriptions of Indian goat breeds

Climatic Zone / State	Goat numbers ('000)	Breeds	Main products or use	Colour	Description
1. Himalayan Temperate					
Himachal Pradesh	906	Gaddi	Hair for ropes; males for pack animals	White, sometimes red	Hardy; long coat of hair (20-25 cm); poor milkers
Jammu and Kashmir	569	Pashmina (Kashmiri)	Cashmere from undercoat, ropes from outer coat; pack animals	White, sometimes grey or brown	Large, hardy; hair coat 10-12 cm, down undercoat; poor milkers
Uttar Pradesh -hills	6,610 (Total)	Chegu (strain Pashmina)	Cashmere; meat	White, greyish red and mixed also	Smaller than Pashmina; poor milkers
2. North-west and central (dry)					
Uttar Pradesh -plains	not given separately	Jamnapari	Milk and meat	Many colours	Large; long pendulous ears, Roman nose
		Barbari	Milk	Many colours	Small; erect ears; prolific, adapts to stall-feeding
Rajasthan	12,163	Kutchi	Milk and meat	Black and white markings	Medium size; long hair; corkscrew horns
		Marwari	Milk and meat	Greyish-red skin, black hair	Medium size; small muzzle; beard
		Sirohi	Good milker; meat	Black or brown	Small; adapts to stall-feeding
Punjab	801	Beetal	Milk and meat	Many colours	Similar to Jamnapari but smaller
Gujarat	3,210	Kutchi	As above		
		Marwari	As above		

Continued

Table 12 Continued

Climatic Zone / State	Goat numbers ('000)	Breeds	Main products or use	Colour	Description
		Mehsana	Good milker, meat	Skin greyish-black; hair black and grey; ears white with black spots	Medium size; Roman nose; small beard; long hair (10 cm)
		Sirohi	As above		
		Zalawadi	Good milker; meat	Skin pinkish blue, hair lustrous black	Large size; straight screw-shaped horns; wattles; long hair (15 cm)
Madhya Pradesh	6,167	Berari	Milk and meat	Dark	
Maharashtra (part)	not given separately	Berari	As above		
3. Southern (medium rainfall, humid)					
Maharashtra (part)	5,911 (total)	Surti (Khandeshi)	Good milker; meat		Short; stall-fed
Andra Pradesh	4,380	Osmanabadi	Milk and meat	Black, sometimes with white or red	Short and long hair types
Karnataka	3,726	No specific breeds mentioned			
Kerala	1,468	Malabari	Milk and meat	Variable	Short and long hair types
Tamil Nadu	3,954	No specific breeds mentioned			
4. Eastern (wet and hot)					
Assam	1,258	Assam Hill	Meat; poor milker	White; sometimes grey	Short legs, long body, long hair

Continued

Table 12 Continued

Climatic Zone State	Goat numbers ('000)	Breeds	Main products or use	Colour	Description
Bihar	7,364	Bengal	Meat; superior skin; poor milker	Mainly black, some brown, some white	Dwarf goat; very prolific
Orissa	2,884	Bengal	As above		
		Ganjam	Meat and milk	Mainly black, some brown, some black with white patches	Well adapted to heavy rain and poor feed. Some have wattles and beard
West Bengal	5,211	Bengal	As above		
Other States and territories	1,066				
Indian total	67,648				

(b) Intensive: Animals are stall-fed in confinement on cultivated fodder, with a high level of concentrates; they have little or no grazing. The practice is usually followed in towns and cities and on organized Government and private farms.

(c) Semi-intensive: This is a compromise between the other two systems and involves combining supplementary feeding with browsing/grazing. It is followed where limited grazing is available.

The extensive system is hampered in the plains by shortage of pastures, due to extension of irrigation and the pressure of human population on land. On the other hand, the intensive system is at present uneconomical because of the absence of a genotype with high feed conversion efficiency. There is need for development of a genotype which will make the intensive system profitable.

(ii) Housing: Goats run under the extensive system on the plains are housed with their owners and other livestock at night, but not during the day, except during late pregnancy. Under the intensive system they are kept in sheds, the quality of which varies according to local conditions, material available and size of flock.

(iii) Mating: Under rural conditions breeding bucks remain with the does all the time, the ratio of males to females being usually 1:4. Females are housed during advanced pregnancy and attended closely when kidding.

(iv) Treatment of young: If the kids can be left with their dams they require no particular attention. Kids of some breeds, however, are raised on artificial milk because their dams cannot provide enough.

Male kids not required for breeding are castrated from 2 weeks to about 6 months of age, using an emasculator or torsion forceps, but the open method is more popular at younger ages. Castration improves the flesh and increases the body weight of adult goats (Singh and Senger 1978).

(v) Feeding: In most of the organised farms, feeding is semi-intensive, with the goats allowed out for browsing/grazing during the day and supplemented with concentrates and green fodder. Hay may be fed in the evening in drought periods. Breeding bucks and does in advanced pregnancy or in lactation are fed an additional 200-300 g concentrate each day. During their pre-weaning period, kids are creep-fed. At some farms, where satisfactory browsing/grazing is not available, and in the cities, goats are kept on stall-feeding only.

Under village conditions, goats are allowed grazing/browsing, and kitchen and garden wastes are fed in place of concentrates. Lactating does and those in advanced pregnancy are given special attention.

5. Reproduction

Most of the Indian breeds, notably the dwarf ones (e.g. Barbari, Bengal, Malabari) have high reproductive efficiency, to which early maturity, high incidence of multiple births and short kidding interval all contribute.

Age at first oestrus ranges from 6-8 months in the Barbari (Prasad, 1974) to 18-20 months in the Jamnapari (Khan *et al*. 1978a). Males generally make an effective service when they are 5-6 months old. In well managed flocks, breeding is not allowed until the does are 1-1½ years old; males are used lightly at one year of age but brought to full use when they are 2 to 2½ years old.

The duration of oestrus is usually 24-48 hours, but may average 18 hours in certain breeds. The oestrous cycle is 17-21 days in length. The gestation period was found to average 150 days, with a range of 147-156 days, in Jamnapari goats (Khan *et al*. 1978a, Kaura 1943, and Slater and Bhatia 1935). The first heat after an oestrus is usually silent and may be missed by a casual observer.

Dwarf goats kid twice a year, but others thrice in two years. The average number of kids born at one parturition is generally 1.3, but in some breeds it is two, and as many as 20% of the goats of some breeds give birth to 3 kids.

The repeatability and heritability of multiple births in Black Bengal goats were found to be 0.14 and 0.09 respectively. Heritability of age at first kidding was high (0.54±0.12) and of first kidding interval was low (0.15±0.09) in Beetal goats (Acharya 1979).

Reports on kid mortality have been very variable, ranging from 8.5% pre- and 15.0% post-weaning (Khan et al. 1978b) to 44.0% overall (Paliwal et al. 1978). In organized farms the kid mortality to 6 months varies from 30-50%.

6. Breeding

It appears that Indian goat breeds have developed through genetic isolation rather than through selection for environmental needs and uses. Research on goat breeding is of very recent origin and efforts are now being made to develop specific strains for milk, meat and fibre through projects such as the "All India Coordinated Research Project on Goats". The projects are along three lines:

(i) Milk: Known milch breeds of goats such as Beetal, Jamnapari, Malabari and Barbari are being evaluated, along with their crosses with developed milk breeds, viz. Saanen and Alpine.

(ii) Meat: Sirohi, Assam Hill, Bengal and their crosses with Anglo-Nubian are being evaluated for meat production.

(iii) Fibre: New breeds are being developed for mohair and cashmere. For mohair production, Angora bucks are being used on Deccani does, while for cashmere production, pure breeding of Pashmina goats is followed, using within-flock selection.

7. Performance

Body weights at different ages, dressing percentages and lactation data for some Indian goat breeds are in Table 13, and reproduction data in Table 14.

Fibre production data are in Table 15.

Goats in the hills, such as Gaddi, produce hair used for ropes and patties. Cross-breeding of these goats with Angoras yields mohair, which persists when the crosses are inter-bred (Bhat 1973, Lall 1947).

Although Pashmina goats from Ladakh and the northern Himalayas support a major cottage industry in the Kashmir Valley, little is known about them. They normally produce twins and triplets, and show large diversity, so it should be possible to apply selection for genetic improvement of meat, milk and fibre. Crossing with Angora might make possible a goat with mohair and pashmina.

IV. PIGS, CAMELS, HORSES AND PONIES, DONKEYS AND MULES

A. Pigs

1. General

Among the domestic animals of the Indian subcontinent, pigs are the most prolific breeders and quickest growers. They are a valuable source of rich animal protein at a very low cost. They excel all other animals in respect of edible flesh of high nutritive value for relatively small investment, and contribute substantially to the economy of socially backward and tribal populations. Pig meat constitutes about 5% of the total meat produced in India.

Traditionally indigenous pigs produce bristles and meat. Before the advent of nylon, pig bristles had a very great market and meat was a byproduct, but with the fall in the bristle market, pork has become the important market commodity.

Indigenous pigs have special adaptability for survival under extremely

Table 13. Body weights (pooled sexes), dressing percentages (for males at 6 months of age), lactation yields and lengths (over all lactations) of Indian goat breeds

Breed	Sex	Body weight (kg) at: Birth	Weaning	6 months	1 year	Adult (range)	Dressing percentage	Lactation yield (kg)	Lactation length (days)	Authors
Gaddi	Male	2.2	11.9	20.9	28.7	36-43	-	-	-	6,30,39
	Female	2.3	10.8	19.2	26.5	31-35	-	-	-	
Chegu	M	2.0	8.1	12.4	19.1	29-55	-	-	-	16
	F	1.9	6.9	10.6	17.1	23-35	-	-	-	
Changthong	M	2.3	8.1	17.0	20.2	23-35	-	-	-	23
	F	2.1	7.4	15.0	11.8	19-24	-	-	-	
Jamnapari	M	3.6	11.5	16.7	22.9	45-68	42	-	-	10,17,21,26,
	F	2.9	10.4	12.2	19.2	44-48	-	211-272	210-287	40,43
Barbari	M	1.9	6.1	8.7	15.8	35-47	49	-	-	26,40,44
	F	1.7	5.7	7.6	11.1	17-28	-	150-228	210-252	
Sirohi	M	2.7	8.7	14.7	-	-	-	-	-	9
	F	2.5	8.1	11.4	21.1	28	-	-	-	
Beetal	M	2.9	10.2	12.7	22.2	40-74	46	-	-	7,28,40
	F	2.7	9.0	11.5	16.6	27-36	-	105-168	161-172	
Malabari	M	1.9	5.4	8.5	18.2	-	-	-	-	20
	F	1.7	5.5	7.8	11.3	-	-	39-151	123-140	
Bengal	M	1.1	4.8	6.7	11.8	19-30	45	-	-	13,15,25,40
(Black)	F	1.0	4.3	6.0	8.1	13-22	-	36-58	119-122	
Assam Hill	M	0.9	2.2	-	-	-	-	-	-	1
	F	0.9	2.3	-	-	-	-	-	-	
Alpine	F	3.7	-	-	-	-	-	374	238	33
Angora	F	2.0	10.7	-	-	33-45	-	-	-	6
Saanen	F	3.5	-	-	-	-	-	306	251	33
Jamnapari x Barbari	F	2.8	8.3	10.9	19.5	-	43	194	203	40

Continued

Table 13 Continued

Breed	Sex	Body weight (kg) at: Birth	Weaning	6 months	1 year	Adult (range)	Dressing percentage	Lactation yield (kg)	Lactation length (days)	Authors
Jamnapari x Beetal	F	2.3	9.2	10.7	19.4	-	43	-	-	40
Jamnapari x Toggenberg	F	2.9	14.2	26.8	-	-	-	219	202	40
Beetal x Saanen	F	3.3	6.8	-	14.7	-	47	310	257	28,30
Beetal x Alpine x Saanen	F	3.7	-	-	-	-	-	351	239	33
Malabari x Alpine	F	2.0	7.5	11.6	19.0	-	-	184	216	20
Malabari x Saanen	F	2.6	6.3	10.7	17.4	-	-	86	101	20
1/2 Angora	M	2.4	7.5	10.7	15.0	27-31	-	-	-	19
	F	2.2	8.2	10.5	18.0	-	-	-	-	

Table 14. Reproduction data of Indian goat breeds (where two estimates are given for a breed, they are from different studies)

Breed	Age at puberty (days)	Age at first kidding (days)	Kidding interval (days)	Gestation period (days)	Twinning percentage	Duration of oestrus (hours)	Authors
Chegu	-	615	219	-	8	-	16
Jamnapari	419	735	238	149	33	-	21,40,42,43
	553	751	229	150	17	39	
Barbari	282	589	238	146	42	47	40,43
Beetal	335	649	296	149	27	48	19,28,40,42
	-	612	332	147	63	-	
Malabari	493	875	286	146	39	-	20
	487	700	284	149	38	-	
Bengal	296	567	221	145	60	46	4,40,42
(Black)	-	455	-	143	45	-	
Jamnapari x Beetal	368	701	-	-	-	36	40
Jamnapari x Barbari	430	799	-	-	-	41	40
Jamnapari x Bengal	325	672	318	-	18	-	40
Saanen	-	514	346	-	-	-	28
Saanen x Beetal	413	581	300	-	-	-	26
Alpine	347	539	382	-	4	-	14,28
Alpine x Beetal	370	461	324	-	50	-	26
Alpine x Malabari	309	459	367	148	15	-	20
Angora	-	722	361	-	33	-	6
1/2 Angora	542	-	389	147	30	-	29

Table 15. Fibre production of Indian goat breeds

Breed	Fibre weight per year (kg)	Fibre diameter (microns)	Fibre length (cm)	Medullation (%)	Authors
Gaddi	1.0-1.5 (hair)	74.0	-	86.5	6,30
50% Angora	-	60.9	2.8	53.8	29
75% Angora	0.5	28.3	5.7	14.8	29
Angora	4.2 (mohair)	35.1	9.3	2.5	29
Pashmina (Chegu)	0.15	11.8	5.9	-	16
Pashmina (Changhang)	0.25	12.1	5.0	-	18

adverse conditions of malnutrition and health. They are believed to be relatively more resistant to disease than exotic breeds. Although this supposition cannot be supported by any quantitative evidence, the fact remains that without disease resistance and adaptation to poor levels of feed, they could not survive.

During the past two decades two industries have developed:

Commercial breeding farms,
Bacon factories for processing pork.

The latter have large pig-breeding establishments attached to them, from which they distribute exotic males to upgrade local stock.

In India pigs and the pork industry are in the hands of traditional pig keepers, belonging to the lowest socio-economic stratum with no means to undertake intensive pig farming on modern scientific lines. With the introduction of purebred stock and improved methods of breeding, feeding and meat handling, this industry is expected to play a significant role in the economy of the country.

Besides domesticated species, there are in India several wild ones, such as the common Indian wild boar (Sus scrofacristatus). The present-day pigs have evolved as a result of gradual domestication of wild pigs. Long, dark-brown longitudinal stripes in new-born piglets, which gradually vanish as the animals grow, are a proof of wild ancestry.

There has been no serious attempt to catalogue the various breeds or strains of domesticated pigs in India, and previously unknown varieties are sometimes found. For example, the author and his students recently located a number of strains of dwarf pigs in the north-eastern region, which might revolutionize pig-breeding there.

The pigs found in India can be divided into four types: wild, domesticated indigenous, exotic and crossbred. Their products are pork, lard (for cooking), bacon, ham, sausages, bristles, skin and manure. These are increasingly in demand for local consumption and for export.

2. Distribution

The total Indian pig population was estimated at 6.9 million in the 1972 census. Distribution by States and Territories is in Table 16. Uttar Pradesh has the greatest number, followed by Bihar and Andra Pradesh.

Table 16. Statewise distribution of pigs, camels, horses and ponies, donkeys and mules (in thousands)

State	Pigs	Camels	Horses & Ponies	Donkeys	Mules
Andhra Pradesh	690	1	25	61	-
Assam	397	-	10	-	-
Bihar	879	-	99	31	1
Gujrat	8	63	63	106	1
Haryana	143	133	24	73	9
Himachal Pradesh	3	1	16	5	7
Jammu & Kashmir	1	3	60	11	6
Karnataka	261	1	34	45	1
Kerala	129	-	-	1	-
Madhya Pradesh	343	14	148	50	2
Maharashtra	203	1	58	54	-
Manipur	134	-	1	-	-
Meghalaya	127	-	5	-	-
Nagaland	111	-	1	-	-
Orrisa	387	-	29	2	2
Punjab	46	102	50	65	9
Rajasthan	117	745	48	186	1
Tamil Nadu	563	-	11	86	-
Tripura	44	-	-	-	-
Uttar Pradesh	1302	44	230	210	37
West Bengal	362	-	29	2	-
Andaman & Nicobar Islands	38	-	-	-	-
Arunachal Pradesh	411	-	-	-	-
Chandigarh	-	-	-	-	-
Dadra and Nagar Haveli	-	-	-	-	-
Delhi	11	1	8	6	-
Goa, Daman and Diu	52	-	-	-	-
Lakshya Deep	-	-	-	-	-
Mizoram	48	-	-	-	-
Pondicherry	2	-	-	-	-
All India	6896	1109	942	994	75

3. Description

Information is available on 3 types of wild and 3 of domesticated pigs.

(i) Wild pigs

(a) The Indian wild pig (Sus scrofa aristatus) is found in the Himalayan jungles up to an elevation of 4,500 m. It measures 150 cm from nose to vent and 86 cm at the shoulder, and exceeds 136 kg in weight, males being larger than females. Wild boars in West Bengal are heavier than those in the Punjab and the Southern Peninsula.

The wild pig has a long snout, short ribs and long legs; it is rusty in colour when young, but with advancing age becomes dark chestnut-brown, the hair being tinged with grey at the extremities. It has a sparse coat, with a full crest and a mane of black bristles running from the nape down the back; there is no woolly undercoat. The tusks are well developed in males and project from the mouth. The pig is extremely active, and when provoked may attack humans; it is highly prolific and breeds in all seasons. The main diet consists of roots, tubers, insects and snakes.

(b) Sus scrofa andamanensis is found in the forest of Andaman Island.

(c) Sus salvanius is found in the dense, moist forests of Sikkim, Nepal, Bhutan and the Eastern Region. Nocturnal in habit, the pig prefers to remain in high grasses and is rarely seen; it lives in herds of 15-20. The length is 66 cm from snout to rump, the weight 7-8 kg and colour brown-black. There is no distinct crest, and no woolly undercoat.

(ii) Domesticated pigs differ in colour in different regions, depending on topography and climatic conditions, the range being from black-brown to rusty grey, or an admixture of two colours. The size also varies. The pig possesses a tapering face, with head and shoulders heavier than the hind-quarters. The ears are from small to medium size, while the tail reaches nearly to the hocks, with a final tuft of hair. An adult pig weighs up to 168 kg, and the female possesses 6-12 teats.

(a) The Deshi pig is widely distributed in Uttar Pradesh, Bihar, Madhya Pradesh and Punjab. It is the largest of the indigenous pigs, but slow-growing. The hairs on the neck and parts of the back are bristly, thick and long, while those on the flank are thinner and shorter. The sow farrows 8-12 piglets (live and dead) at a time.

(b) Ghori pigs are found in Manipur, Assam, Arunachal Pradesh, Nagaland, Mezoram, Sikkim, Bhutan and the Terai (foothills) Himalayan Region. In Assam and Bangladesh they are referred to as "dome" or "pigmy" pigs.

These pigs are kept by tribal peoples. They are mainly black, with an admixture of light brown. There is always a row of coarse, straight bristles, starting from the neck down the back, like that of wild pigs.

(c) Ankamali pigs are generally found in the Southern Peninsula Region, i.e. Kerala, Karnataka, Tamil Nadu and Maharashtra. They are black with white patches, the overall appearance being rusty-grey, weighing 40-70 kg and with a length of 91 cm. Sows produce 12-15 piglets at a time, but only 6-8 survive.

(iii) The exotic breeds introduced are Berkshire, Large White Yorkshire, Middle White Yorkshire, Landrace, Hampshire and Wessex Saddleback.

4. Environment, management and feeding

(i) Indigenous pigs: Most indigenous pigs are raised as scavangers on human nightsoil, kitchen waste, roots and so on; one exception is the Himalayan pigmy pig, which is essentially grass-based. No pig is given housing, except for a small place to rest during the hot summer.

In the rural areas pigs are let loose within the village or hamlet and looked after by women or small children. In the bigger towns, piglets are weaned by 3 weeks of age and left in various sectors of the town, the only investment the owner makes being to count the number left alive every Sunday morning when he is not otherwise occupied. He collects the pigs at about one year of age when they weigh 30-40 kg; they are then slaughtered and sold as fresh pork. No processing is done except pickling.

Castration is practised by the open method.

In the Central and Southern Peninsula Regions herd size ranges from 2 to 15 sows. In the lower Himalayas, Arunachal Pradesh and Nagaland the Ghori pig is a status symbol, and is maintained in herds of 15-30, with identification at birth by ear-notching. Weaner pigs are sold for slaughter and supposed to be a great delicacy.

(ii) Crosses: Crosses with exotic breeds are raised in villages under essentially similar conditions, but are given supplementary feeding and slightly better health management, particularly now that better prices are being received for meat.

(iii) Exotic breeds: Exotic introductions are raised by commercial companies, Government agencies, Universities and other agencies on European or American standards of feeding and management, modified and adapted to the tropics.

5. Reproduction

Under village conditions males run continually with females, without restraint. Boars are generally fit for service at 8-18 months, and perform satisfactorily till 4 years old. Young gilts reach full maturity at about 2 years of age; if well looked after they can be bred first at 1½ years. Early breeding is generally avoided.

There are usually two breeding seasons, August-September and February-March. Liberal feeding during these times will help bring sows on heat early. Heat lasts 40-65 hours, and recurs at intervals of 21 days till the sow becomes pregnant. The gestation period varies from 112-116 days, with an average of 113. Sows come on heat again 5-7 days after the litter is weaned.

With special conditions of feeding and management around bacon factories, two litters can be obtained in a year.

Mortality in piglets is heavy, particularly around 3 days after birth. About 3/4 of piglets born fail to reach weaning age, causes of death being overlaying by the sows, insufficient milk and feed.

Mortality in adult indigenous pigs is around 17 percent.

6. Breeding

There are no records of mating systems for indigenous pigs; random mating is assumed, the ratio of males to females being usually 1:5 or 1:3.

Pigs are receiving greater attention under Government of India development programmes. The general opinion is that indigenous pigs can be improved by crossing with exotic breeds, and cross-breds are slowly becoming more popular, particularly in Central India. Their higher growth potential makes them attractive, but, given current management systems, the survivability of the cross-bred is low and its advantage marginal. In spite of this, the indigenous pig in the Central Region is becoming extinct through extensive crossing with the Large White.

7. Performance

Performance records for indigenous pigs under their usual conditions are not available. It is now considered imperative that these breeds should be properly documented and performance-tested, both in the present and intended environments, so that breeding-cum-development strategies can be decided. The Government of India has now decided to set up small nuclear farms with various indigenous pig breeds at about 5 stations.

A few figures for local and exotic breeds and their crosses, obtained in research programmes are given in Tables 17 and 18.

Table 17. Performance of Indian indigenous pigs in the North-eastern regions

Traits	SIKKIM Local (Pigmy)	SIKKIM Large White	SIKKIM Cross bred	WEST BENGAL/ASSAM Local (Dome)	WEST BENGAL/ASSAM Large White	WEST BENGAL/ASSAM Cross bred
Average age at first mating (days)	429	290	-	-	-	-
Gestation period (days)	114	116	112	-	-	-
Mean litter size (live piglets)	3.7	6.3	6.0	5.1	7.9	5.4
Average weight at birth (kg)	1.07	1.64	1.12	0.63	0.91	1.59
Litter size at weaning	3.2	4.0	5.0	4.1	6.0	5.0
Average weight at weaning (kg)	7.0	10.0	9.0	5.2	9.3	8.0
Body length (cm)	109	-	-	102	-	-
Height (cm)	70	-	-	66	-	-

Source: Bhat (1977)

Table 18. Performance of Indian indigenous pigs in the Indo-Gangetic Plain

Traits	Desi	Middle White	Crossbred
Percentage of piglets born dead	7.7±0.61	7.8±0.81	3.9±0.43
Mean litter size (live piglets)	7.8±0.42	8.7±0.83	9.5±0.61
Mean birth weight of piglets (kg)	0.9±0.02	1.3±0.03	1.2±0.04
Mean weaning weight (kg)	4.0±0.23	7.0±0.30	6.7±0.36
Mean weight at 48 weeks (kg)	40.0±0.90	73.5±0.95	51.0±0.84
Growth rate per day from birth to weaning (g)	0.073	0.108	0.102
Growth rate per day from weaning to one year (g)	0.117	0.237	0.205
Gain per unit of feed	0.178	0.185	0.175
Dressing %	66.0	67.4	68.3
Average carcass length (cm)	65.0	68.6	70.4
Average ham weight (kg)	6.7	6.4	6.7
Average backfat thickness (cm)	3.7	2.5	4.5
Skin thickness	++++	+	++

Source: Bhat (1977)

B. Camels

1. General

The camel has been aptly described as the ship of the desert. It is indeed the most valuable beast of burden and transport in hot, arid, sandy regions. Due to its extraordinary power to resist thirst and hunger, it is commonly thought of as a "mystery" animal, and can maintain itself on thorny shrubs in a desert where other herbivores would die of hunger.

Special features fit the camel for desert life, viz.-

Hump - emergency food store in fatty tissue,
Thick skin - low water loss,
Fine insulating hair coat - against heat stroke,
Hard lips - eating thorny bushes,
Long neck - long reach,
Thick foot pad - for loose sand,
Long eye-lashes - protection from sand,
Loose nostril skin - can close nostrils during sandstorms.

The Arabian one-humped camel (*Camelus dromidarius*) is the only species found in India. It is used extensively for different kinds of work: riding, carrying loads, ploughing, threshing grains, pulling carts, as motive power for water wheels or mills to crush sugarcane and oilseeds. It has earned a special reputation for military transport. The camel is said to do everything for its master except cook his food!

The camel has extraordinary patience, even under neglect and rough handling, but at times under extreme conditions it may show an obstinate and revengeful character.

The camel's products are meat and milk for human consumption, hair for warm garments and cords, hides for saddlery and dung for fuel. When properly fed and looked after, a camel may prove to be a valuable source of milk in desert regions; the milk has a pleasant taste, similar to cow's milk, and has a high sugar content (5.5 percent) with low fat (3.0 percent).

India is one of the most important countries as far as camel husbandry is concerned; its population of 1.1 million constitutes about 22 percent of the world total.

2. Distribution

The numbers of camels in the various States are in Table 16, the largest population being in Rajasthan, followed by Haryana and Punjab.

3. Description

Indian camel breeds are divided into:

Plain - Desert-riding type
- Riverine-baggage type
Hill - baggage type.

The hill camel is more compact than the plain, with shorter legs, round feet and a muscular body.

(i) Desert camel: This is light in weight, with a small head, fine muzzle, thin neck, small ears, well-developed muscles and comparatively small feet. The animal is alert and dignified, and can walk 190 km overnight at a speed of 15 km/hour.

(a) Bikaneri is the most important desert camel breed; nearly 50 percent of all Indian camels belong to it, and 25 percent more carry Bikaneri blood. The height of the camel is 1.9-2.3 m.

(b) Jaisalmeri: This is found in the Jodhpur Division of Rajasthan. It is lighter than the Bikaneri and has finer limbs. It is used for riding and can travel long distances; its capacity for endurance, without food and water, is greater than that of the Bikaneri. Its height is 1.9-2.0 m.

(c) Sindhi: This is found on the border of the Jodhpur Division. The camel is short in stature, with a small, less curved neck. There are two distinct types: the Mahri, for riding, and the Laddu, for baggage.

(d) Mixed breeds: Other important mixed breeds of camel found in Rajasthan are Marwari, Jalori, Mewari, Shekhawati, Mewati and Kutchi.

(ii) Riverine camels are found in the districts of Uttar Pradesh and Punjab, where there is a good water supply. They carry heavy loads and are slow in movement, with a speed of 3 km/hour. They are 1.9-2.0 m in height.

4. Management and feeding

Management of camels varies according to the breed, locality and type of work for which they are engaged. Camels are housed in suitable and simple sheds, consisting of an open space with an enclosure for shelter against sun and rain. Camels are usually troublesome during the rutting season, and males are then kept away from females.

The animal is always held firmly by a nose peg made of wood, and a nose rope. Periodic grooming is necessary.

In areas where winter is severe, camels grow a thick coat, which is clipped in spring. Calves are not clipped till the monsoon breaks, to afford protection against hot winds. After clipping, camels are covered with blankets at night. In the hot season clipping is not necessary.

Camels live by browsing on trees, shrubs and bushes. A camel at rest can thrive solely on grazing and browsing for at least 8 hours a day. Size of the hump is a good indication of its nourishment. When sufficient grazing is not available, the camel is given supplementary stall-feeding. Continuous feeding of dry fodder is avoided, since camels get indigestion and skin diseases; dry feed is always supplemented with chopped green fodder.

The forage crops generally fed are mung (*Phasceolus mungo*), sengi (*Meliolotus perviflora*), sarson (*Brassica alba*) and green pea (*Pisum sativum*), while dry fodder consists of bhoosa (wheat straw) and barley straw. The desert plants relished by the camel include babul (*Acacia arabica*), sheesham (*Dalbergia sisoo*), neem (*Azadirachta indica*), peepul (*Ficus religiosa*), and mulberry and mango trees.

When there is insufficient grazing while the camel is being worked heavily, it is given grain rations of gram, barley, oats, maize or cotton seeds, crushed and soaked in water. Because of their biting habits, the animals are fed at separate troughs.

Camels can tolerate a water loss of 30 percent of their body weight, whereas other animals die at 12 percent loss. They can be kept on dry food without water for 18 days in summer and 30 days in winter, but in normal conditions should be given water twice a day, 40 litres being required daily. A camel can drink 140 litres at a time, which is stored in blood. A very thirsty camel will sometimes suffer from over-distension after a long, quick drink.

5. Disease

In wet regions, 30 percent of camels suffer from anthrax, while pneumonia is common in the Punjab. Twenty percent of camels suffer from surra, which if not treated in time causes heavy losses. Camel pox is suffered by 70 percent of young camels.

6. Reproduction

The camel has a well-defined breeding season. Sexual activity is suppressed for most of the year in males, which come into rut (called "musth") only in winter (November-March). When a number of male camels are available in a village, only one or two of the strongest come markedly into musth; they grind their teeth, foam at the mouth and belch.

Males show signs of sexuality as early as two years, but are usually only allowed to mate after 6 years. A single male generally serves 30-50 females in a season, but may go to 70 if in good condition.

A female camel matures at the age of 4 years, and continues to breed up to 20 years. She breeds once every 2 years, giving one calf at a time after a gestation of 389 days. She is milked twice a day, and has a lactation period of 10-18 months, giving 2750 kg of milk per lactation.

The first 3 weeks constitute the most critical period for a young camel. It is weaned at 15 months of age.

7. Research and development

Very few attempts have been made in India to breed camels on scientific lines. Superior studs are rarely available for providing breeding stock, so artificial insemination is being studied in detail. The Government of India has established a farm at Bikaner, with a herd strength of about 400 Bikaneri camels, to study breeding, feeding and development of the breed.

C. Horses, ponies, donkeys and mules

1. General

The horse is proverbially known for its robust common-sense. It has been widely used in Himalayan warfare, and is still necessary for transport at high altitudes, in spite of a setback to its importance on the plains because of mechanization.

The donkey is a hardy animal, which can work without rest on poor forage. It does well in hot and semi-arid areas, and is well-known for its stupidity though this probably arises from ill-treatment by man.

The mule is the result of crossing a male donkey with a female horse; it is supposed to have inherited intelligence from the horse and sure-footedness from the donkey. It has a great capacity for endurance under adverse conditions of climate and food. A mule is said to be its own boss; it is shy with strangers and often kicks freely. It remains important in high Himalayan regions which can only be reached by horses or mules.

At the 1972 census there were in India 0.94 million horses and ponies, 0.99 million donkeys and 0.075 million mules.

2. Distribution

The distribution of these animals by States is given in Table 16. Uttar Pradesh has the greatest number of horses and mules, and Rajasthan of donkeys.

3. Description

(i) Horses: There are 6 important breeds of Indian horses and ponies, which are described below.

(a) Kathiawari: This is one of India's best breeds, and is found in Rajasthan and Gujarat. It is hardy, vigorous, well known for its pace and speed, and possesses good endurance power under tropical heat and intense cold. Animals are between 12-15 hands (1.2-1.5 m) in height and 1.4-1.5 m in girth. The head of the animal resembles that of the Arab horse; its ears are inclined and meet towards the centre of the poll; the hocks are sickle shaped. The colour is chestnut, bay, brown, grey, piebald or skewbald.

(b) Marwari: This bears a close resemblance to the Kathiawari breed, and is closely associated with great feats of bravery attributed to the Rathor chiefs of Rajputana. The main characteristics of the Marwari breed are similar to those of Kathiawari. It has ease of pace, speed and endurance, with a height of 14-15 hands (1.4-1.5 m) and a weight of 360 kg. The colours are chestnut and grey. The Kathiawari and Marwari breeds are believed to have common ancestry.

(c) Bhutia: These are bred along the Tibetan border and the sub-Himalayan tract from Punjab to Darjeeling. The breed has a compact body, short thick neck, strong back, round muscular quarters, coarse hairy legs, long tail and mane. It is very popular in hilly areas for riding as well as for pack purposes. The height is 13.0-13.2 hands (1.31-1.33 m), and weight 270-360 kg; the colour is grey to iron-grey.

(d) Manipuri: These have been bred in Manipur and Assam for many centuries. Though small in size, the animals possess a proportionate body; the head is small, carried well up on a strong muscular neck, the face is long, muzzle fairly broad and well dilated, the chest is broad, the legs are fine. Knees and hocks are strong and the pastern has a gradual and proportionate slope. The height of a good pony is about 11-13 hands (1.1-1.4 m), and the weight 294 kg. Well known for elegance and speed, these animals are sturdy and surefooted. They are in great demand for polo, racing and military transport.

(e) Spiti: This pony inhabits the Spiti Valley, lying within the Kulu Subdivision of the Kangra District. It is hardy and surefooted, and averages about 12 hands (1.21 m) in height. The body is well developed, with fairly strong bones. The legs are covered with long coarse hair; the colour is dark grey, or iron grey to dun. This breed is capable of thriving in cold regions only, and can withstand adverse conditions such as scarcity of feed and long journeys. Inbreeding is practised to maintain the desired size of the animals.

(f) Zanskari: Among the domesticated species of horses, special mention is to be made of the horses found in Leh, Ladakh. These are very much valued in the district and are some of the finest animals. A true Zanskari horse is whitish grey. The stallion has a compact body, broad forehead and strong back, with a long tail which reaches well below the fetlock of the animal and even touches the ground. The mane hairs are long, the neck is short and the animals have an alert look. The height for males is 13.5-14.0 hands, and females 13.0-13.5 hands. They are used for transport and carriers of loads, as well as for riding and polo.

(ii) Donkeys: There are two kinds in India.

(a) The Small Grey has zebra markings on the limbs, neck and quarters, and is found in most parts of the country. The average height is 0.81 m.

(b) The Large White is commonly found in Kutch, and has an average height of 0.93 m.

(iii) Mules: Two kinds are in common use with the army.

(a) General Service (GS): The army specification for a GS mule is: Age 4-18 years, height 13.0-14.2 hands (1.32-1.47 m), girth not less than 1.5 m, weight 300 kg.

(b) Mountain Artillery (MA): The army specification is 4-18 years, height 14.0-14.3 hands (1.4-1.5 m), shank minimum 17.8 mm, girth 1.63 m, weight over 350 kg.

4. Management and feeding

Horses need skilful handling. Stall feeding is practised, the stalls being bright, well-ventilated and free from draught. Manure is removed daily in the morning. Clean bedding of dry wheat straw is laid; the horses are groomed daily to free them of skin dust, dirt, sweat and dandruff. Hoofs are cleaned and legs massaged; it is common practice to keep them in good physical condition.

Donkeys need comparatively little attention, and only small quantities of rations. They do well on poor quality forage and can withstand rain, cold and exposure very well.

Mules herded together can be trained to graze where facilities are available. They are not greedy drinkers and can endure thirst well.

Horses, ponies, donkeys and mules are all fed individually according to the type of work done.

Oats are the most suitable and safest of all grains for feeding horses, but barley and gram are commonly used instead, plus good hay of lucerne or dub grass. In stud farms and army animal holding units, the prescribed daily ration that is fed consists of 2.5 - 3.5 kg of grain, 6 kg of hay and 50 g of common salt. When green grass is available, 1.5 kg of grass replaces 0.5 kg of hay.

Donkeys on a full day's work are fed 1.5 - 2.5 kg grain, 9.0 - 12.0 kg fodder and 4.5 kg bhoosa.

Mules are fed on the same lines as horses, the quantity depending on the size of the animal. The scale of rations is: Fodder, hay or bhoosa 5.4 - 9.0 kg, crushed grain 1.1 kg, barley 0.9 kg and salt 20 g.

5. Reproduction

Horses have a lower reproductive rate than other domestic animals. They are more difficult to breed, and have a long gestation period of 340 days. The average age at puberty for a filly is 15-18 months, but she is not bred till the age of 3 years or more. Race and show mares are generally bred after their careers have ended.

Stallions attain maturity at the age of 4-5 years but are sparingly used for breeding from 3 years of age.

Early spring is considered the best breeding season for horses; there is less mortality in spring than in winter foals.

As a rule 30-40 mares are allowed to a stallion, depending on its age and number of services per mare. Generally, under the best conditions of management, 2-3 stallion services per mare are required. The conception rate is around 50%. The oestrous cycle in mares averages 21 days, and heat lasts 7-9 days.

Donkeys have no particular breeding season, and are bred throughout the year. Breeding commences at 2½-3 years of age. Mature males can be allowed 160 matings in a year, but not more than 2 a day. The oestrous cycle averages 28 days, and heat lasts 3-7 days, the optimal service time being on the third day. The gestation period is one year, and the young are weaned at 8 months.

Mules are sterile.

6. Breeding

Horse breeding has been practised in India for a long time. Horses are bred by controlled natural mating. Army establishments lend the services of a stallion free of charge to breeders, and purchase the progeny from them at open market rates. There are 36 stud farms in India where selection is done. Bhopal is one of the oldest breeding centres in the country.

There has been no organized donkey breeding work in India. As far as possible, males and females are kept separately. Castration of unhealthy stock is done to prevent poor progeny. A few standard breeds of donkey stallions have been imported from Italy, Spain and France, mainly for mule breeding by the army. For many years past the Government of India has been making strenuous efforts to improve the breed of donkeys in the plains and to rear good quality mules. Donkey stallions are being supplied for breeding work and rewards and prizes are offered for good mules.

V. CHICKENS (POULTRY), DUCKS, GEESE AND TURKEYS

A. Chickens (poultry)

1. General

India and the neighbouring countries have been referred to as the original home of Red Jungle Fowl (*Gallus gallus*), from which present day domestic birds are believed to have descended. The Aseel or Malay Fowl is reported to have given rise to all the breeds of poultry. There is substantial evidencce to show that these birds moved through the Middle East to Europe and gave rise to the present day European breeds. It is believed that this migration took place about 2000 years ago. Some records also indicate that specialized poultry breeding was known in Italy about 50 B.C.

At present in India, in addition to ducks, geese, turkeys, there are many breeds of chickens (*Gallus domesticus* Linn.). The chicken population can be roughly classified into two types: Indigenous (Desi) and Exotic (Improved). The total chicken population in 1956 was 94.7 million; in 1961, 114.25 million; in 1966, 115.45 million and in 1972, 136.77 million. At present, the total population of the indigenous type is about 50 million in contrast to exotic breeds (including crosses) which number around 100 million. The indigenous birds are usually active and hardy and are supposed to withstand varying climatic conditions. Although all the Desi birds are not a single breed, yet they have some common traits, such as compact body size, approximately equal body weights of the two sexes, and a low breast-bone covered with feathers which lie close to the body.

An exhaustive survey of indigenous breeds has not been made. However, 18 breeds of the indigenous type are on record: Aseel, Karaknath, Ghagus, Bursa, Chittagong (Malay), Miri, Dao Thaigir, Brown Desi, Denki, Titri, Harringhatta Black, Kashmir Faverolla, Kalasthi, Lolab, Naked Neck, Punjab Brown, Teni, Tellichery.

Exotic breeds can be classifed, according to their place of origin, as:

Asiatic (other than India), with three breeds, Brahma, Cochin and Langshan,

American with four, Plymouth Rock, Wyandotte, Rhode Island Red and New Hampshire,

English (including Australia) with six, Sussex, Orphington, Australorp, Cornish, Dorking and Redcap,

Mediterranean, with six breeds, Leghorn, Minorca, Ancona, Spanish, Andalusian, Buttercup plus miscellaneous ones such as Bantams (Brahman, Buff Cochins, Rose Comb) and Spanish Fowl.

All these exotic breeds are now available in India and can be regarded as adopted natives.

2. Distribution

Table 19 gives the numbers of chickens in each State, while Figure 6 shows the geographical location of some breeds. Breed numbers are not recorded.

Indigenous breeds have acclimatized themselves to the environments of different regions, and are restricted to specified parts of the country, as detailed in Figure 6 and in the descriptive paragraphs of the next section. Exotic breeds/strains have flourished well in the entire country, but nevertheless "poultry pockets" have developed in different regions, due to entrepreneurship, availability of cheaper inputs, financial resources through public incentives, marketing facilities and more favourable climatic conditions.

Table 19. Numbers of chickens in each State (thousands), 1966 and 1972 censuses

State	1966	1972
Andhra Pradesh	14715	19047
Assam	8936	7732
Bihar	10850	12560
Gujarat	2325	2736
Haryana	479	963
Himachal Pradesh	206	189
J.& K.	1535	1654
Karnataka	8277	10315
Kerala	9909	12207
Madhya Pradesh	5739	6701
Maharashtra	9902	12217
Manipur	623	938
Meghalaya	943	975
Nagaland	438	730
Orissa	7698	8452
Punjab	1680	3170
Ragasthan	865	1235
Tamil Nadu	11226	13336
Tripura	663	518
Uttar Pradesh	3771	3983
West Bengal	12818	15401
Union Territories	1847	1736
Total	115445	136768

Source: Directorate of Economics and Statistics, Ministry of Food and Agriculture (Department of Agriculture), New Delhi

3. Description

Indigenous breeds are described, but exotic breeds are not, as their characteristics are the same as in their country of origin except that performance will vary with environment and management.

Indigenous breeds are given in alphabetic order, the State where each is found being recorded. Uses of these breeds are summarized in Table 20.

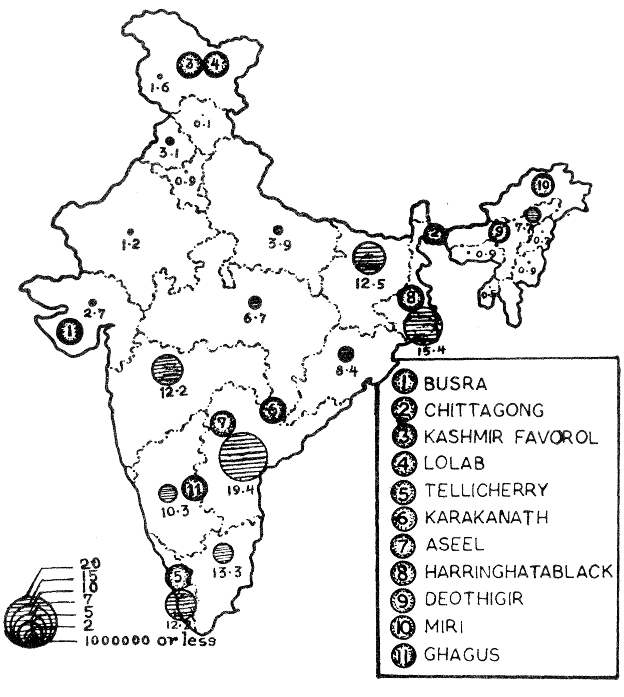

FIG.6_ DISTRIBUTION OF POULTRY IN INDIA

Fig. 6- Distribution of chickens in India.

Aseel: The original Aseel is a medium sized, round-bodied and well-built bird, which is a native of Andhra Pradesh. However, large specimens have also been bred and developed by the promotors of cock-fighting. The short body has a broad breast, straight back and strong tail root. The feathers are tough, close, scanty and almost absent on the face, breast, thigh and the first joint of the wings. Aseels have small beaks. The comb is pea-shaped and small, but Thimur (Triple) and Tekerial or Jaeker (Rose) combs are also occasionally encountered. The breed is famous for great stamina, majestic gait and dogged fighting qualities. The standard weight of the cock is 4 to 4.5 kg and of the hen 2 to 3.5 kg. The birds are poor layers, but are reputed for their delicious meat. The hen is a good sitter. With the ban on cock-fighting, the Aseel is losing much of its importance, and as a result pure specimens are becoming rare.

The breed has several varieties, depending upon their colour, viz. Peela (golden yellow), Yakub (black and red), Nurie (white), Kagar (black), Ghita (black and white spotted), Java (black laced), Subja (white and golden) and Reza (light red). The last variety (Reza) is light in weight and small in size.

Karaknath: This small sized bird is a native of Western Andhra Pradesh. The chicks have a peculiar colour variation from bluish black (with irregular dark stripes over the back, with no head-streak), to a reddish-brown colour (with a dark head streak and more regular striping over the back). The plumage in the adult also ranges from silver and golden spangled to a bluish-black colour without spangling. The breed has a characteristic blackish flesh colour and intensive black colouration of internal body organs due to the presence of melanin. The blood is dark in colour. Adult males and females have an average weight of 1600 g and 1125 g respectively.

Ghagus: This is a large-sized, square-shaped bird, usually running with the nomads of Karnataka and Andhra Pradesh. Its thickly covered body may range in colour from red to black, or grey to brownish-black. The legs are long, smoky yellow and without feathers. The bird has a single small pea-shaped comb, with short wattles and ear lobes. It is a fair layer with efficient brooding characteristics. It is a hardy breed, and is supposed to have resistance to diseases and parasites. It is gradually becoming extinct due to neglect.

Busra: This is a medium-sized bird, and is found in small numbers in the central and western regions of India. The body coloration is widely varying. The breed has light feathers and semi-buttercup shaped comb, with a characteristic tuft of feathers on the head, and grey legs. The body configuration is typical of layers with majestic appearance and alert nature. However, it is a poor layer and not very resistant to parasitic and other diseases.

Chittagong (Malay): The breed is large in size, with a broad breast; the male weighs from 3.5 to 5.0 kg. Its original home is Bangladesh, but it is also distributed in some parts of Eastern India. The plumage is short, thick and white in colour with a splash of golden markings on the wings. The birds have a single short comb, small head, long yellow beak and white/yellow eyes. The back slopes gradually backwards. The birds grow fast and are considered ideal for table purposes.

Miri: This is a small-sized bird, found with other types of indigenous birds in two districts of Upper Assam. They lay more eggs than other locally available Desi poultry. The birds are usually maintained by the Miri tribe, who inhabit upper Assam.

Dao Thaigir: This breed is found in the lower parts of Assam and is reared by the Boro community. It is a heavier breed with good growth rate and body weight at maturity. It has delicious meat. The name Dao Thaigir has been given by the Boro community.

Denki: This is a fairly large-sized breed and is a native of the Vizagapatnam district of Tamil Nadu State. The glossy and lustrous appearance of its red plumage makes it an attractive and handsome bird. Sometimes, the feathers have mixed dark colours. The hens are poor layers. The cocks have long necks and legs, like a game fowl, and have fighting qualities. They have a single compressed comb which is rosy in colour. The average weight of the male bird ranges from 2.5 to 3.0 kg, and that of the female from 2.0 to 2.5 kg. The hens have a strongly broody nature.

Titri: This breed has speckled black and white feathers, with yellow beak and legs. Females have a comparatively smaller comb, although it is erect in both sexes. The birds have poor laying capacity. The average body weight of the cock is 2.0 kg and of the hen about 1.5 kg.

Kashmir Faverolla: These birds are natives of Kashmir. The breed has red and black feathering with yellow beak and legs. In the male, the small comb is erect and the wattles are short. In females, the wattles are very small and the comb is feathered. The hen is a fair layer and weighs about 2.0 kg on average. The weight of the cock varies from 2.0 to 2.5 kg.

Kalasthi: These birds belong to the Chittor district of Tamil Nadu, and closely resemble Denki, except that they are shorter in size. They are attractive birds, and have red lustrous plumage occasionally mixed with dark shades. The hens are poor layers. The birds have inadequate dressing percentages which makes them less valuable for table purposes. The weight of cocks varies from 2.0 to 2.5 kg and of hens from 1.5 to 2.0 kg.

Naked Neck: These birds are found around the west coast of Bombay and resemble an exotic breed found in Hungary. It is presumed they may have a common origin. The colour and shape of the body are variable and not yet fixed. The average body weights of cock and hen are 2.0 kg and 1.5 kg respectively.

Punjab Brown: This breed, a native of Punjab and Haryana States, is brown in colour with yellow beak, legs and feet. These birds are good for meat purposes as they gain about 1.0 kg of live-weight in 17-18 weeks. The average weight of the male bird is from 3.0 to 4.0 kg and of the female from 2.0 kg to 2.5 kg. The shell of the egg is brown in colour. The cocks have a fighting nature.

Teni: This is a common breed of fowl, which has many varieties in all parts of the country. The breed has a small size and a compact solid body. The feathering is light and wiry. The skull is fairly broad; the beak is short and stout; the eyes are bright and bold and the breast bone is well covered. The comb, wattles and ear lobes are small in size. This is an all-purpose bird which suits village conditions, owing to its qualities as an active forager and excellent sitter. It also stands up well to high temperatures. The average weights of female and male are 1.5 kg and 2.0 kg respectively.

Tellichery: This bird is found in the Malabar region. The body is round in shape and the birds have black skin. However, the plumage colour varies from black to grey, sometimes with various combinations of colours. The breed produces fair layers who lay tinted eggs. The male birds weigh around 2.0 kg and the female around 1.5 kg. The breed also is used for medicinal purposes in the Indian system of medicine.

Table 20. Various preferential uses of Indian chicken breeds

Breed	Meat	Eggs	Manure	Cock-fighting	Aesthetic
Aseel	+		+	+	+
Karaknath	+		+		
Ghagus	+	+	+		+
Busra	+		+		
Chittagong	+	+	+		
Miri		+	+		
Dao Thaigir	+		+		
Brown Desi		+	+	+	+
Denki	+		+		+
Titri	+		+		
Harringhatta Black	+				
Kashmir Faverolla	+	+	+		+
Kalasthi	+		+		
Lolab	+	+	+		+
Naked Neck	+	+	+	+	+
Punjab Brown	+	+	+	+	
Teni	+	+	+		
Tellichery		+	+		

+ Does not indicate degree of use

4. Status of the chicken industry

The Indian economy is entirely based on agriculture, including animal husbandry, so the chicken industry has a significant role in the production system.

Table 21 shows the increasing financial support given to poultry (chicken) programmes in the successive five-year plans of the Government of India, while Table 22 shows the increasing total output from the industry.

Table 21. Five year plan outlays for the Indian chicken industry

Plan	Second (1956-61)	Third (1961-66)	Fourth (1969-74)	Fifth (1974-78)	Sixth (1978-83)
Outlay (Rs. million)	28.0	45.8	115.0	335.0	746.0

Table 22. Total value of production of the Indian chicken industry

Year	1961	1968	1971	1974	1977	1983(Projected)
Value (Rs. million)	650	1500	1855	3400	4950	8400

This remarkable increase in poultry production has been due to large scale chick production programme which has been a major phenomenon during the seventies as a result of the opening of commercial hatcheries. Approximately seventy per cent of the total production comes from chicks that have been supplied by these hatcheries.

The major role of these hatcheries has been : (i) introduction of quality hybrids, (ii) helping expansion and growth of poultry farms, (iii) imparting practical management knowhow to farmers, (iv) creating a sound distribution network throughout the country.

Table 23 shows the increases in numbers of layers and eggs produced from 1961 to 1979. The "improved" layers consist of hydrids producing an average of 210 eggs per year, while crossbreds with indigenous breeds produce 100 eggs per year, and the indigenous produce 60.

The per capita egg consumption in India (including eggs from all types of poultry) rose from 5.3 in 1961 to 16.5 in 1977.

Table 24 shows the increase in broiler production from 1971 to 1977, and the estimate for 2000.

Table 23. Estimated laying stock and production (in millions) of the Indian chicken industry

Year	LAYERS (HEN)			EGGS		
	Desi	Improved*	Total	Desi	Improved*	Total
1961	33	2	35	1980	360	2340
1966	35	4	39	2100	720	2820
1971	35	18	53	2100	3240	5340
1974	42	29	71	2520	5220	7740
1977	42	40	82	2520	7300	9820
1979	42	55	97	2520	9900	12420

* Crossbred and hybrid

Table 24. Broiler production of Indian chicken industry

Year	Number of broilers (millions)
1971	4
1975	10
1977	17
2000	71.8

Source: National Commission on Agriculture, 1976, Government of India, New Delhi

5. Management and feeding

(i) Indigenous: Indigenous breeds are mostly kept by small and marginal farmers and agricultural/landless labourers to supplement their nutritional and financial needs. The birds are maintained on a traditional open range/backyard system, and are penned part of the time, particularly at night, when they are housed one to six birds in a wooden pen; no intensive or semi-intensive systems exist for village poultry.

Feed consists of household waste, together with food grains or crop by-products seasonally available in the villages, such as rice, maize, wheat, millets, oats, gram or any other type of full or crushed grain. The feed is thrown on the ground, or placed in earthenware, wooden or tin containers. Water outside is drunk from drains, ditches or ponds, but a water source in a vessel is constantly available inside the owner's house.

Average flock size is one to 20 hens per owner, with a male:female ratio from 1:5 to 1:10. Eggs are kept by the hen for brooding, the entire process being hen-dependent.

Disease occurrence is frequent, and sometimes a single attack wipes out a whole village flock. The prevalent bacterial diseases are pullorum disease (BWD), paratyphoid, fowl typhoid, fowl cholera, tuberculosis, infectious coryza and chronic respiratory disease (CRD). The viral diseases which deserve a mention are Ranikhet disease, fowl pox, fowl plague, infectious laryngotracheitis, infectious bronchitis, avian leucosis complex and avian encephalomyelitis. The protozoan disease coccidiosis causes great losses in Indian poultry. The methods of treatment are antiquated in the villages. However, with the initiative and efforts of Central and State Governments many projects, schemes and extension services have been made to operate in the rural areas. The workers approach the farmers and help in the prevention of diseases under these rural development programmes.

In the village, there is no definite age to which the birds are kept for rearing. This is a highly variable factor and depends upon the need and interest of the owner.

(ii) Commercial flocks: The management practices in specialised commercial enterprises in and around the urban and semi-urban areas are quite different, as high standards of poultry management have been adopted. The same is also true for the group of medium-sized farms who are aware of inputs and the knowhow of modern poultry raising. The farms have very large poultry houses, which may accommodate from 500-10,000 birds in a single undivided construction. Most of the farms are on the deep litter system but large farms on the Californian cage system are also gradually developing: the number of birds per unit varying from 500 to 20,000.

Birds maintained on the intensive system are given standard poultry feed, which is formulated by the leading feed manufacturing units in the country on national recommendations. These are different for chicks, growers, layers, breeders and broilers (starters and finishers). The feed is served in feeders designed for the management system in use, and are different for deep litter and cage systems. The water supply system is also designed to suit the housing system. Automatic feeding systems are not yet adopted in India, although there are a few commercial and research farms who have moved to an automatic watering system.

6. Reproduction

There is no definite mating period, one cock being left with a few hens on the range. Artificial insemination is not used, except in research for genetic improvement in institutions.

Age at first egg in indigenous (Desi) breeds is delayed to about 170-200 days because of limited nutrition. The improved hybrid varieties of White Leghorn maintained commercially have been reported to lay the first egg as early as 130 days, reaching 50 percent production at 170 days.

Hens are used for breeding at maturity. With village fowls the hens are not segregated but remain with males from the day-old chick stage; incubation is by brooding hens.

No statisitics on fertility are available under field conditions but Table 25 gives the results of experimental observations.

Table 25. Hatchability of eggs from the Karaknath breed of Indian chickens

No. of eggs set	Infertile	Dead germ	Dead in shell	No. of chicks hatched
70	13 (18.5)	15 (26.3)	9 (15.8)	33 (58.0)
100	8 (8.0)	10 (10.4)	14 (15.7)	68 (13.9)
150	15 (10.0)	26 (19.2)	27 (18.6)	82 (62.2)
105	5 (4.7)	7 (7.0)	16 (16.0)	77 (77.0)

Numbers in parenthesis denote percentages, based on total eggs set (TES) for infertile eggs, and on fertile eggs (FES) for the remainder

A reference can also be made here to a study on three indigenous breeds conducted at Haryana Agricultural University, Hissar (Anon. 1972). The results revealed that the percentage of fertility and hatchability, both on FES and TES, did not differ significantly among breeds and among hatches. However, hatchability on TES of exotic breeds, also involved in the experiment, was better than all three indigenous breeds. Another study, conducted at the University of Udaipur (Anon. 1974), also indicated that hatchability in Desi breeds was generally satisfactory, although it varied considerably between hatches and in different generations, presumably due to higher ambient temperatures.

Mortality records for indigenous breeds are equally scarce. The only information available is from private commercial poultry farms of varying capacity, where indigenous breeds are maintained for show. Nevertheless, it is interesting to note that the initial mortality in the Desi birds is comparable to the exotic breeds who are so methodically and scientifically maintained at the commercial or semi-commercial farms. The maximum mortality is, as expected, in the age-group of 0-6 weeks. In the growers, the mortality is less than in the chicks and it is further reduced in the adult flock. Management, nutrition and climate all play a significant role if diseases are not taken into consideration.

7. Breeding

In India, poultry breeding has been a source of attraction to breeders, in both the private and public sectors; and considerable activity is going on in various research institutes, universities and in Government and private organisations.

Except for those large-scale private hatcheries which have their principals and interest in other countries, the male stock in India is homebred. In open village conditions, where the poultry is maintained on the range, no breeding programme is possible. The large farms and hatcheries have their own definite programmes. However, small-scale and medium-scale poultry farmers have taken some interest in breeding and have developed their own strains of various poultry breeds, and have even tried crossbreeding with various available breeds, to produce day-old chicks of the desired quality.

The large scale private hatcheries/farms have a definite and well-planned breeding programme to meet marketing requirements. It is usually not disclosed but is based on either inbreeding, pure line selection or outbreeding. In these cases, the grand-parent stocks and/or parent stocks are supplied by the principals to hatcheries who support the programme by rearing them at their farm, then selling day-old chicks to the various categories of farmers who produce and market eggs. There is no hiring system of males.

There is no definite age at which selection is made. The selection criteria for males are fertility, rate of growth, age at maturity and egg production besides many physiological parameters. For females the criteria are fertility, hatchability of eggs, rate of growth, age at maturity/first egg/fifty per cent production, maintenance of production peak and annual egg production. Other characteristics such as size, egg qualities, meat/carcass ratio, disease resistance and behaviour pattern also are taken into consideration at selection.

8. Performance

There are no special feeding or management conditions for birds in production. Highly sophisticated commercial farms have adopted automatic watering (nipple-drinkers) and are likely to use automatic feeding systems in the near future.

The average egg production per year of Desi hens is 50-60 eggs, compared with 240-250 for improved White Leghorns, while eggs from the Desi also weigh less. Table 26 gives average egg weights for some indigenous breeds.

Table 26. Egg weights of various indigenous breeds of Indian chickens

Breed	Egg weight (g)
Aseel	61.3
Izatnagar (Desi)	43.4
Naked Neck	51.0
Black Bengal	49.0
Brown Desi	46.4
Black Bengal (Izatnagar)	42.0
Harringhatta Black	50.0
Local Breed (Izatnagar)	36.2

For village fowls, there is no definite age to which the birds are kept; they are allowed to lay till they completely cease production.

There is no definite information on weights and growth rates according to age for indigenous birds. It is a common observation that a one year old Desi bird weighs about 1.3 kg. However, a study on grading-up Desi chicks, carried out in the Indian Veterinary Research Institute (IVRI), Izatnagar, indicated that weights of these birds at 8, 16 and 24 weeks were 312, 785 and 1281 g, respectively.

Performance for a recently introduced new broiler developed by a leading hatchery is given in Table 27.

Table 27. Performance of a new strain of broiler developed in India.

Age (weeks)	Average body weight (g)	Age (weeks)	Average body weight (g)
1	86	5	900
2	216	6	1240
3	409	7	1480
4	605	8	1780

Average body weights in relation to age for improved varieties of White Leghorn, presently adapted in India, are in Table 28.

Table 28. Body weights at various ages for White Leghorn in India

Age (weeks)	Average body weight (g)	Age (weeks)	Average body weight (g)
8	520	20	1250
10	620	22	1300
12	720	26	1480
14	840	30	1600
16	960	52	1720
18	1080	72	1800

For Desi birds there is no definite age for slaughter, which is entirely dependent upon the available market. However, broilers in commercial industry are usually slaughtered at 8-16 weeks of age to meet marketing requirements. The exotic layers maintained at the medium- and large-scale farms are, as a rule, slaughtered at the end of the laying cycle, and sold as table birds.

The dressing percentage of the exotic broilers is 70-75 per cent. A study conducted in the Poultry Research Division at IVRI showed that the percentage of total edible meat was highest in Desi and lowest in White Leghorn at all stages of growth. This study also indicated that indigenous breeds are superior in meat yield to White Leghorn and Rhode island Red. The dressed and eviscerated yields obtained in a study of three indigenous breeds at Hissar (1972) are shown in Table 29.

Table 29. Dressing percentages in various indigenous breeds of Indian chickens

Breed	Dressed %	Eviscerated %
Desi	93.2	78.0
Naked Neck	83.3	71.7
Black Bengal	93.1	77.5

In a similar study conducted at the University of Udaipur, Rajasthan, the dressing percentage in indigenous birds was 80%.

B. Ducks, turkeys and geese

1. General

Ducks constitute about 6 percent of the total poultry population, but turkeys and geese only between 1 and 2 percent.

There are about 20 breeds and 34 varieties of ducks. Indigenous breeds are Indian Runner (white and white-fawn), Sylhet Meta (light brown with black feather-tips and yellow beak) and White-breasted Nageswari (black body with white breast and throat).

Exotic breeds of ducks include White Campbell, Khaki Campbell, Dark Campbell, Muscovy, Pekin and Aylesbury, the last three being popular for table purposes.

Ornamental duck varieties like Rouen and Shelkrake are small and beautiful, and are stocked in zoos, parks, gardens and sanctuaries.

About 400 million duck eggs are produced in India per year, but are not considered equal to hen eggs in market value and acceptability.

The common breeds of turkeys are Norfolk, British White, Beltsville Small White, and Broad-breasted Bronze. They are consumed at Christmas and are less in demand at other seasons.

Brown-backed and White geese are found everywhere, often running together. When they inter-breed, the crosses are generally of one colour, either white or brown. The white goose weighs 3-4 kg and the gander 4-5 kg.

2. Distribution

Table 30 gives the numbers of ducks, turkeys and geese in each State.

3. Description

No detailed descriptions are available.

4. Management and feeding

Management for ducks is of two types, free or grass range, and backyard, the latter being more common. Housing is simpler than for hens; ducks are only sheltered at night, and kept enclosed in the morning until laying is completed.

In the villages ducks are given thick crumbs of bread, green vegetables, crop by-products and kitchen leftovers. In duck farms, dry or wet mash is given in wooden or tin containers, greens being separately fed. The dry mash contains mash and grain in the ratio 2:1, while in wet mash the ratio is 3:1.

Table 30. Numbers of Indian ducks, turkeys and geese in each State (thousands), 1961 census

State	Ducks	Turkeys and geese
Andhra Pradesh	394.5	69.5
Assam	n.a.	n.a.
Bihar	244.4	1017.1
Gujarat	5.5	6.6
Jammu & Kashmir	85.6	12.4
Kerala	387.1	10.6
Madhya Pradesh	29.8	125.4
Madras	485.9	89.2
Maharashtra	49.7	21.8
Mysore	32.7	20.8
Orissa	163.9	289.7
Punjab	28.5	23.6
Rajasthan	5.3	2.5
West Bengal	4580.6	49.5
Uttar Pradesh	71.8	95.3
Delhi	0.2	0.02
Himachal Pradesh	0.4	0.09
Manipur	42.9	9.1
Tripura	81.6	n.a.
Andaman & Nicobar Islands	6.9	0.2
Total	6697.2	1843.3

Source: Directorate of Economics and Statistics, Ministry of Food and Agriculture (Department of Agriculture), New Delhi

n.a. - Not available

With light-weight duck breeds, one drake is mated with 8 ducks, but for heavier breeds the ratio is 1:4.

No further data are available for these species.

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Discussion

Turner: India is to be congratulated on the steps that have been taken towards evaluation and conservation of its many breeds of livestock. However, I am concerned by what I have seen of data on sheep documentation that the numbers of animals included often have been too small to provide useful information. I trust that this deficiency will be overcome in future work.

Bhat: I quite agree that this has been a deficiency. It should be remembered though that herd and flock sizes in many breeds are very small (10-15 animals) so that it is very difficult to get good comparative information for evaluating different breeds and strains. I would welcome any comments or suggestions on this problem.

Turner: In these small flocks, you might consider the use of a reference breed, that is, providing a few animals of a particular breed to each of the farmers from whose flocks data are to be collected. In cattle and in districts where artificial insemination is available, the problem is more easy to overcome by using a reference sire or sires in each of the herds.

Tanabe: In relation to possible improvement in the milking buffalo, I would like to know what is the maximum yield recorded for the Murrah or Nili-Ravi.

Bhat: If I remember correctly, the maximum recorded milk yield in a lactation for a Murrah buffalo was obtained in about 1932, one female yielding about 4000 kg in a lactation of 310 days. However, the genetic quality of the breed appears to have deteriorated. It is very difficult now to find cows recording better than 2,500 kg per lactation.

Suntraporn: I am doubtful about the wisdom of the establishment of a National Bureau of Animal Genetic Resources. It seems to me that in the developing countries, too much emphasis often is placed on the establishment of new Institutes, which may in fact duplicate existing facilities, and create more problems. It may be better to spend the funds on doing better experiments and getting better data.

Bhat: I agree that this can be a problem, but each country must determine what is the best way to utilize its available resources of scientific manpower and money. By creating this Bureau in India, we hope to focus specifically on the problems that are important to this Workshop and we believe that this will be the best way to do it.

Subramaniam: I would agree with Dr. Suntraporn that there have been unwise decisions in some cases in relation to new Institutes. However, if a Government determines that a particular project requires priority attention and if existing facilities are inadequate, then creation of a new Institute may be the best solution. However, it is not its creation that matters, but the provision of sufficient support so that it can do the task which it is set and do it properly.

ANIMAL GENETIC RESOURCES IN INDONESIA

Wartomo Hardjosubroto and Maria Astuti

I. INTRODUCTION

Indonesia is an archipelago extending between latitude 6° North and 11° South, and between 95° and 145° lines of longitude East, with a population of 138 million people. There are wide differences in climate. The eastern islands have distinct wet and dry seasons, while the western islands are more humid. The average rainfall varies from 1460 mm to 4760 mm and about 50% of the land area gets over 3000 mm. The average temperature ranges from 23° to 35°C in the low plains and from 20° to 30°C in the higher plains.

There are about 94 thousand dairy cattle, 6 million cattle and 2 million buffalo in Indonesia. The dairy cattle are primarily grade Friesians. Bali, Madura and Ongole cattle are the most important cattle which are used as draught animals. The swamp buffaloes are very useful for land cultivation. Sheep and goat are for meat production. The sheep produce poor quality wool. The native pigs are the Bali, Sumatra and Java pigs. Native chickens are of Kampung and Kedu types, which are kept as scavengers. Native duck breeds are the Tegal, Bali and Alabio. In contrast to chickens, the Alabio has a high egg production record. Most of the livestock are kept under traditional husbandry systems, and are concentrated in Java.

II. DAIRY CATTLE

Dairy farming was introduced to Indonesia by the Dutch in the 19th century by importing Friesian cattle from Holland. In North Sumatra, milk production was developed by Indian immigrants, who introduced Hissar cattle. Both Friesian and Hissar cattle were bred to local cattle and the cross between Friesian and the local cattle resulted in the "Grati" cattle which, after many generations, appear to be well-adapted to the tropical climate, as they thrive well even at sea level.

The main purpose of dairy cattle is for milk production; however, in certain areas, *e.g.* in Lembang and Boyolali, Grati cattle are kept mainly for manure and draught, milk being only a by-product of the production system.

The total number of dairy cattle in 1976 was only 94 thousand (Anon. 1978a), of which 85.8% were in Java and 10.7% in Sumatra. Most of the dairy cattle are grade Friesians (Grati cattle) and it is estimated that only 2 to 4% are purebred Friesian. The number of cattle of predominantly Hissar origin is about 10 to 15 thousand, and these are located in North Sumatra (FAO 1978).

There are about 5,000 smallholders who own less than 10 dairy cattle per farm, and these are located in remote rural areas. There are about 260 larger dairy farms, located in the large cities.

A. Description

Mature male and female Grati cattle have body weights of 500 and 400 kg respectively (FAO 1978), and their wither height and chest girth range from 120 to 130 cm and 180 to 193 cm respectively. The colours of Grati cattle are black and white, and the hair is quite short, ranging from 1.0 to 3.0 cm in length. The cattle have no hump and their curved horns are short, varying from 3 to 25 cm in length. Most of the Grati cattle appear to have small udders, but no quantitative data exist on size and volume. The teats point downwards, and are about 35 to 60 mm long.

Their temperament is docile, and the cattle appear to have low heat tolerance. The coefficient of heat tolerance was found to be 66.2 (Atmadilaga, cited by Sutrisno et al. 1978). Their resistance to infestation by parasites and diseases is fair.

B. Environment, management and feeding

Most dairy cattle are concentrated in Java and found in both low and high areas. The average temperatures in the low areas (up to 300 m above sea level) range from 23 to 33°C, while the range of rainfall varies from 2,100 to 2,426 mm a year. The low areas include Jakarta, the area around Semarang-Boyolali-Surakarta, and Surabaya-Pasuruan. The high areas (above 750 meters above sea level) have average temperatures ranging from 16 to 24°C with a rainfall of 2,392 - 3,000 mm a year. The high areas include Bogor, Pengalengan, Baturraden, Lembang and Malang.

Milk production from local dairy cows provided only 17% of domestic needs in 1977 (Anon. 1978a). As Grati cattle are used in some areas as a source of manure and for draught, changes in production systems will improve milk production from these cattle.

Dairy cattle feeding consists of providing 30 to 42 kg of cut roughage (zero grazing) and 4.5 to 6.0 kg of concentrate per day (Kusumadewa et al. 1977), in which the roughage consists of local grasses, such as elephant grass, green rice straw, peanut vines, corn stalks and other food crop by-products. The concentrates consist of rice bran, cassava chips, coconut meal and salt. Grazing of pasture is not used for dairy cows. The average size of the herds owned by smallholders is 5.6 animals, while that of the dairy farms is 12.2 to 65.1 animals per farm (Kusumadewa et at. 1977).

Grati cattle are housed in confined quarters 24 hours per day, water from wells being given twice a day. Calves are kept separately from the cows soon after birth. Early feeding consists of providing 2 to 6 liters of milk, given twice a day and concentrates are fed after the calves are 8 weeks old. Castration of bulls is not usual in Indonesia. Foot and mouth disease appears to be the most important disease in dairy cattle. Most cattle have liver flukes, while brucellosis and mastitis are common in some areas of Java.

C. Reproduction

The mating of dairy cows in Java is usually by artificial insemination; however, remote rural areas still use natural mating. The ratio of males to females in smallholders' herds and that of dairy farms is 1 : 8 and 1 : 13.8 respectively (Anon. 1978b). Age at first parturition is 37.8 months (Anon. 1978b) and there appears to be no seasonality of oestrus and births. The interval between successive parturitions is 13.7 months. Mortality is estimated to be 8.11% (Anon. 1978b).

D. Breeding

As some small holders have no bulls, they mate their cows to bulls owned by neighbours. There are therefore no adequate selection criteria in the breeding of cattle. Selection appears to be based on the external appearance of the cow and her production test during 3 to 5 days. Selection based upon whole production records can be found in large dairy herds. Selection of the bulls is based on external appearance, as progeny testing has not been initiated. Crossbreeding is accomplished by using Friesian bulls on local cattle, and the resulting Grati cows are backcrossed to Friesian bulls.

E. Performance

There appears to be no special management or feeding of lactating cows. Milking is done by hand twice a day. The milk yields of Grati cattle owned by smallholders and the large dairy farms are 6.32 and 7.76 liters a day, respectively (Paggy and Suharsono 1978). Milk production reaches its peak during the fourth lactation period, and the average lactation length in Central Java is 323.2 days. Hissar cows have an average milk production of 2.4 liters a day (Pulungan 1978).

When high-concentrate rations were fed, Moran (1978) found that the growth rate of Friesian grade bulls was 0.90 kg/day, and their dressing percentage averaged 59.3%. Further data on growth rate and dressing percentage of the dairy cattle kept in traditional husbandry system are not available.

III. DRAUGHT/BEEF CATTLE

There are several breeds of beef cattle in Indonesia, namely, Bali, Madura and Ongole.

Bali cattle are descendants of the indigenous Banteng (*Bos sondaicus*). They have been developed through a long domestication period, since prehistoric times. They are maintained as a pure breed in Bali.

Madura cattle represent a distinct breed, and are thought to have originated from a cross between Banteng and indigenous cattle, which descended from types introduced by early traders.

Ongole cattle are a pure breed in Indonesia, and there are also grade Ongole cattle. The purebred Ongole is called the "*Sumba Ongole*", while grade Ongole cattle are called "*Peranakan Ongole*". The Sumba Ongole descended from cattle imported from India in 1914, and these remain as purebred cattle in Sumba Island, which is now the source of purebred Ongole for the other islands, *i.e.* Java, Kalimantan and South Sulawesi. "*Peranakan Ongole*" originated from crossing between Sumba Ongole cattle with local Javanese cattle.

The main purpose of these cattle is to supply draught animals and farm manure. Madura cattle also are used for bull racing. In addition, all cattle produce beef and hides.

The number of Bali cattle is estimated to be 1,000,000 (FAO 1978) and they are concentrated in the islands of Bali, South Sulawesi, Timor and Lombok. According to the 1976 census, the number of Madura cattle was 683,950 in Madura Island and more than 100,000 in East Java. The Sumba Ongole on Sumba Island numbered 33,163 in 1976. The estimated number of Ongole grade cattle is about 4,000,000, and these are concentrated in the islands of Java, Sumatra and Sulawesi.

The cattle number in Indonesia in 1977 was estimated to be 6,044,000 (Anon. 1978a), the distribution being as follows: Java and Madura 61.1%, Bali and Nusatenggara 14.7%, Sumatra 10.4%, Sulawesi 12.4% and Kalimantan 1.5%.

A. Description

The adult size of the Indonesian cattle is as follows:

	BALI[1)]	MADURA[1)]	SUMBA ONGOLE[2)]	GRADE ONGOLE[1)]
Body weight (kg)				
male	384.2±40.3	305.3±2.8	544.0	383.5±10.6
female	257.8±17.1	206.0±2.9	408.0	289.6± 6.9
Wither height (cm)				
male	128.0± 5.4	126.6±1.6	149.0	131.8± 2.6
female	109.8± 4.2	108.6±0.4	132.0	125.3± 0.9
Chest girth (cm)				
male	187.7± 8.1	164.1±2.8	210.0	169.3± 1.2
female	163.2± 4.8	141.6±1.2	147.0	161.6± 2.0

1) Based upon data from several slaughterhouses (Anon. 1977)

2) Gurnadi and Martoyo 1978

Fully grown Bali, Madura and Ongole cattle are estimated to weigh 400, 300 and 530 kg respectively (FAO 1978).

The colour of Bali cattle is red, with a distinct black stripe along the back. Bali males turn black when they are mature. Both male and female have clearly defined white areas on the hind quarters which extend along the belly, white socks starting from the hooves to just above the hocks, and white hair in the ears, around the muzzle and on the tail.

Madura cattle are brownish-fawn to red in colour with a lighter colour on the muzzle, legs and tail.

Ongole cattle are whitish-grey in colour. The hump, neck and head are dark grey, with black colour surrounding the eyes. The grade Ongoles have wide colour variations, from grey to almost black, red spots being sometimes found on the body.

Both Bali and Madura cattle have small ears, which extend straight outwards. Ongole cattle on the other hand have drooping wide ears. The horns of Bali cattle are semi-circular, growing outwards and backwards, but remaining on the same plane. Madura cattle also have small horns, which curl upwards, while those of Ongole cattle vary in size and shape, and are relatively short.

Bali cattle have no hump, but the males have a distinct cervical crest, while Madura cattle have a broadly based hump which is located somewhat ahead of the shoulders. Ongoles have large humps characteristic of *Bos indicus* cattle. The udder and teats of all three breeds are small and poorly developed, and milk yields are low.

Bali cattle are watchful and alert, while Madura cattle appear to be less so. Grade Ongoles are docile and easy to manage, while Sumba Ongoles are more aggressive.

Heat tolerance of these cattle is good. By using the heat tolerance method which was developed by Rhoad, Sutrisno *et al.* (1978) found that the coefficients of heat tolerance of Bali, Madura and Ongole cattle were 92.9, 81.9 and 83.7, respectively. Also Moran *et al.* (1979) reported that there was little difference in rectal temperatures and respiration rates between sun and shade treatments in Ongole bulls. However, exposure to the sun caused a significant increase of cutaneous evaporation in Madura cattle. Resistance to parasites and diseases is fair in all three breeds, but the Ongoles appear to be more resistant than Bali and Madura cattle. Bali cattle are susceptible to "Jembrana" disease.

B. Environment, management and feeding

Purebred Ongole cattle are found in Sumba Island, which has a dry climate. The soil is not suitable for food crop production and natural grassland was established. Purebred Bali cattle are found in Bali, while most of the grade Ongoles are found in Java. As Bali and Java are densely populated islands, most of the available land is utilized for the production of food crops, and the amount of cultivated land available for fodder production is restricted. However, both islands have high levels of rainfall. The climate in Madura exhibits definite wet and dry seasons and drought sometimes lasts for periods up to eight months or more. However, the island is cultivated using dry land agricultural methods. Madura Island is the source of purebred Madura cattle.

Most of the beef production in the islands of Bali, Java and Madura is derived from smallholders whose primary purpose is to produce and use draught animals. The cattle are used mainly for land cultivation, some also being used for road transportation. Exceptions to the traditional smallholder livestock system are a limited number of beef cattle ranches. The contribution of cattle to meat production in 1977 was 167,313 tons or 36.3% of the total meat produced (Anon. 1978a).

Usually, smallholder cattle are allowed to graze the natural grassland in the vicinity of the village: road sides, play grounds, idle farm land, etc. Improved pastures are in almost negligible quantities and these have not as yet had a significant impact on livestock production. However, this situation is changing as many are interested in improved grasses and legumes. In some areas, cattle are kept in stalls and fed cut grasses, food crop residues and other feeds. Stall-feeding usually consists of feeding 30-35 kg leaves and cut grasses per day. Many feed the animals rice straw, maize crop residues and sugar cane tops. Rice straw feeding has tremendous importance for Java because of the shortage of better forages. Usually cattle are kept in a shed at night. In Nusatenggara, they are kept in corrals. The water supply is usually from wells, springs or creeks.

There are about 2,974,000 holdings in Indonesia with an average of 2.1 cattle per unit (FAO 1978). The mating ratio of Bali cattle in Bali is 1 male for 5.5 females (Mansyoer et al. 1978), while in Madura the Madura cattle have a ratio of 1 : 3.3 (Rangkuti and Siregar 1978). The mating ratio of Ongole cattle on Sumba is 1 : 8.6 to 1 : 33.7 (Gurnadi and Martoyo 1978). There appear to be no data on the proportion of males to females in grade Ongoles.

Castration, when used, is by the Burdizzo or rubber elastrator when bulls are 18 to 24 months of age. The weaning age of grade Ongole cattle is 10.9 months, and grade Ongole cows are kept up to 5 to 6 calvings (Hardjosubroto and Sudiono 1975).

Foot and mouth disease, haemorrhagic septicaemia and anthrax are still endemic in some parts of the country, and especially in Java, Bali and South Sulawesi. "Jembrana" disease occurs in Bali and apparently affects only Bali cattle. To prevent the outbreaks of foot and mouth disease and haemorrhagic septicaemia, cattle are vaccinated annually in areas where the disease is recurrent. Anthrax is also controlled through vaccination, but to a lesser extent than in the case of haemorrhagic septicaemia.

C. Reproduction

The dominant mating system of cattle in Indonesia is natural mating.

However, artificial insemination for beef cattle was introduced in Java in 1974 and is becoming more popular. The grade Ongole bulls are first used for breeding when about 2.8 years old (Hardjosubroto and Sudiono 1975). The age at first parturition in Bali cattle under ranching conditions is 857±137 days (Sumbung et al. 1978), while in grade Ongoles under village conditions 41 to 47 months (Hardjosubroto and Sudiono 1975).

Bali cattle show a seasonality of oestrus, as 66.0% of Bali cattle show oestrus from August to January (Pastika and Darmadja 1976), and 70.9% of the births occur from May to October. Ongole cattle apparently show no seasonality of oestrus or births, and this also appears to be true for Madura cattle.

Based on ranch observations, Sumbung et al. (1978) found that the interval between parturitions in Bali cattle was 388±61 days; however, Darmadja and Sutedja (1976) found the interval was 528±155 days for Bali cattle kept in villages. Figures for grade Ongole cattle were 19 months (Hardjosubroto and Sudiono 1975). The pre- and post-weaning mortality of Bali cattle was found to be 7.0% and 3.6% respectively (Darmadja and Sutedja 1976). The annual mortality at maturity appears to be about 2.7% (Sumbung et al. 1978). The annual mortalities of Madura and Ongole cattle were estimated to be about 10-15% (FAO 1978).

D. Breeding

For breeding purpose, some farmers use their own bulls, but in most cases they use the bulls of the village. Bulls are selected only on their external appearance and there appear to be no special selection criteria. Bali cattle in Bali island are to be kept pure by government decree, but elsewhere some cross-breeding is now being used. In Sulawesi, some Bali cows are bred to Simmental and Limousin bulls, using A.I. Santa Gertrudis bulls have been bred to Madura cows in the western part of Madura. The A.I. Centre in Java makes semen available from several breeds of beef animals, which is used to breed grade Ongole cows. Semen from the American Brahman appears to be used most, but semen from Charolais, Simmental, Limousin, Shorthorn, Hereford, Aberdeen Angus and Santa Gertrudis also is available.

E. Performance

Daily gains of Bali cattle and grade Ongole cattle were 0.35-0.50 and 0.12-0.30 kg, respectively (Anon. 1975). When a concentrate feeding system was used, Moran (1978) found that the daily gains of Bali, Madura and Ongole cattle were 0.66, 0.60 and 0.75 kg respectively.

From observations in abattoirs, the percent of carcass in Bali, Madura and grade Ongole cattle was 55.8%, 52.5% and 51.9% for males and 55.2%, 49.2% and 50.6% for females, respectively (Anon. 1977). When high concentrate feeding was used, Moran (1978) found the carcass percentage of Bali, Madura and Ongole cattle to be 56.6%, 60.8% and 58.8%, respectively.

Bali and Madura cattle are first used as draught animals from 12 to 14 months of age, and grade Ongole from 16-20 months of age.

IV. BUFFALO

Most of the buffaloes in Indonesia are of the swamp type, while in North Sumatra there are some of the dairy type, the Murrah breed. The swamp buffaloes are used primarily for work in ricefields, but some are used for pulling carts. In South Sulawesi, some swamp buffaloes are milked, and are also a symbol of wealth and prestige. Surely, the buffalo is also needed as a source of meat.

The total number of buffaloes in the year 1977 was estimated to be 2,480,000 (Anon. 1978a) of which 45.3% were in Java, 22.3% in Sumatra, 16.0% in Bali and Nusatenggara, 15.8% in Sulawesi and 0.4% in Kalimantan. There are about 6,000 head of Murrah buffaloes in North Sumatra. The wild Anoas (dwarf buffaloes) are still found in Sulawesi.

A. Description

The fully grown animal is estimated to weigh 500-600 kg. The wither height of the male and female is 127.7 ± 1.7 and 124.4 ± 4.6 cm and the chest girth is 191.2 ± 3.6 and 180.1 ± 7.9 cm, respectively.

Most of the swamp buffaloes are dark grey in colour, with uncoloured patches in the groin, axilla and under the throat. In Bali island, 60% of the swamp buffaloes are albinoid (Toelihere 1979). Black and white buffaloes (Piebald) are found in South Sulawesi. Adult animals may possess a solid coat of black hair, or a mixture of black, yellow and brown hair. The horns grow outwards horizontally, curling into semi-circles, but remain on the same plane as the forehead. The udder is poorly developed and hidden between the thighs.

Swamp buffaloes are usually docile, but those raised entirely under range conditions have wild temperaments. The heat tolerance of buffaloes is only fair. They are in obvious distress when exposed to the sun, and this is reflected in their physiological responses, i.e. respiration rates and body temperature, which rise rapidly. Buffaloes appear to be less susceptible to diseases than cattle.

B. Environment, management and feeding

Buffaloes are usually found in swampy areas, especially in the rice producing areas, which usually have a high annual rainfall. However, buffaloes are also found in Nusatenggara, where the season is dry for 7 to 8 months a year. Buffaloes play an important role for the farmers as draught animals, as a source of income, as suppliers of farm manure and as a source of food. The importance of buffaloes as meat producing animals is only secondary to that of the power requirement. In terms of the quantity of beef supplied, the contribution of buffaloes to meat production in 1977 was 47,178 tons or 10.2% of the total meat consumed (Anon. 1978a).

Usually the animals are allowed to graze on natural grasses near villages when they are not working. Stall-feeding consists of providing grasses and leaves. Only a few farmers give concentrate feeding. The average size of the herd varies markedly from one province to another. Central Java has the lowest herd size of 2.8 while in East Nusatenggara the herd size is 37.5 heads (Robinson 1977a). The ratio of males to females in Java and Bali is 1:3, while that in North Sumatra and East Nusatenggara is 1:8 (Toelihere 1979). During the night, buffaloes are kept in shelters. In Nusatenggara, they are put in corrals without roofs. Castration for the purpose of culling is not practiced in buffaloes, except in animals for export.

Weaning of calves in swamp buffaloes is not practiced by the farmers. The calf usually stays with the dam for up to one year or even more. The most important diseases are septicaemia epizooticae, foot and mouth disease, surra and liver fluke. Vaccination is used only against septicaemia epizooticae and foot and mouth disease.

C. Reproduction

The mating system in swamp buffaloes is natural mating. In only a small number of buffaloes in West Java has A.I. been tried. Male buffaloes are first used at the age of 3.5 years, and the age at first parturition is 3 to 5 years. There is no seasonality of oestrus; they may be bred throughout the year. Twinning is rare and is thought not to exceed 0.02% of births (Cockrill 1974). The calving interval is 687 days (Robinson 1977b), and annual mortality is estimated to be 10-15% (FAO 1978).

D. Breeding

Males used for breeding are home bred or bought, and external appearance seems to be the only criterion for selecting sires.

E. Performance

Milk production in Murrah buffaloes in North Sumatra appears to be about 2 to 7 liters a day in a lactation period of 11 months. Swamp buffaloes in Toraja (South Sulawesi) produce 3 liters of milk daily (Toelihere 1979). The percent of carcass in male and female swamp buffaloes was 42.8% and 41.6%, respectively (Anon. 1977a). Buffaloes are first used as draught animals at 3 years of age.

V. SMALL RUMINANTS

There are several breeds of sheep and goat in Indonesia, namely: (1) Javanese thin-tailed sheep, (2) Priangan sheep, (3) Fat-tailed sheep, (4) Kacang goat, (5) Peranakan Ettawa (Grade Ettawa goat) and (6) Kambing Gembrong (Gembrong goat).

The Javanese thin-tailed sheep is small; its tail shows no sign of fat and does not reach the hocks. Priangan sheep originated by crossing Merino Cape sheep from South Africa with the local sheep. It is larger than the thin-tailed sheep, has a convex facial profile, and a distinct layer of fat at the base of the tail. In Garut (West Java), there is a special strain of Priangan sheep which is used for fighting; it is also known as the Garut sheep. The fat-tailed sheep were probably brought to Indonesia by Arab traders several centuries ago. They have a wedge-shaped fatty tail.

The "Kacang" goat is thought to be indigenous, and is widespread in Indonesia. It is a small goat. "Peranakan Ettawa" is a grade Ettawa goat, resulting from crossing the Kacang goat and Ettawa (Jamnapari) breed, originally introduced from India. "Kambing Gembrong" is intermediate in size between the Kacang and grade Ettawa. It is found on the eastern coast of Bali (Robinson 1977a). The uses of sheep and goats are as follows:

(a) Both species are especially bred for meat and hide production.

(b) A small flock of Ettawa goat is specialized for dairy purposes.

(c) Garut sheep are used primarily as fighting sheep.

(d) Both species are kept for manure production.

The total number of sheep and goat in 1977 was 3,337,000 and 5,951,000, respectively (Anon. 1978a), and the distribution was as follows: Java and Madura 83.0%, Bali and Nusatenggara 5.2%, Sumatra 8.1%, Sulawesi 3.1% and Kalimantan 0.5%.

A. Description

Fully grown animals are estimated to have body weights as follows:

		Male (kg)	Female (kg)
(i)	Sheep:		
	(a) Thin-tailed	40	30
	(b) Priangan	60	35
	(c) Fat-tailed	40	35
(ii)	Goat:		
	(a) Kacang	35	30
	(b) Grade Ettawa	60	50
	(c) Gembrong	45	38

The Javanese thin-tailed sheep is usually white and commonly has black patches around its eyes and nose. Priangan sheep on the other hand show variegated patterns of black, brown and white. Fat-tailed sheep are usually white with black or brown patches. The Kacang goat has no uniformity in colour, but is usually black, brown or white, with various combinations of all three colours. Grade Ettawa goats are brown with black and white spots, while the colour of Gembrong goat is white gold.

The sheep have a light fleece of extremely irregular, coarse and hairy wool (Mason 1978), of a poor carpet-type. They have semi-pendulous ears of medium size. The Kacang goat has small ears, while grade Ettawa has medium to long pendulous ears.

The Javanese thin-tailed sheep have small curled horns, while the Priangan rams have heavy horns with pronounced cross ridges and sharp angles, forming a loose lateral spiral. The typical fat-tailed sheep is hornless in both sexes. Both male and female Kacang goats have short horns, which are backward-sloping with tips bent outwards. The grade Ettawa have large horns.

All the sheep and goats have small udders and teats. The only exceptions are some Ettawa goats which are used solely as dairy-goats. The temperament of both sheep and goats is docile. Their adjustment to heat is good while their resistance to parasites is fair.

B. Management and feeding

Sheep and goats are important for meat production. They are also valued as a source of manure and as a form of savings for emergencies. Usually the animals graze on natural unimproved grassland during the day. Some are kept indoors and stall-feeding consists of 5 to 8 kg of forage or agricultural waste, tree strippings and native grasses. The average size of the herd is 2.9 heads (FAO 1978). The pens are made of bamboo with the floor raised 30 to 50 cm off the ground. All are kept in pens at night. Castration is not practiced in either sheep or goats. The weaning age is 100 days, with a range of 90 to 120 days, and the animals are kept up to 4 to 5 years old.

The most important diseases in sheep and goats are haemonchosis, coccidiosis and scabiosis (skin disease). A viral disease called Ichtyma contagiosa, resulting in lesions on the lips, occurs; it is easily spread among goats, the affected animals becoming poor in condition. Pneumonia causes frequent deaths, especially during the wet season.

C. Reproduction

Natural mating is used, males being first mated at the age of 12 to 14 months. Age at first parturition is about 15 to 18 months. Neither sheep nor goats show seasonality of oestrus or births. The proportion of fat-tail females producing one, two and three lambs is 63.9%, 32.9% and 3.2%, respectively

(Hardjosubroto *et al*. 1978). The interval between successive parturitions of the fat-tail is 8-10 months, and in goats 7-9 months. Pre-weaning mortality for all sheep breeds is 7.9% (Hardjosubroto *et al*. 1978) while that of post-weaning is 4.2% (Adjisudarmo *et al*. 1978). The estimate of annual mortality of goats is about 15% (FAO 1978).

D. Breeding

Home-bred males are used for breeding purposes. Selection criteria appear to be based on the external appearance of the animals. The Government is importing several breeds of sheep, namely Merino, Suffolk, Sufmer and Dormer breeds, in order to cross these with Priangan and fat-tailed sheep.

E. Performance

Observations taken in several slaughterhouses indicate that the percent carcass in the Javanese thin-tailed and fat-tailed sheep is 51.1% and 49.6%, respectively; while that for the Kacang and grade Ettawa goats is 50.6% and 54.1%, respectively (Anon. 1977). The daily gain of the fat-tailed sheep is 0.08-0.14 kg (Adjisudarmo *et al*. 1978). Milk production of Ettawa dairy-goat is about 500 to 1,200 ml a day, with a lactation length of 3 to 7 months.

VI. PIGS

There are several breeds of native pig, among which are: Java pig, Bali pig and Sumatra pig.

Java pig originated from the crossing of European breeds with indigenous pigs. This pig is short and fat, and displays a mild swayback position, with a heavy mane of bristles on the neck and along the snout. Bali pigs are of the Chinese type, with an extreme swayback position; in fact, the belly almost touches the ground. There is also a great deal of skin folding in adult animals. Sumatra pigs appear to be more nearly related to the feral pig, of which there are still thousands in the jungles. This pig is small, with a tight skin, and has well developed tusks (Robinson 1977a).

The number of native pigs is not known, but the total population, including imported types, was about 2,428,000 in 1977. The distribution was about 4.8% in Java, 45.4% in Bali and Nusatenggara, 23.1% in Sumatra, 12.2% in Sulawesi and 14.4% in Kalimantan.

A. Description

At the first week of age, the average weight of the Bali pig is 0.60 kg, and at weaning age, 4.7 kg. The average adult weight of Java and Bali pig males and females is 100 and 90 kg respectively, and for Sumatra pig males and females, 80 and 70 kg respectively. Java pigs have a white coat colour, Bali pigs are black and white, and Sumatra pigs are all black. All of these pigs have short, small and erect ears.

B. Management and feeding

The Bali and Sumatra pigs are kept as scavengers, roaming the streets, villages and households. Stall feeding is usually practised in Java and the ration is composed of rice bran, soybean cake meal, coconut meal, corn and additional green leaves, like banana leaves, sweet potato leaves, etc. The pigs are fed two or three times daily and the ration is prepared as wet mash.

Castration is done before weaning, or just at weaning time. The age at weaning is between 8 to 13 weeks, with an average of 11 weeks. Common diseases are diarrhea, pneumonia and scabies.

C. Reproduction

Pigs are mated by controlled natural mating, the boar being left with an oestrous sow or gilt for an average of about 25 minutes. The age of male at first service is about 12 months, and the average age at first parturition is about 9-12 months, with an interval between parturitions of about 7 months. Average litter size is 8-10 piglets. Mortality pre-weaning is in the range of 12.5 to 34.0%, and post-weaning about 5%.

D. Breeding

To upgrade the native breeds, Landrace and Yorkshire pigs are used for crossbreeding Java pigs, while for Bali pigs, Saddleback and Berkshire are used.

E. Performance

The average weight of Java pigs for market (at 10 to 11 months old) is 70 to 85 kg, and the carcass percentage is 65.1-69.5% (Anon. 1977).

VII. POULTRY

The native poultry in Indonesia are Kampung and Kedu native chickens, and Tegal, Alabio, Bali and Manila native ducks.

The Kampung and Kedu chickens are considered as the descendants of the Red Jungle Fowl through a long period of domestication. There are about 101 millions of Kampung chickens, and the distribution is 62.4% in Java, 16.8% in Sumatra, 7.5% in Bali and Nusatenggara, 7.6% in Sulawesi and 4.5% in Kalimantan. The distribution of Kedu chickens is limited to the Kedu area in Central Java. Kampung and Kedu chickens are raised in the traditional way in the villages as an intact population. They are kept under minimum conditions with poor feeding. These chickens produce meat and eggs, and they provide about 90% of the chicken meat and 40% of the total eggs produced (Kingston 1979). The meat and eggs of native chickens are appreciated; the meat is a little tough but tasty.

The total number of native ducks is 16 millions, and the distribution is 57.7% in Java, 21.6% in Sumatra, 4.5% in Bali and Nusatenggara, 8.7% in Sulawesi and 4.5% in Kalimantan. They produce meat and eggs, but are mostly kept for meat production. Tegal ducks are raised mostly in Java, Bali ducks in Bali and Alabio ducks in South Kalimantan. During the last three years, Alabio ducks have been distributed to other islands. These ducks are kept as layers and the Muscovy or Manila duck (*Cairina moschata*), a meat type, is used to hatch the eggs.

A. Native Chicken

1. Description

The average body weight of the adult Kampung chicken is 800-1,300 grams. At 30 weeks of age, the body weight is 1525 grams (Kingston 1979). The Kampung chicken has a variegated plumage colour: white, black, brown, grey, etc. The Kedu chicken is either white, or black with a green metallic sheen. The Kampung chicken has a different pattern, which has not been described. They are of either single or rose comb type, and the colours of the comb, wattle and earlobes are red.

Kedu chickens have a black comb when young, the colour turning red at 5-6 months of age.

The temperament of the native chickens is semiwild, alert and aggressive. It is believed that native chickens are more resistant to diseases and parasites than the other breeds.

2. Management and feeding

Native chickens are kept in open range conditions. The average flock size is 5 to 10. The young chick is obtained by natural hatching where the hen sits on 5 to 10 eggs. Under this open range system, the chickens are out in the yard the whole day where they look for insects, ants, worms etc. Sometimes they get an extra feeding as rice bran, cracked rice, kitchen waste, or cassava chop. The water supply is given ad libitum.

Of diseases diagnosed at the Government Diagnostic Centre, the most important are coccidiosis (17.5%), Newcastle disease (11.9%), Marek's disease (8.8%), aspergillosis (13.6%) and nematodes (11.1%). Other diseases represent 37.1% (Ronohardjo and Nari 1977). Vaccination is only against Newcastle disease, but the majority of the birds are not vaccinated.

3. Reproduction

The mating system is free, the males running continually with the females. The mating ratio of males and females is 1 to 4-5. Both males and females are used for meat when mature. The age at first laying in Kampung chicken is 202±22.5 days, and in Kedu chicken 191.0±21.4 days (Hardjosubroto and Supiyono 1977). The fertility of eggs set in Kampung and Kedu chickens is 97.1±3.8% and 95.2±4.6%, and the hatchability of fertile eggs is 65.8±21.9% and 62.6±18.9%, respectively (Hardjosubroto and Supiyono 1977).

According to Kingston (1979), the mortality up to 6 weeks of age was 68.5%, and for the adult birds 7%. These data were based on field observations.

4. Performance

The number of eggs of Kampung chicken and Kedu chicken per year is about 104 and 120, respectively, and the egg weight for Kampung chicken and Kedu chicken was 45.27 and 45.95 grams respectively (Hardjosubroto and Supiyono 1977). The eggs of native chickens have either white or brown shell colour.

The body weight of Kampung chicken and Kedu chicken at different ages is shown in the following table (Hardjosubroto and Supiyono 1977):

Age (week)	Kampung chicken (g)	Kedu chicken (g)
1	38.05	40.70
4	112.90	127.65
8	359.00	368.95
12	713.45	707.75
20	1170.00	1220.00

The average weight of adult birds at slaughter age was 1,316±0.32 gram, and the dressing percentage of Kampung and Kedu chickens at that age was 60.7% and 59.0%, respectively (Hardjosubroto and Supiyono 1977).

B. Native Duck

1. Description

At seven months of age, the average body weight of the female Alabio duck (*Anas platyrhynchos borneo*) is 1.5 kg (Robinson *et al*. 1977). There are three kinds of feather colours, (a) "*branjangan*", brown or grey with black and white dots, (b) "*jalakan*", greenish black stripes and (c) white.

2. Management and feeding

The average flock size is 40 to 200 birds (FAO 1978). The Tegal and Bali ducks are penned at night and shepherded to the post-harvest rice fields in the morning, where they remain during the day. They eat snails, insects, etc. In South Kalimantan, the Alabio ducks are penned under the typical homestead "*lanting*" of the duck farmers; the "*lanting*" consists of a single storey house floating on large logs and tethered about one meter above the water level. The ducks are released onto the water during the day and penned at night. The young are hatched by natural hatching, the Manila duck being used to sit on the eggs. Ducklings are kept in separate pens, where they are fed four times daily. The feeds for ducks are rice bran (wet mash), cracked rice, chopped fresh snails or eels. The Alabio ducks are fed chopped fresh sago palm, fresh shrimp, boiled fresh fish and chopped fresh snails.

The most important diseases in ducks are salmonellosis, botulism and endoparasites. Other diseases are pox, aspergillosis, air sacculitis and virus infection.

3. Reproduction

The mating system is free, males and females running together. The mating ratio of males to females is 1 to 30. Males and females are used as they reach sexual maturity. The average age at first egg was 183 days and the range 165-192 days (Darmadja and Suwena 1977). The fertility and hatchability were 86.2% and 75.9%, respectively (Supardjata *et al*. 1977).

In the Alabio duck, the mortality usually was less than 1%, but 50% mortality may occur due to infrequent disease epidemics (Robinson *et al*. 1977).

4. Performance

The egg production under traditional husbandry is about 80-150 for the Tegal duck, and 200-240 for the Alabio. The average egg weight for Tegal and Alabio eggs is 63 and 54 grams, respectively. The ducks are kept for laying until 3 years of age. No data are available for meat production.

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Discussion

Turner: In the Indonesian sheep breeds (Priangan and fat-tail particularly), you have a valuable genetic resource in that they will breed all year round and have a high incidence of multiple births. The Indonesian government is now introducing sheep breeds from Australia, but these breeds have a shorter breeding season and a lower incidence of multiple births.

Are steps being taken (i) to evaluate reproduction rate of the crossbreds and (ii) to preserve pure Priangan and fat-tail sheep?

Hardjosubroto: A research study is in progress to evaluate the crossbred animals. If their productivity is unsatisfactory, the crossbreeding will be stopped.

Turner: Another reason for preserving the high fecundity sheep breeds is to provide material for research on the mechanism of high egg production. Dr. B. Bindon in Australia and Dr. R. Land in Edinburgh are studying the relationships between hormones and fecundity in some of the few breeds in the world which have high fecundity. In some breeds such as the Finn, output of the hormone causing follicle maturation is followed by a long interval before the eggs are shed. In contrast, in the Australian high fecundity Booroola Merinos, that interval is short. Thus we need a range of high fecundity sheep to investigate the mechanisms responsible for high fecundity.

Naito: Two questions - (i) What are the local cattle that contributed to the Grati breed, and (ii) What work is being done on crossing between Bali cattle and *Bos taurus* or *Bos indicus*, and are these crossbreds fertile?

Hardjosubroto: (i) The local cattle have resulted from a mixture of *Bos sondaicus* (Bali cattle) or their ancestor the Banteng, and *Bos indicus*. (ii) Bali cattle are maintained pure on Bali island, where no crossbreeding is allowed. Crossbreeding studies are being done on other islands, particularly Java, Sulawesi and Lombok.

The first-cross males are sterile, but females are fertile.

Barker: In relation to crossbreeding of exotic and native cattle, (i) is this being done in designed evaluation programs, (ii) how many animals are involved, and (iii) what have been the results for calf mortality, reproduction rate and growth rate? On the last question, early results in Sulawesi indicated that particularly in crosses with Bali females, dystocia at birth and thus calf and cow losses may be very high.

Hardjosubroto: (i) Yes, but the designs may not be as good as they should be. Evaluation in Java is being done under village conditions, and there is the problem that the farmers tend to give the crossbreds both more and better feed.

(ii) Several thousands altogether.

(iii) The daily gain of the first cross was 60-80% better than for native cattle, but no data have been collected on mortality and reproduction rate of the crossbreds.

Watanabe: What is the pathology of Jembrana disease in Bali cattle?

Hardjosubroto: When this disease first appeared in 1964, it was mistaken for rinderpest. However, it has since been shown to be a separate entity. It is apparently due to a vector-borne virus, and *Boophilus microplus* has been shown to be a vector. The disease only affects Bali cattle.

Eusebio: In relation to milk production of the Indonesian swamp buffalo, (i) what is the lactation period for the indicated yields of 3 litres per day, (ii) What are the average calving intervals of the albinoid and of the black and white buffalo, and (iii) Have there been any attempts to cross Murrah buffalo with the local swamp buffalo?

Hardjosubroto: (i) and (ii) - no data available. (iii) No.

Yamada: Are there any preferences, due to religious beliefs, for particular colours in any of the Indonesian livestock species?

Hardjosubroto: Yes, for buffalo. The Toradja people of Sulawesi have a strong preference for the black and white buffalo for ceremonial purposes.

Tanabe: What is the origin and performance of the Alabio duck?

Hardjosubroto: The Alabio breed is native to Kalimantan. Indonesian duck breeds are being evaluated at the Centre for Animal Research and Development, Bogor, and in first test, the Alabio averaged 185 eggs/duck over a 318 day test period.

ANIMAL GENETIC RESOURCES IN JAPAN

Kiyoshi Namikawa

I. INTRODUCTION

The major animals used in all sectors of our livestock production are those imported in former times or at present. The singular developmental processes of our production are related to this fact. The natural environment of our land favors grain cultivation, mainly rice, as the most efficient means of food supply. Furthermore, our ancestors were blessed with fishery products from surrounding seas, and wildlife meat from the forest. They did not consider their farm animals as a source of animal protein (Animal Industry Bureau 1966, Kamo 1976, Livestock Industry Promotion Corporation 1978, Uesaka 1964).

In the old food habits, there was no public demand for animal products, such as meat and milk, for about 1,200 years up to the Meiji Restoration in 1868, because of religious reasons ascribed to Buddhism and Shintoism. Therefore, livestock production in olden times was limited to animals useful as a labor source, except for aesthetic purposes in the case of small animals. It has been established that our Japanese ancestors did not themselves domesticate large animals, such as horses and cattle (Animal Industry Bureau 1966, Kamo 1976, Naito 1978, Nishida 1974, Uesaka 1964), but that these animals were brought by immigrants from the Asian Continent.

From the genetic view-point, it is interesting to point out that our livestock species had been isolated substantially for over 200 years. A noteworthy event was the national isolation enforced by a "shogun" in 1635, which lasted for two centuries up to 1854, with the exception of foreign trade with the Netherlands and China. There had been essentially no introduction of new species or breeds to our livestock populations during this period, except for horses and chickens.

After the Meiji Restoration in 1868, the new government was intent on introducing western food habits as well as culture. With release of the prohibition on eating farm animal meat, and the promotion of drinking milk, consumption of animal products increased gradually. Since the Restoration, the importation of various livestock species or breeds has also been promoted by the government. Cattle for milk and beef, horses for riding and draught, sheep for wool and meat, goats for milk, hogs for meat and chickens for eggs were imported early in the century (Animal Industry Bureau 1966, Ishihara 1952a, Japanese Beef Cattle Association 1979, Naito 1978, Nishida 1974, Oou National Livestock Breeding Station 1978, Uesaka 1964). In some cases, imported animals had been used for crossbreeding to improve native ones, while in others they were used for production as pure bred animals, where traditional production and demand had been weak or lacking. With the introduction of foreign animals, agricultural importance had been taken over by these or by the improved modern breeds derived from crossbreds, whereas pure native animals had gone out of existence, except for small populations which were saved from crossing by chance. In this presentation, the genetic resources of these survivors will be excluded to concentrate on the description of active resources in current livestock production.

II. CURRENT STATUS OF LIVESTOCK PRODUCTION

Current livestock species can be classified in three categories, as shown in Table 1.

Table 1. Current livestock species

Category*	Species	Uses
Major species	Cattle	Milk and beef
	Hog	Pork
	Chicken	Eggs and meat
Minor species	Horse	Racing, draught and meat
	Sheep	Meat and wool
	Goat	Milk and meat
Rare species	Duck, turkey, quail, goose, guinea fowl, rabbit, mink	

* Classification of species - arbitrary, but according to agricultural significance and population size

Major species are contributing to our agricultural production and meeting the national demand for animal food products completely or considerably. On the other hand, species included in minor categories are losing their agricultural significance, regardless of their former role, although the reason for this tendency varies with each species (Naito 1978, Uesaka 1964). Most of the species in the third category, i.e. rare species, have been used for production to meet special demand and are not likely to become incorporated in the first category in our future agricultural production.

The population numbers of each kind of livestock and poultry are shown in Table 2. These figures are obtainable from the "Livestock Census" which is conducted every year nationwide by the Statistics and Information Department, the Ministry of Agriculture, Forestry and Fisheries (MAFF). As rare species are excluded from the general census, the figures for these species are supplied by the "Statistics on Livestock Improvement" which are compiled by the Animal Industry Bureau (AIB). Some available fractional figures of major livestock species are also added in Table 2.

The population numbers of each breed are listed by species or uses in Tables 3, 4, 6 and 7. The Holstein is the predominant dairy cattle breed, as shown in Table 3, and is maintained mostly as a pure breed. As a whole, existing dairy cattle are not an original genetic resource, but have been imported from the United States and the Netherlands. Importation of breeding stocks takes place even at present from Canada and the United States. All minor breeds are also imported.

It should be noted that the situation for beef cattle is quite different from that of dairy cattle. The Japanese Black, Japanese Brown, Japanese Poll and Japanese Shorthorn shown in Table 4 are domestic breeds, and our beef cattle production mainly depends on them. Above all, the Japanese Black is the predominant breed, with nationwide distribution. The Aberdeen-Angus and Hereford, which have been imported during the last decade (Japanese Beef Cattle Association 1979) account for only a minor part of the beef cattle population.

Table 2. Population numbers of each species of livestock and poultry

Species and fraction	Numbers* 1,000 head
Dairy cattle (female only)	1,975
Less than 2 years	598
Two years and over	1,377
Beef cattle	2,030
Female	977
Male	487
Dairy bull calves (for beef)	566
Hog	8,780
Less than 6 months	6,474
Six months and over	2,306
Laying hen	165,675
Commercial hen	156,864
Breeding stock	8,811
Broiler	115,773
Horse	25
Sheep	11
Goat	79

Species	Numbers** 1,000 head
Duck	148
Turkey	21
Quail	6,436
Goose	0.437
Guinea fowl	45
Rabbit	98
Mink	235

* "Livestock Census" compiled as of Feb. 1, 1978 by the Statistics and Information Department, the Ministry of Agriculture, Forestry and Fisheries (MAFF).

** "Statistics on the Livestock Improvement" compiled as of Feb. 1, 1978 by the Animal Industry Bureau (AIB), the Ministry of Agriculture, Forestry and Fisheries (MAFF).

Table 3. Population numbers of each dairy cattle breed*

Breed	Female	Male
Holstein	1,972,670	1,207
Jersey	5,236	16
British Friesian	895	8
Guernsey	67	3
Ayrshire	112	3
Brown Swiss	14	-
Red Danish	6	-
Total	1,979,000	1,237

* "Statistics on the Livestock Improvement", compiled as of Feb. 1, 1978 by AIB, MAFF.

Table 4. Population numbers of each beef cattle breed*

Breed**	Female	Male
Japanese Black	719,227	1,319
Japanese Brown	72,066	171
Japanese Poll	2,229	13
Japanese Shorthorn	30,948	587
Aberdeen-Angus	3,396	43
Hereford	3,549	91
Charolais	93	7
Others	181	16
Total	831,689	2,247

* "Statistics on the Livestock Improvement", compiled as of Feb. 1, 1978 by AIB, MAFF.

** Fattening cattle are not included in the statistics.

Table 5. Foreign breeds crossed with native cattle

Name of modern breed	Prefecture	Foreign breeds used in crossing
Japanese Black	Kyoto	Brown Swiss
	Hyogo	Shorthorn, Devon, Brown Swiss
	Okayama	Shorthorn, Devon
	Hiroshima	Simmental, Brown Swiss, Shorthorn, Ayrshire
	Tottori	Brown Swiss, Shorthorn
	Shimane	Devon, Brown Swiss, Simmental, Ayrshire
	Yamaguchi	Devon, Ayrshire, Brown Swiss
	Ehime	Shorthorn
	Ohita	Brown Swiss, Simmental
	Kagoshima	Brown Swiss, Devon, Holstein
Japanese Brown	Kochi	Simmental, Korean Cattle
	Kumamoto	Simmental, Korean Cattle, Devon
Japanese Poll	Yamaguchi	Aberdeen-Angus
Japanese Shorthorn	Aomori	Shorthorn
	Iwate	Shorthorn
	Akita	Shorthorn, Devon, Ayrshire

Table 6. Population numbers of each hog breed*

Breed	Sow**	Boar**	Pork Pig***
Middle Yorkshire	2,742	183	4,660
Berkshire	6,412	267	11,265
Landrace	309,605	10,485	356,682
Large Yorkshire	47,398	6,883	86,148
Hampshire	42,652	17,615	93,951
Duroc Jersey	19,041	7,535	45,349
Spotted Poland China	631	304	2,687
Chester White	226	50	2,697
British Saddleback	6	7	-
Others	2,987	168	2,707
Crossbreds	589,668	1,696	4,609,789
Total	1,021,368	45,193	5,215,935

* "Statistics on the Livestock Improvement" compiled as of Feb. 1, 1978 by AIB, MAFF.

** Sow and boar are 8 months old and over.

*** Pork pigs includes 3 months old and over.

Table 7. Population numbers of each sheep and goat breed*

Breed	Ewe or Doe**	Ram or Buck
Sheep		
Japanese Corriedale	3,414	490
Suffolk	3,460	376
Others	1,476	82
Total	8,350	948
Goat		
Saanen	39,495	1,577

* "Statistics on the Livestock Improvement" compiled as of Feb. 1, 1978 by AIB, MAFF.

** Ewe and doe are 1 year old and over.

Cattle of the domestic breeds are not pure descendants of native cattle, but composite products from native and imported ones. A brief explanation will be given on the process of establishment of these breeds. After the Meiji Restoration in 1868, various British and continental breeds were imported up to 1910, and used for crossing with native cattle (Japanese Beef Cattle Association 1979, Nishida 1974, Oou National Livestock Breeding Station 1978, Uesaka 1964). The majority of native cattle were graded up by the imported breeds for a few generations. Crossing at that time was not successful, because crossbreds were not particularly improved, and appeared even inferior in working performance. In addition, a great decline in the price of crossbred cattle led to a state of panic among the farmers in 1910, and no more crossing with foreign breeds was repeated thereafter (Animal Industry Bureau 1966). The imported breeds crossed with native cattle are listed in Table 5. These differed among prefectures and even among counties. Furthermore, the influence which these breeds exerted on native cattle also varied in each region. Crossing practices actually lacked unity, even though gene pools expanded rapidly.

According to a decision taken by the government, selection and registration started for the so-called "Improved Japanese Cattle" in 1919 (Ishihara 1952a, Japanese Beef Cattle Association 1979, Japanese Cattle Registry Association 1976, Uesaka 1979). This term referred to cattle having superior traits brought about by both native and foreign ancestors. The Japanese Black, Japanese Brown and Japanese Poll were considered as established breeds in 1944, followed by the Japanese Shorthorn in 1957. As shown in Table 5, these breeds derived from different ancestral foreign breeds which had economic characteristics considerably different from each other. A distribution map is given in Fig. 1. The Japanese Black is reared in all prefectures, while the Japanese Brown is mainly reared in Kumamoto and Kochi Prefectures, and has been recently introduced to Hokkaido. The Japanese Poll is raised mostly in Yamaguchi Prefecture and the Japanese Shorthorn in the northern districts.

The numbers of each hog breed are shown in Table 6. Contribution of old native hogs or domesticated wild boars to the present hog is probably negligible (Naito 1978), although there is some evidence that hog rearing was carried out in olden times. Both the Middle Yorkshire and Berkshire had been predominant breeds for a long period of time (Pig Breeders' Association of Japan 1974), from their first importation in the Meiji era to the recent introduction of the Landrace. Large-sized and meat type breeds, as well as the Landrace, are currently reared as breeding stocks to produce commercial crossbreds. As in the case of dairy cattle, it seems that there is no original genetic resource in our hog population.

Sheep production is a minor sector of our livestock production because of international trading (Naito 1978), where large quantities of fleece and mutton are imported, and sheep are hardly profitable farm animals in most of the producing areas. The major breed is the Japanese Corriedale. Sheep of this breed were first imported in 1914, and large numbers were imported subsequently from New Zealand and Australia, up to about 1940 (Uesaka 1964). The term "Japanese Corriedale" does not mean that they were crossed with native animals, because there were no native sheep.

Goat production has a somewhat different history from that of sheep. Some domesticated goats were brought from the Asian Continent about 1,500 years ago (Uesaka 1964); the small-sized native goats are regarded as offspring of these, and have been reared as meat animals. The imported major breed in the Meiji era was the Saanen, which is considered as a dairy goat. Saanens had previously increased as useful animals, supplying milk for private use, but their current numbers have fallen to about 40,000 head, as shown in Table 7. Outstanding genetic resources in sheep and goats, that still maintain agricultural significance, cannot be found in our livestock production.

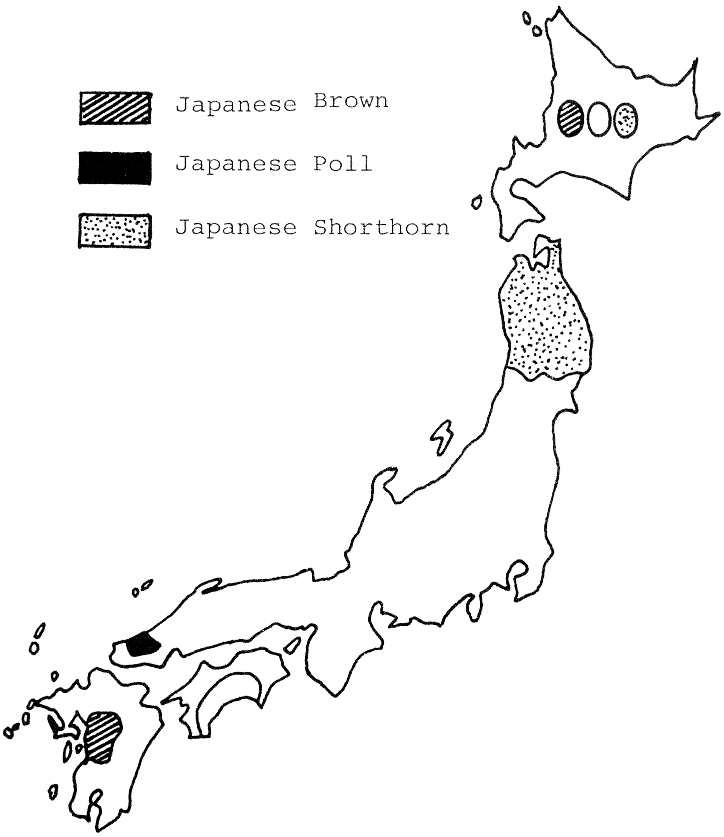

Fig. 1 - Main producing area of each beef cattle breed.

The numbers of each chicken breed, including all types for egg, dual purpose and meat production are shown in Table 8.

Table 8. Population numbers of each chicken breed*

Breed	Female	Male
	(1,000 head)	(1,000 head)
White Leghorn	1,486.90	133.90
Barred Plymouth Rock	1.48	0.09
Rhode Island Red	51.62	3.23
New Hampshire	0.29	0.03
Nagoya	10.48	1.06
White Rock	1,295.68	54.60
White Cornish	101.22	114.15
Commercial layer	955.30	94.39
Commercial broiler	3,700.28	417.53
Total	7,603.20	818.97

* "Statistics on the Livestock Improvement" compiled as of Feb. 1, 1978 by AIB, MAFF.

Among egg and dual breeds, the White Leghorn is the major one for egg production. Breeding stocks of the breed have been imported continuously since 1887 (Uesaka 1964), and they have been improved for several economic traits (Tanabe 1971). Imported chicks took over from domestic ones after World War II, although commercial chicks produced by domestic breeding stocks are used partially at present. The White Rock is reared as a maternal breed, which is crossed with the White Cornish to get commercial chicks for broiler production. Native chickens have not been retained within the active breed group, except for the Nagoya. This breed was established by crossing the native chicken with the Buff Cochin, and further crossing with the Brown Leghorn, Buff Leghorn and Rhode Island Red (Uesaka 1964). Chickens of this breed constitute one of our original genetic resources.

There are numerous native breeds in the pet bird group (Tanabe 1971), such as the long-tailed Fowl, Shokoku, Totenko, Japanese Bantam etc., but they are not mentioned in this paper.

III. DESCRIPTION OF CATTLE BREEDS

In most sectors of livestock production, imported breeds have been used in the pure state. It would not be necessary to describe their characteristics because they have common or identical external traits with their ancestors, even though they have gained somewhat different performance levels by adaptation to the new environmental conditions. Original livestock breeds are found only in beef cattle and chickens, with which crossing between early native animals or birds and imported ones has been practised to establish modern breeds.

As outlined in the previous section, four domestic breeds of beef cattle were established from miscellaneous mongrels. Figures on the target size and normal growth curve are indicated in Tables 9 to 11.

Table 9. The target mature size of each beef breed, as defined by each breed registry association

	Body weight (kg)		Wither height (cm)	
	Male	Female	Male	Female
Japanese Black	940	560	142	128
Japanese Brown*	950	600	143	130
Japanese Poll	980	600	140	127
Japanese Shorthorn	950	560	142	128

* Kumamoto strain. Target figures for Kochi strain are the same as for Japanese Black

There are slight differences in the concept for the true type of each breed, although all breeds are to be used for beef production. The differences seem to stem from the influence of ancestors, rearing systems, preference of fanciers, etc. (Fukuhara 1976b, Japanese Cattle Registry Association 1976, Oou National Livestock Breeding Station 1978, Uesaka 1979). In general, medium-sized animals are regarded as preferable for our production (Fukuhara, Obata and Kihara 1973, Kumazaki, Tanaka and Kihara 1955, Mizuma, Yamagishi and Sato 1974, Obata *et al*. 1977, Okamoto *et al*. 1966), reducing maintenance costs on the one hand and achieving efficient gains in early life on the other. Furthermore, animals of all beef breeds are beef type and produce beef of good quality (Fukuhara 1976a, Ishihara, Tsuchiya and Taguchi 1955, Japanese Cattle Registry Association 1978, Kumazaki and Sasaki 1972, Mukai, Sasaki and Namikawa 1977, Namikawa 1978, Oou National Livestock Breeding Station 1978, Uesaka 1979) although they were developed as working animals (Ishihara 1952a, Ishihara and Yoshida 1956). They are humpless, and bulls usually have a well developed crest.

Japanese Blacks are characterized by a solid and dull black colour of coat, skin and mucosae (Ishihara 1952a, Japanese Cattle Registry Association 1976). Those with a slightly brownish colour at the top of black hair are preferred.

Table 10. Body weight ranges (kg) in the normal growth curve of each beef breed

Age	Japanese Black*		Japanese Brown* (Kumamoto)		Japanese Shorthorn**	
	Female	Male	Female	Male	Female	Male
Birth	26- 32	26- 38	-	-	33± 2.5	36± 4.2
6 mths	160-230	198-273	160-205	220-270	159±18.5	188±28.4
12 mths	285-414	369-509	268-320	400-475	212±15.6	340±56.9
18 mths	354-521	530-722	340-400	540-625	339±55.2	447±28.2
24 mths	395-579	636-845	396-463	630-740	404±58.9	637±55.6
36 mths	431-629	754-970	448-517	745-880	500±51.0	930
48 mths	510-610	890-990	460-534	810-943	545±51.8	1,090

* Ranges shown are $\bar{x} \pm 2$ s.d. from "The Normal Growth Curve" of each registry association

** The figures are $\bar{x} \pm$ s.d. from the record of the Oou Livestock Station

Table 11. Wither height ranges (cm) in the normal growth curve of each beef breed

Age	Japanese Black*		Japanese Brown* (Kumamoto)		Japanese Shorthorn**	
	Female	Male	Female	Male	Female	Male
Birth	65- 73	68- 76	-	-	67±2.7	70±2.1
6 mths	96-106	102-112	99-106	98-108	97±4.4	99±4.3
12 mths	110-121	120-129	111-117	117-125	104±3.3	114±5.0
18 mths	117-127	129-138	117-122	127-133	111±6.9	122±6.1
24 mths	121-130	133-142	120-126	131-137	117±4.2	131±4.0
36 mths	123-132	134-143	123-129	134-142	122±5.1	142
48 mths	125-131	135-144	124-131	136-145	123±5.4	145

* Ranges shown are $\bar{x}$ ±2 s.d. from "The Normal Growth Curve" of each registry association

** The figures are $\bar{x}$ ± s.d. from the record of the Oou Livestock Station

It is considered that these characteristics were originally predominant in early native cattle (Ishihara 1952a, Oda 1952, 1953, Oda, Ishibashi and Kawada 1953). Variations in coat colour, pattern, spots or brindles are scarcely found in this breed at present, except for a small white spot in the udder or pubic area and scanty mixed-coloured hair in some parts (Japanese Cattle Registry Association 1976). The length of hair is about 4 cm, whereas that of wool is about 2 cm. Hair and wool show high population density, with fineness and softness (Uesaka, Matsuki and Kawashima 1943), and sometimes with beautiful curls on shoulder and neck. The skin is elastic and not so baggy as that of the Zebu (Uesaka 1950), while some cattle of the Japanese Black show a small pendulous dewlap and chin. Horns are short, curved upwards, of small size, black in colour at the top and bluish white at the bottom. Ears do not droop and are of medium size. These quality characteristics in live animals, including feet and cannon bones, have been the most important selection criteria (Japanese Cattle Registry Association 1976, Uesaka 1979), in relation to carcass quality.

Females of the Japanese Black are rather poor milk producers (Ishihara 1952a), although wide variations are observed in their dairy characteristics, such as size of udder, relative size of quarters and size and position of teats (Ishihara 1952a, Japanese Cattle Registry Association 1976, Uesaka 1979). Milk yields of cows in an early experiment averaged about 1,200 kg during a 180-day suckling period (Ishihara 1952a). The temperament of this breed is excellent, as early Japanese cattle and crossbreds were selected for working ability in rice paddies. They are also tolerant of heat and direct solar radiation, regardless of their black hair. Resistance to tick-borne diseases has been observed in grazing cattle that have been infected once (Ishihara 1952a, Ogawa et al. 1977, Uesaka 1979).

There are two distinct strains in the Japanese Brown breed (Uesaka 1979), although they are regarded as one breed by their coat colour. About 90% of the Japanese Brown belong to the Kumamoto strain, and the remainder to the Kochi strain. Both strains have been influenced more by the Korean Cattle and Simmental than by the early Japanese cattle. The Kumamoto strain has been much more influenced by Simmental than by Korean Cattle, whereas the Kochi strain has been strongly influenced by Korean Cattle (Animal Industry Bureau 1966, Nishida 1974). There are therefore some differences in their size and external traits (Koba 1971, Okamoto, Koga and Matsuo 1960, Okamoto et al. 1966). The coat colour of the Kumamoto strain is solid light brown, with the skin, mucosae, horns and hooves of the same colour. In contrast, the Kochi strain has a reddish brown coat, with black mucosae and skin in certain parts of the body, such as muzzle, eyelids, tongue, anus, horns, feet, tail, etc. As this character is variable, some animals in the strain show a solid colour (Uesaka 1964).

The hair of the Japanese Brown is similar to that of the Japanese Black as a whole, but there are differences in density and fineness. The Kumamoto strain is of larger size, slightly rangy and heavier in the forequarters, but showing a superiority in grazing ability comparable to that of foreign breeds (Naito 1978). The temperament of the Japanese Brown is quite excellent; it has a mild nature and is easy to handle. The horns are short and tend to thrust forwards. The breed is also hardy in summer grazing areas in the south-western region, and is resistant to tick-borne diseases.

The Japanese Poll has been considerably influenced by the Aberdeen-Angus; the breed thus has an excellent beef type and low-set conformation (Animal Industry Bureau 1966, Ishihara 1952a, Ishihara et al. 1952, Japanese Beef Cattle Association 1979, Kamo 1976, Kosaki et al. 1979, Naito 1978, Uesaka 1964, 1979). The coat colour of the breed is similar to that of the Aberdeen-Angus (Ishihara 1952a), being of a solid and darker black than that observed in the Japanese Black, with black skin and mucosae. Characteristics of hair condition are similar to those of the Japanese Brown, except for the colour. Polledness is the most noticeable external trait. Very few horned newborn calves have been observed in recent years (Japanese Cattle Registry Association 1976) as a result of strict selection for this trait. Japanese Polls are more or less nervous, while they become mature earlier and are superior in their ability for roughage utilization (Naito 1978).

The Japanese Shorthorn has the same coat colour and pattern as those of its ancestor, the British Shorthorn, because the breed was established by crossing the Dairy Shorthorn and Beef Shorthorn with the early native cattle (Mizuma and Sasaki 1974, Mizuma, Yamagishi and Sato 1974, Naito 1978, Oou National Livestock Breeding Station 1978, Uesaka 1964, Yamamoto et al. 1979). There are three types of colour and pattern: red, red and white, and roan, with a wide range of red shades. The hair of the breed is longer and coarser than that of any other domestic breeds (Uesaka 1964). The horns are short and usually thrust forwards, being amber in colour. As it can readily be imagined, cows of the breed are superior milk producers, and have good mothering ability, supplying enough milk for their calves, even under range conditions (Oou National Livestock Breeding Station 1978). Well developed udders in front and rear quarters, with nicely placed teats, are commonly observed. Cattle of the breed seem to be susceptible to summer heat in the western part of the main island, although this has not been proved by experimental results.

IV. ENVIRONMENT, MANAGEMENT AND FEEDING

A. Environment

Our land comprises four large islands and more than 1,000 small dotted islands, which are located from the sub-arctic zone to the subtropical zone. Generally, the climate is temperate and humid, although it is diversified among regions and by seasons. Of the total area, covering 372,000 km^2, only about 16 percent is arable, as most of the area is occupied by steep mountains. Both the abundant rainfall throughout the year and mountainous topography have enabled the development of ample forest regions, and rapid streams run off immediately to the sea. These natural factors also have brought about the paddy soil and peat in the form of alluvial plains from the upper streams, while the weathered volcanic ash is the most unique soil in our natural environment. The vegetation is characterized consequently by predominantly wet-forest type plants with a restricted growth of dry-savanna type plants.

B. Management and feeding

Livestock production is one of the growing industries among various sectors of agriculture. The output from animal production accounted for about 26 percent of the total agricultural production in 1977. Domestic meat production, however, does not meet the national demand, although the output was 2.5 million tonnes in 1977, 6 times higher than in 1960 (Japanese Beef Cattle Association 1979, Livestock Industry Promotion Corporation 1978, Naito 1978). Of the meat demand, about 23 percent depends on imports. There is a shortage of beef, due particularly to the recent rapid increase in beef consumption, whereas the consumption of other animal products, such as eggs, milk and poultry meat, is in balance with the supply. To rear animals and poultry, vast amounts of feed reaching more than 7.9 million tonnes in 1977, have been imported. Our livestock production places its main reliance on imported feeds, accounting for more than 80 percent of the feeds consumed. The low rate in self-sufficiency of feeds is the most important problem in the economic production system, in spite of the introduction of larger operations, together with modern feeding and management techniques in most of the sectors (Namikawa 1978, Uesaka 1979). Forage crops are too expensive and insufficient in quantity to feed animals. The ratio of concentrates to forage tends to be high in feeding plans for all kinds of livestock, even for ruminants, while various agricultural by-products are also utilized as an energy or cellulose source. In general, dairy or beef cattle operations are rather small, and more intensive than those in foreign countries, while the hog and poultry producers tend to increase their management scale (Naito 1978). The size of beef cattle operations still remains small, with 5 head on the average, due to the lack of productive bases for grazing or forage production areas. There is no clear difference in the feeding and management conditions for hog production, compared with those in foreign countries, as these depend mainly on concentrate rations.

Grazing areas are limited to mountain sides, hilly regions and highlands, where rice production is impossible without irrigation. Cattle, horses and sometimes sheep are grazed rotationally on fenced ranges or pastures in summer from May to October (Naito 1978, Uesaka 1979), but they are usually kept in barns in winter, because green forage is unavailable in most of the grazing areas, due to withering or heavy snow cover in winter. Major species of pasture grass are orchard grass, timothy grass, ryegrasses and fescues, and those of legumes are red clover, ladino clover and white clover (Naito 1978, Uesaka 1979). Seeds are sown as a mixture of grasses and legumes at appropriate mixing rates. In the south-western region, where all the year round the temperature is higher than in the northern region, dallis grass, bahia grass and napia grass are used to keep good pasture condition in the summer. Miscanthus, bush clover, bamboo grass, ground bamboo and kudzu etc. are useful and popular forage species in ranges. Young growing heifers and calves are fed supplementary or creep feeds even in summer. Bulls are seldom grazed in dairy and even beef cattle rearing. Less than 80 beef cows are sired by a bull, when free breeding is practised.

Grazing is not a popular rearing system, but housing in barns is the principal one in dairy and beef production with supplementary forage such as fresh green cut grass, silage and hay. Then, there is no standardized herd size for grazing. In some cases, farmers can leave their cows in common grazing areas on paying a fee, and grazing capacity is calculated on the basis of 0.3 hectare per head for pasture and 1.0 hectare for range (Naito 1978).

Castration of bull calves is an essential practice during the suckling period for beef cattle (Ishihara et al. 1957), because castrated calves are marketed as feeders for fattening. They are castrated by the Burdizzo or the knife, usually when they become 2 or 3 months old, or at the latest, 7 or 8 months old (Naito 1978, Uesaka 1979). Almost all calves are creep-fed from the age of 2 or 3 months. Dairy bull calves are castrated in the same way (Japanese Beef Cattle Association 1979), but they are placed under artificial nursing up to the age of 40 or 50 days.

Along with the extension of group feeding, loose in barns, wide movement of feeders, abnormal feeding of steers and the importation of feeder cattle, various new diseases become troublesome for dairy and beef cattle production. Infectious diseases by bacteria and viruses, such as infectious respiratory diseases, new-born calf diarrhoea, stillbirth (Akabane disease) and red nose (Naito 1978), have prevailed in the past decade. Theileriosis, a kind of tick-borne disease, and pink eye are apt to occur in grazed cattle.

Cattle of the domestic beef breeds can live up to the age of 25 years (Fujiwara and Irie 1969), but such long life is rare even for breeding stock which have been raised under careful management. Cows used for feeder calf production are usually fattened when they are less than 8 years old (Uesaka 1979), when their carcasses are still profitable.

V. REPRODUCTION

In accordance with the development of techniques and establishment of services all over the country, artificial insemination has been applied to all species of livestock and poultry (Naito 1978). In 1978, the proportions of artificially inseminated females were about 98 percent for dairy cattle and 91 percent for beef cattle. The figures for other species were 12 percent for horses, 24 percent for hogs and 9 percent for goats in 1975. Strawed semen in the liquid form has been rapidly substituted by the frozen type. Among the artificially inseminated females, 97 percent of dairy cattle and 79 percent of beef cattle were served with frozen semen. As only selected superior males are used in the system, the ratio of males to females is extremely low (Table 3). The semen of young bulls is collected first at about 18 months of age, and thereafter periodically (Naito 1978, Uesaka 1979). Heifers have their first service when 13 to 17 months old, although it had been a routine practice to mate at older age (Uesaka 1979). The first parturition can be expected to occur at about 2 years of age, without any calving difficulties. Cows have the next service within 40 to 60 days after calving, to shorten the calving interval. There is no seasonality of oestrus in domesticated cattle, although it is convenient to restrict the breeding season within a given period for the management and marketing of calves.

Conception rates were about 87 percent for dairy cattle, and 83 percent for beef cattle in 1978. Calf crops were 80 percent in both dairy and beef cattle. The natural rate of twinning or multiple births has been masked recently by the administration of estrogenic substances to repeated breeders. According to Ishihara (1952b), the rate is very low in domestic breeds of beef cattle, amounting to 0.11 percent in the Japanese Black and 0.19 percent in the early Japanese cattle. Furthermore, it has been observed that the frequency of monozygotic twins is higher than that of European breeds. The average calving interval is estimated at about 13.5 months for both dairy and beef cows. The management of cattle is so intensive that mortality is fairly low throughout animal life with the exception of periods of infection.

VI. BREEDING

As a general rule, active males in most of the livestock species are now home bred, after a long history of complete dependence upon importation. For dairy cattle, draft and race horses, and hog production, male breeding stocks have been supplied by a relatively small number of breeders (Naito 1978). Some breeders are still importing stocks to hold their priority. National and prefectural livestock breeding stations also are sources of breeding stock. For beef cattle, bulls of domestic breeds have been supplied by small-scale breeders and livestock breeding stations. Hereford, Aberdeen-Angus and Charolais bulls have been imported since 1962 (Japanese Beef Cattle Association 1979, Tokachi National Livestock Breeding Station 1974) to cross with domestic beef cows, but crossing has not been accepted by farmers.

It is a conventional procedure to select weaned animals as a first step. Selection criteria are body conformation, pedigree and ancestors' performance records (Japanese Cattle Registry Association 1976, Uesaka 1979). Then, performance testing to qualify individuals is planned in the second stage. Thirdly, progeny testing is conducted to get proven stocks (Japanese Cattle Registry Association 1976).

In dairy cattle, young bulls and heifers are selected by classification score, pedigree and performance records of dam and ancestors (Naito 1978). Performance records are obtained from 305-day testing of cows on total milk yield, average milk fat percentage and total milk fat yield. These are the selection criteria required for high class registration of the Holstein breed. Official progeny testing for dairy cattle aims at the selection of bulls by the contemporary comparison method. Herd testing was initiated in 1976.

Similar procedures are adopted for beef cattle, but the subjects of performance testing and progeny testing are limited to the male. Performance testing is used for weaned bull calves to test their gaining ability and feed utilization, while progeny testing also is done to estimate the breeding value of a sire, using weaned steer calves (Japanese Beef Cattle Association 1979, Japanese Cattle Registry Association 1976, Uesaka 1979). Their average records on feedlot performance and carcass characteristics are observed as important selection criteria for the tested sire. Weaned heifer calves are selected on rather mild bases of registration class, pedigree and calf grade, although no official testing for females is practised. The cows that meet the requirements for classification score at younger ages (approximately 16-32 months) and no record of genetic defects in the pedigree, may qualify for higher registration classes, when they have achieved a satisfactory reproductive performance and shown their ability to transmit superior conformation (Japanese Cattle Registry Association 1976).

A systematized nationwide project is being undertaken to produce and preserve superior breeding stocks by an on-farm testing system in concert with a station testing system (Japanese Beef Cattle Association 1979).

In hog production, performance testing and progeny testing are also carried out at the early stages of animal life. Main selection criteria for evaluation are age at a constant body weight, daily gain and feed conversion in performance testing, while backfat thickness and carcass characteristics, such as dressed carcass percentage, rib-eye area and proportion of the ham cuts, are added in progeny testing (Pig Breeders' Association of Japan 1974). About 10 national and prefectural livestock breeding stations specialized for hog breeding have made a great deal of effort to establish domestic inbred lines (Mizuma 1974).

Crossbreeding is popular in hog production and breeds used for the purpose are shown in Table 6.

VII. PERFORMANCE

In dairy farming, relatively large amounts of forage are supplied, but there are extremely intensive farms in suburbs, where rations, consisting mainly of concentrates and by-products from brewery, with a marginal quantity of forage or rice straw, are fed to dairy cattle (Naito 1978). More special feeding conditions are prevalent in beef cattle production (Namikawa 1978). Steers are finished at 582 kg live weight and 26.3 months of age on the average, after spending about 17 months fattening from weaning. During this period, they consume about 3 tonnes of concentrate rations and gain 0.61 kg a day. Such a fattening system is too long and not reasonable, but can be profitable at present, as a result of the strong demand for high quality beef.

Milking of dairy cows is carried out by machine twice a day (Naito 1978). Total milk yield, milk fat percentage and total milk fat yield from Holstein cows admitted to the high class registration in 1977 were 7,175 kg, 3.75 percent and 268 kg respectively. These figures are corrected to mature equivalent, with two milkings a day and on the basis of a 305-day milking period, to indicate the present milking performance of higher class cows.

The current level of meat producing ability of each beef breed, as well as breed differences, can be estimated in broad outline from the records of official performance testing and progeny testing (Fukuhara 1976a, Japanese Cattle Registry Association 1978, Kumazaki and Sasaki 1972, Mizuma 1974, Mukai, Sasaki and Namikawa 1977, Uesaka 1979). It is difficult, strictly speaking, to compare the records between or among breeds, as these were obtained at different testing stations, and testing programs differ among breeds with regard to testing period and concentrate feeding level. The programs have been revised frequently since 1968 (Japanese Beef Cattle Association 1979). In the current performance testing program of the Japanese Black, candidate bull calves are put on a given fattening ration at 6 to 7 months of age when they weigh 200 to 300 kg (Japanese Cattle Registry Association 1976). They are fed individually for 16 weeks, instead of 20 weeks as previously.

The performance testing records, shown in Table 12, were obtained in 1974 for the period of 20 weeks. The Japanese Brown, Japanese Poll, and Japanese Shorthorn are breeds of a larger size from the view-point of birth, initial and final weights, but are not highest in daily gains.

The features of the domestic breeds as regards feedlot performance are also observed in the progeny testing records, as shown in Table 13. In the current progeny testing program of the Japanese Black, 8 weaned steer calves of each sire are group-fed with free access to both concentrate ration and forage, from the age of 7 to 8 months, when they weigh 200 to 280 kg (Japanese Cattle Registry Association 1976). After a 52-week feeding period, they are slaughtered to record their carcass characteristics. The most noticeable carcass trait is marbling, which is the main trait of carcass quality in Japan. A higher proportion of Japanese Blacks are superior in this trait, as they are finished at younger age and lighter weight, without excess subcutaneous and intermuscular fat. The importance of marbling is, of course, questionable from the scientific viewpoint. The trait is definitely heritable (Kumazaki and Sasaki 1972, Mukai, Sasaki and Namikawa 1977, Uesaka 1979), and probably results from superiority of the early native cattle (Ishihara, Tsuchiya and Taguchi 1955).

In hog breeding the performance testing program is aimed at evaluating more than 10 male piglets at a time, from 30 kg to 90 kg in body weight (Naito 1978, Pig Breeders' Association of Japan 1974). Progeny testing is possible in boars and sows at the same time. Four piglets from a litter, including 2 females and 2 castrates, are used to test their dam. In the testing program, 16 piglets from 4 litters are used to test their sire, because a boar is mated to 4 sows to get his offspring. The testing period is the same as that of performance testing, but all fattened piglets are slaughtered to record their carcass characteristics (Tables 14, 15).

The progeny testing records for daily gain, feed conversion and proportion of ham cuts, which were obtained in 1976 with 328 Landrace boars and 1,245 sows of the same breed, averaged 749.5 g, 3.44 kg and 32.3% respectively (Naito 1978).

Table 12. Performance testing records of beef cattle breeds*

Items	Japanese Black	Japanese Brown	Japanese Poll	Japanese Shorthorn	Aberdeen-Angus	Hereford
Number of tested bull calves	52	28	9	49	10	30
Birth weight, kg	31	32	33	37	30	34
Initial weight, kg	257	366	285	300	235	233
Final weight, kg**	402	512	435	451	395	392
365-day weight, kg	391	439	432	407	380	368
Daily gain, kg	1.04	1.04	1.07	1.08	1.14	1.12
Concentrates intake, kg	715	872	679	720	770	578
Forage intake, kg	361	469	336	604	565	697
TDN/kg gain, kg	4.8	5.9	4.5	5.5	5.3	4.9

* "Beef Cattle Performance Testing and Progeny Testing Records", 1975.

** Performance testing period was 140 days in all breeds.

Table 13. Feedlot performance and carcass characteristics of domestic beef breeds*

Items	Japanese Black	Japanese Brown	Japanese Poll	Japanese Shorthorn
Number of tested bulls	22	3	2	2
Testing period, day	301	329	315	294
Initial age, day	296	259	257	271
Initial weight, kg	253	284	247	232
Final weight, kg	516	562	537	520
Daily gain, kg	0.88	0.84	0.94	0.98
Concentrates intake, kg	1,859	1,853	1,662	1,775
Forage intake, kg**	770	1,140	1,092	1,070
Carcass weight, kg	310	353	312	297
Dressing percentage, %	63.6	64.0	62.8	59.9
Marbling score***	2.7	1.7	0.8	1.3
Rib eye area, cm^2	42	45	41	38

* "Beef cattle Performance Testing and Progeny Testing Records", 1976. Animal Production Section, AIB, MAFF.

** Air dry basis.

*** Carcasses were ribbed at the 7-8th section, and on the marbling score eleven ratings are adopted from the highest 5 to the lowest 0 by visual appraisal.

Table 14. Breed comparison by extracted progeny testing records*

Items	Middle Yorkshire	Berkshire	Landrace	Large Yorkshire	Hampshire
Years	1970	1970	1972	1972	1972
Number of piglets	88	42	1,308	75	155
Age at 20 kg body weight, day**	73.3	73.5	62.5	68.1	68.7
Age at 90 kg body weight, day	203.5	201.1	173.2	172.4	177.7
Daily gain, g	547.8	550.6	657.1	667.4	651.0
Feed conversion, feed/kg gain	3.83	3.64	3.48	3.35	3.47
Rib eye area, cm^2***	16.7	19.8	17.8	18.5	19.5
Backfat thickness (average), cm	3.4	3.3	2.6	3.0	2.4
Proportion of ham cuts, %	30.0	29.8	32.9	31.9	33.1

* "Manual for Hog Performance Testing and Progeny Testing", 1975. Japanese Breeding Hog Registry Association.

** Progeny testing was carried out in the previous program.

*** Rib eye area was measured at the 5-6th rib section.

Table 15. Feedlot performance and carcass characteristics of crossbred hog*

Items	Trial 1**					Trial 2		
	H	LH	L	LW	W	L	LD	D
Age at 20 kg body weight, day	74.9	67.6	67.5	65.1	79.3	70.8	67.0	71.5
Age at 90 kg body weight, day	183.4	171.1	181.7	175.4	198.1	176.9	164.1	175.3
Daily gain, g	653	679	619	640	596	666	726	681
Feed conversion, feed/kg gain	3.51	3.38	3.72	3.56	3.89	3.43	3.12	3.33
Rib eye area, cm^2	18.9	19.2	17.3	18.5	18.1	17.2	18.7	18.7
Backfat thickness (average), cm	2.3	2.5	2.8	2.6	2.7	2.7	2.5	2.4
Proportion of ham cuts, %	32.8	32.6	32.4	31.6	31.5	33.5	33.1	33.5

* "Hog performance testing and progeny testing records", Vol. 5-Vol. 15, 1966-1977. Ibaragi Branch Station, Shirakawa Livestock Breeding Station.

** H:Hampshire, L:Landrace, W:Large Yorkshire, D:Duroc Jersey. Large Yorkshire in this trial was imported from Canada.

VIII. POULTRY

The Nagoya is the sole domestic chicken breed classified as dual purpose (Naito 1978, Tanabe 1971, Uesaka 1964). The mature body weights of males and females are 3.0 kg and 2.5 kg respectively. The feather colour is buff, with black tail feathers. The colour of shanks is dull lead, while the skin is white. Other external traits are single comb and red ear lobes. The number of eggs is 150 to 200 per year, the first laying age is 200 to 250 days, egg weight is 50 to 55 g and eggshell colour is reddish brown (Naito 1978, Uesaka 1964). The breed is losing its agricultural significance, although good meat quality has been evaluated recently (Naito 1978, Takeda, Asayama and Mizutani 1966, Uesaka 1964).

The management and feeding practices of commercial and breeding stocks are similar to those in other countries.

The present performance level of commercial chicks for laying and broiler production can be estimated from those which are shown in the targets of improvement. The targets fixed by MAFF in 1969 for laying and meat types respectively are shown in Tables 16 and 17. To realize these targets, the breeding stations, specializing in poultry production are in charge of the introduction and conservation of foundation stocks, and the establishment and conservation of new stocks by line breeding or line crossing, so as to supply seed stocks for the commercial chick production (Mizuma 1974, Nishida, Komiyama and Yamada 1965, Nishida and Yamada 1970, Tanabe 1971). However, foreign breeding stock firms are mostly involved in the competition for seed stock supply.

IX. PROSPECT OF DOMESTIC CATTLE BREEDING

It is certainly a natural feature of livestock production in crop farming areas to feed animals with surplus grains and agricultural or industrial by-products. In this connection, the consolidation of bases for feed should be considered, as well as conservation of genetic resources (Uesaka 1979). From another view-point, it is obvious that ruminants could become a reliable source of animal protein in the case of a food emergency in the future.

Among those originating from native animals, beef cattle are the sole farm animals contributing to practical production at present. Four domestic cattle breeds have been established from a mongrel population by strict selection over more than 40 years. Since the time of establishment as a pure breed, each breed has been kept under a completely closed breeding system (Uesaka 1979), excluding crossing among them. Furthermore, various sub-breed groups have persisted within the Japanese Black breed, because active bulls or semen have been seldom exchanged among prefectures, and the sub-breed groups originated 80 years ago from crosses with different introduced breeds.

From a number of breeding groups created by enthusiastic farmers, 20 groups are qualified to form each breeding stock association, in which lines of the Japanese Black or line crosses are maintained to produce superior breeding stocks. The lines of each association are characterized by different economic traits or combinations. One typical cattle line is found in the associations located in Hyogo Prefecture. These cattle are characterized by genetic excellence of meat quality. Their finely marbled beef is famous under the name of "Kobe-beef" or "Matsuzaka-beef". It is a general misconception that high quality beef is produced by special feeding and management techniques. These animals represent a unique genetic resource to be conserved.

Table 16. Targets for laying chicken improvement*

Year	Egg numbers	Egg weight (g)	First laying age-50% of hens (day)	Rate of raising-1-150 days (%)	Viability to 1 year (%)	Body weight(g) (10 mth of age)	Feed conversion (1 year of laying period)
1972	248 (68%)	50	165	80-85	80-85	1,800-1,900	2.8
1985	263 (72%)	58-60	160	95	95	1,700-1,800	2.5

* The targets were fixed by MAFF on June 3, 1969

Table 17. Targets for meat type chicken improvement for traits at 10 weeks of age*

Year	Body weight (g)	Rate of raising (%)	Feed conversion
1972	2,150	96-97	2.6
1985	2,400	98	2.2

* The targets were fixed by MAFF on June 3, 1969

It would be very difficult, however, to conserve farm animals discarded from present commercial production. Market requirements may vary without a sense of perspective, and animals which lose their economic value tend to disappear rapidly, although they may be useful in future and have distinct biological characters. Actually, some species or breeds can become endangered by present needs and preferences of the market. The Japanese Poll seems to be an example.

Several species of native animals, i.e. horse, cattle and chicken are preserved under governmental protection as national treasures. We may not expect to add a much larger number of potential resources in practical production.

In the case of our beef cattle breeding, many small breeding units are maintained in the Japanese Black at present. These will probably become integrated gradually, when cattle in each unit reach comparable levels of characteristics. Several lines upgraded with different traits could be obtained in each district. Commercial cattle become fitted for the market by crossing between these lines. From a wider view-point, crossing among domestic breeds could become possible in future.

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Discussion

Tomita: Dr. Namikawa has noted that there are a number of rare breeds in Japan, but has not discussed them in his paper. While Dr. Nozawa will report on relationships of some of these to other breeds, I would like to say that these rare breeds are as follows: Cattle - Mishima and Kuchinoshima wild cattle, Pigs - Ohmini (a dwarf breed), Japanese Quail - more than 20 varieties, Chicken - more than 20 breeds of fancy fowl, and Horse - more than 5 varieties.

Barker: Your data suggests that Aberdeen-Angus and Hereford are inferior to the Japanese cattle breeds for growth rate and feed efficiency. These results on performance of the Japanese beef breeds provide a useful indication of the possible value of synthetic populations (mixtures of local and exotic breeds) in developing highly productive breeds adapted to specific climatic-management systems. However, do you have any data on the exotic breeds for carcase traits that would be comparable to data given for the Japanese breeds? Also in relation to carcase traits, is there any evidence that the special characteristics of 'Kobe-beef' are genetic, and not due only to feeding and management?

Namikawa: There are no useful data on the exotic breeds for carcase traits. Evidence from progeny testing shows that the 'Kobe-beef' characteristics are inherited.

Rendel: Two questions - (i) How important is dairy beef production in Japan, and how do the Holsteins and their crosses compare in performance with the Japanese beef breeds? (ii) Do you use Japanese beef bulls on Holstein heifers to produce an F_1 animal for beef production?

Namikawa: More than 500,000 dairy bull calves are fattened for beef production each year, and this production meets about 30% of national beef requirement. While some farmers recognize the profitability of Japanese Black x Holstein crosses for fattening, this crossbreeding is not popular. Experimental work has been done and Dr. Watanabe may comment.

Watanabe: Experimental crossbreeding between Japanese Black and Holstein was done on a small scale during 1950-1960, to investigate the value of the F_1 for dairy purposes. Dairy characteristics of the crossbreds generally were intermediate between the parents. Daily gain also was intermediate, but beef quality (marbling) was similar to Holstein. The work performance of F_1 animals was not better than that of the Holstein. However, because of a rapid increase in the Holstein population, these F_1 animals never came to extensive use for dairy production. The main reason why dairy-beef crossbreeding is not common in Japan is that the marbling characteristic of the crossbred does not meet the consumers' taste.

ANIMAL GENETIC RESOURCES IN KOREA

Bong Kug Ohh

I. INTRODUCTION

Because of increased income in recent years, there has been rapid progress in development of the livestock industries in Korea to meet the increasing demand for livestock products. To solve the difficulties of increasing animal protein production, the Korean government has launched a long-term livestock development program in the 4th five-year economic development plan (1977-1981).

The latest statistics of farm animals (Table 1) show that the Korean native cattle population comprised 1,624,000 head, the dairy cow population 135,000, the swine population 1,719,000 and the chicken population 40,753,000. Although the average number of farm animals per farm has been increasing gradually, it still remains on a small scale, averaging 1.5 head for Korean cattle, 10 head for dairy cattle, 2.5 head for swine and 35 birds for chicken. The total increase from 1970 to 1978 was 28% for Korean cattle, 487% for dairy cattle, and 53 and 74% for swine and chicken respectively. The increase in the per capita consumption during the past eight years has been 96% for meats, 50% for eggs and 507% for milk (Table 2). It is anticipated that the consumption of livestock products will double by 1981, when the per capita income is expected to reach over 2,000 dollars.

Table 1. Livestock numbers in Korea ('000)

Livestock	Year				% increase 1970 to 1978
	1970	1975	1978	1981 (Projected)	
Korean native cattle	1,271	1,546	1,624	1,698	28
Dairy cattle	23	85	135	338	487
Swine	1,121	1,247	1,719	2,408	53
Chicken	23,477	20,939	40,753	45,744	74

Source: Livestock Industry Development Corporation (1978), Livestock Statistics.

Table 2. Consumption of livestock products per capita per year

Item	Year				% increase 1970 to 1978
	1970	1975	1978	1981 (Projected)	
Meat (kg)	5.2	6.4	10.2	14.4	96
Egg (no.)	76	82	114	165	50
Milk (kg)	1.5	4.6	9.1	19	507

Source: Livestock Industry Development Corporation (1978), Livestock Statistics.

A. Beef cattle

Since the early period of Korean agricultural history, Korean Native Cattle have been kept chiefly for draught purposes. Today Korean Native are still the predominant breed, Aberdeen Angus, Charolais and Hereford being minor breeds. The problem of improving Korean Native Cattle for beef production has been discussed from about the early sixties, as the income of Korean people and the demand for beef began to increase. In 1951, Korean Native Cattle weighed on the average 175 kg at 18 months of age. The growth rate was gradually enhanced to attain 210 kg of body weight at that age, or 20% increase by 1978; this increase being largely due to improved feeding and management. However, when intensively fattened they weigh from 380 kg to 451 kg at 18 months of age. In crossbreeding experiments, the hybrid progeny of Charolais or Aberdeen Angus crossed with Korean Native Cattle weighed 550-630 kg at 18 months of age.

B. Dairy cattle

The history of dairy cattle farming in Korea is very short as compared with other countries. At present, dairy cattle are raised for city milk purpose and raising is entrusted solely to milking interests. With the increase in national income and improvement of food habits, the consumption of city milk and dairy products has risen. Thus the government enacted the Dairy Promotion Act to meet this situation and dairy farming has rapidly developed in recent years (Table 1). Almost all dairy cattle are Holstein imported from U.S.A., Australia, and New Zealand.

The average annual milk yield per cow was increased from 3,200 kg in 1961 to 5,000-6,000 kg in 1977. The increase in milk yield over 16 years is ascribed largely to importation of superior dairy bulls and widespread use of semen from these bulls through artificial insemination.

C. Swine

In the past, swine were raised by farmers as a sideline. However, as feed conditions became favorable and the demand for meat increased, the number of farm households keeping swine has shown a rapid increase in recent years.

The swine raised in Korea before 1950 were mainly the crossbred between the Korean Native Stock and Berkshire. Improvement of swine was initiated from 1952, when purebred Berkshires, Hampshires, and Durocs began to be imported from abroad. Later, in 1963, new stocks of purebred Berkshires, Landraces, and Hampshires were imported and reproduced at the Livestock Experiment Station. In 1973 and 1974, improved stocks of Large White, Landrace, Hampshire and Duroc breeds were imported to the Livestock Breeding Station. These improved stocks are being reproduced and distributed as purebred breeding stocks for producing three breed crosses.

The average daily gain of pigs increased from 208 grams in 1951 to 600 grams at the present time through the importation of improved stocks. In the earlier stage of swine raising in Korea, purebred pigs were generally favored and distributed. In recent years, however, the superiority of the crossbred over the purebred has been well recognized, and two breed crosses or three breed crosses are widely used for pork production.

D. Poultry

Due to increased demand for egg and meat, the poultry industry has developed greatly in recent years.

The improvement of chickens in Korea began from 1840. For about 100 years from that time, the chickens were kept by farmers as a sideline, and the improvement achieved was not significant. A planned improvement program of chickens in Korea was initiated in 1952 with the importation of pure strains from abroad. The average annual egg production per hen increased from 150 in 1952 to 230 in 1978. The consumption of poultry meat, especially that of broilers, showed a rapid increase and at present more than 110 million head per year are produced.

Since 1963, the increase in numbers of grandparent and parent stock imported from the United States, for both layers and broilers has been remarkable. In 1977, imports accounted for about 65% of layers and 40% of meat type birds.

For broiler production, White Plymouth Rock are used for the female line and Cornish for the male line. For egg production, White Leghorn hybrids account for 55% and others such as New Hampshire, Rhode Island Red, Barred Plymouth Rock and their crosses for the remaining 45%.

E. Breeds of each species

The breeds of each species in Korea, together with total population numbers are given in Table 3, the use of each breed in Table 4, and the distributions of the main species in Figures 1-4.

II. DESCRIPTION

A. Size

Adult body weights and sizes of the various breeds are given in Table 5.

B. Colour pattern and coat

Colour patterns are given in Table 6, together with details of the coat for sheep and rabbits.

C. Hump

All cattle breeds are humpless.

D. Ears

All breeds of cattle, sheep and goats have medium-sized ears, which are erect outwards. Duroc pigs have medium-sized drooping ears, while other pigs have medium-sized ears which are erect forwards. Lop ear rabbits have ears 6.6 cm long, drooping backwards, the Angora has ears 7.5-10 cm long pointing backwards, and all other rabbits have medium-sized, backward-pointing ears.

E. Horns

Descriptions of horns in beef cattle and goats are given in Table 7.

F. Tail

Cattle have medium length, round tails, Korean Native tails being 65 cm long, Holstein and other breeds, 80 cm. The sheep breeds have medium length, non-fat tails.

Table 3. Population numbers for breeds within species

Species	Breeds	No. of head	Species Total
Beef cattle	Korean Native	1,624,301	
	Brahman	593	
	Aberdeen Angus	5,089	
	Hereford	5,272	
	F_1	13,310	
	Others (minor imported breeds)	2,790	
	Total		1,651,355
Dairy cattle	Holstein	135,272	
	Jersey	165	
	Guernsey	38	
	Others	328	
	Total		135,803
Horses	Native	4,408	
	Improved	959	
	Donkey	165	
	Mule	164	
	Total		5,696
Sheep	Corriedale		
	Polwarth		
	Total (mainly Corriedale)		7,900
Goats	Native	159,469	
	Improved milk (Japanese, Saanen, Alpine, Nubian)	5,616	
	Mixed breeds	79,162	
	Total		244,247
Pigs	Others (including Korean Native and Large White)	1,041,843	
	Berkshire	111,667	
	Yorkshire	34,393	
	Landrace	469,044	
	Duroc	25,453	
	Hampshire	36,964	
	Total		1,719,364
Rabbits	Angora	31,637	
	New Zealand and Japanese White	444,085	
	Other breeds (Chinchilla, Californian, Lop Ear, Rex and other mixed breeds).	648,284	
	Total		1,124,006
Chickens	Egg type	27,755,409	
	Meat type	12,997,840	
	Total		40,753,249
Ducks	Pekin		
	Khaki Campbell		
	Total		559,919
Turkeys	White Holland		
	Bronze		
	Total		40,867
Geese	Chinese		
	Total		6,925

Source: Ministry of Agriculture and Fisheries. Yearbook of Agriculture and Fishery Statistics, 1978, pp. 99-110.

Table 4. Uses of the various livestock breeds (Lee *et al*. 1962, pp. 72-147)

Species	Meat	Milk	Fibre	Skin	Draught	Egg	Other
Beef cattle	All breeds			All breeds	Korean cattle		
Dairy cattle		All breeds					
Horses					Native horse Mule Donkey		Improved horse (racing)
Sheep			All breeds				
Goats	Korean Native Goat	Saanen Alpine Nubian					
Pigs	All breeds						
Rabbits	N.Z. White Japanese White		Angora	Chinchilla N.Z. White Japanese White Rex			
Chickens	New Hampshire R.I. Red Plymouth Rock Cornish					White Leghorn New Hampshire Plymouth Rock R.I. Red	
Ducks	All breeds					All breeds	
Turkeys	All breeds						
Geese	All breeds						

1) Korean Native cattle

Fig. 1 - Distribution of Korean Native Cattle.

2) Dairy cattle

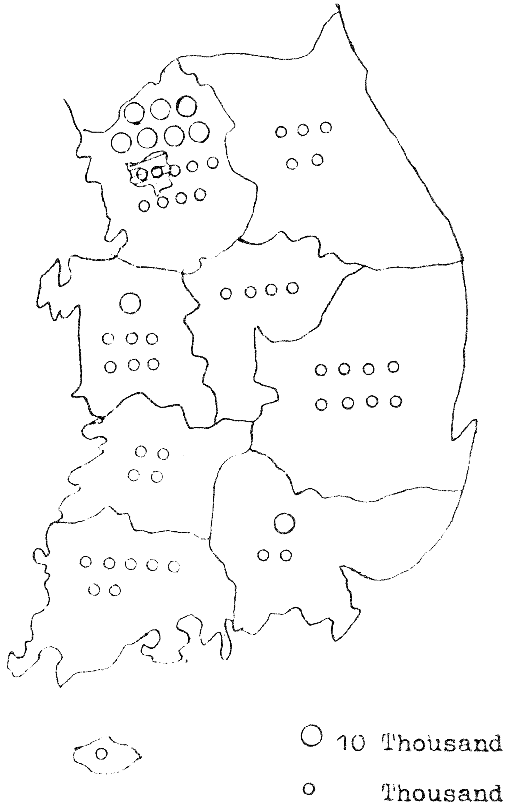

Fig. 2 - Distribution of dairy cattle.

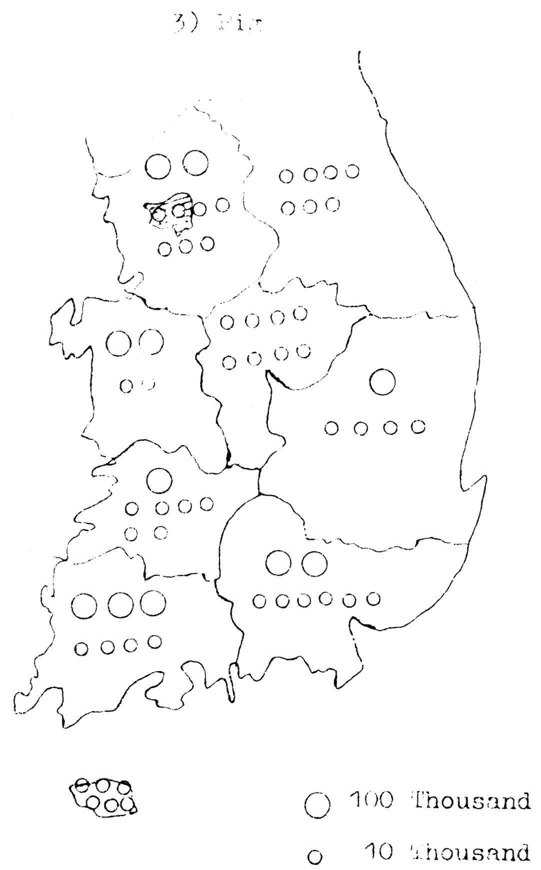

Fig. 3 - Distribution of pigs.

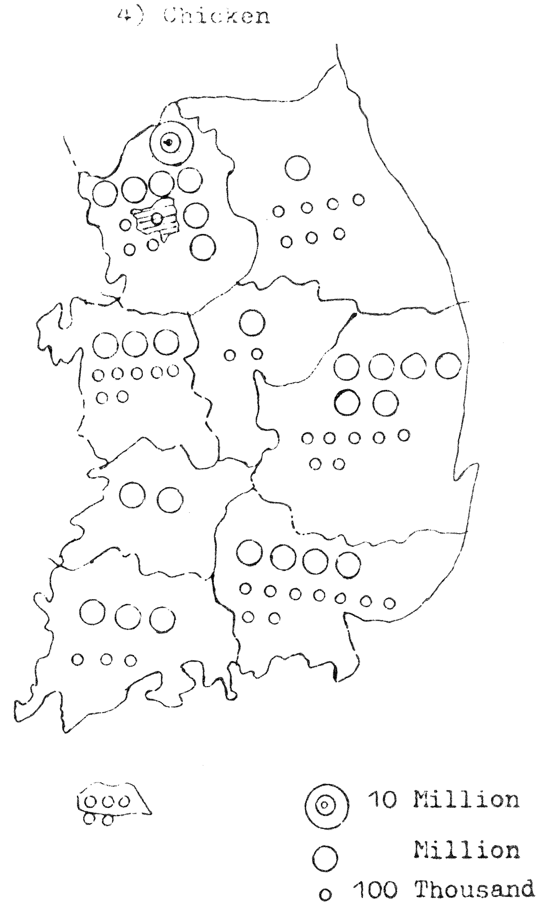

Fig. 4 - Distribution of chickens.

Table 5. Adult body weights and sizes of each breed

Species	Breed	Sex	Body wt. (kg)	Wither height (cm)	Chest girth (cm)	Authors *
Dairy cattle	Holstein	M	800 - 1,000	152	236	8 : 10
		F	500 - 550	138	200	
Beef cattle	Korean Native	M	370 - 500	136	195	8 : 9
		F	270 - 340	127	180	
Horses	Native	M	-	109	146	1 : 2
		F	145 (at 18 mth)	110	151	
Sheep	Corriedale	M	65	-	-	7
		F	45	-	-	
	Polwarth	M	60	-	-	
		F	40	-	-	
Goats	Native	M	30 - 40	-	-	4 : 6 : 8
		F	25 - 30	51	69	
	Saanen	M	70 - 90	84	87	
		F	45 - 55	68	81	
	Alpine	M	-	75	89	
		F	55	71	78	
Pigs	Native	M	-	-	-	3 : 5
		F	90	-	-	
	Berkshire	M	200 - 240	-	-	
		F	180 - 220	-	134	
	Yorkshire	M	340 - 370	-	-	
		F	300 - 340	-	-	
	Landrace	M	250	-	-	
		F	175 - 200	-	136	
	Duroc	M	300 - 350	-	-	
		F	280 - 300	-	-	
	Hampshire	M	320 - 440	-	-	
		F	260 - 340	-	138	
Rabbits	Angora	M	-	-	-	6 : 8
		F	2.5 - 3.0	-	-	
	New Zealand White	M	3.52	-	-	
		F	2.95	-	-	
	Japanese White	M	3.45	-	-	
		F	3.06	-	-	
	Californian	M	3.70	-	-	
		F	2.80	-	-	
	Chinchilla	M	2.80	-	-	
		F	2.70	-	-	
	Rex	M	-	-	-	
		F	4.00	-	-	

* 1. Kang (1965); 2. Kang (1967); 3. Lee (1977); 4. Livestock Experiment Station (1969); 5. Livestock Experiment Station (1973); 6. Livestock Experiment Station (1977); 7. Nam Won Sheep Experiment Station (1979); 8. Organization of Rural Development (1977); 9. Animal Improvement Association (1977b); 10. Yook _et al._ (1975).

Table 6. Colour patterns (Lee et al. 1962) and coat details

Species	Breed	Colour pattern	Coat Length (cm)	Coat Fineness (count)
Beef Cattle	Korean Native	Yellowish brown		
	Angus	Black		
	Hereford	White and red		
	Charolais	Light grey		
Dairy Cattle	Holstein	Black and white		
	Jersey	Light red		
	Guernsey	Fawn and white		
Horses	Native	Roan		
	Improved	Bay, brown and chestnut		
	Donkey	Roan		
	Mule	Variable		
Sheep*	Corriedale	White, with black muzzle	9 - 15	50 - 56
	Polwarth	White, with black spot on muzzle	-	58 - 60
Goats	Native	Black		
	Saanen	White		
	Alpine	Variable		
	Nubian	Variable		
Pigs	Native	Black		
	Berkshire	Black, with white legs, mouth and tail		
	Yorkshire	White		
	Landrace	White		
	Duroc	Range from light golden to dark red		
	Hampshire	Black, with white belt encircling from legs		
Rabbits**	Angora	White	6.2 - 8.7 (curled)	-
	N.Z. White	White		
	Japanese White	White		
	Californian	White, black mouth and ear		
	Chinchilla	Grey, white or lemon yellow		
	Lop ear	Several colours with white		

* Nam Won Sheep Experiment Station - personal communication.

** Animal Improvement Association (1977) Livestock Registration Rules, pp. 24-26.

Table 7. Descriptions of horns.

Species	Breed	Sex	Length (cm)	Shape	Distance between horns (cm)	Diameter (cm)	Colour
Beef cattle	Korean Native	M	14.8	For-outwards	15.5	18.0	Light grey
		F	15.4	For-outwards	15.6	15.3	Light grey
Goats	Native	M	20.3	Curved back-wards	2.2	13.8	Black
		F	11.0	Curved back-wards	2.5	8.3	Black

G. Udder and teats

Korean Native Cattle (Animal Improvement Association, 1977a) have small teats, with quarters of similar size, uniformly placed on the udder. The Holstein (Yook et al. 1965) has an udder weighing 50 kg, with quarters of similar size, uniformly placed.

H. Temperament

All species of domestic animals are mild and docile, but the Korean Native goat and Korean Native pig are wild and a little untamed as compared with other breeds within these species. Korean Native cattle are very gentle and can be adapted under any management.

I. Reaction to heat and solar radiation

There are no experimental data about heat resistance of farm animals because heat tolerance problems have not influenced the livestock industry under Korean weather conditions.

J. Resistance to parasites

Korean Native cattle are strongly resistant to tick-borne disease (Yook et al. 1974, pp. 231-2).

III. ENVIRONMENT, MANAGEMENT AND FEEDING

A. Environment

Korea is a peninsula located between the continent and islands of the Orient at 33°06' - 43° north latitude (33°06' - 38° in South Korea) and 124°11' - 131°52' east longitude. The overall area of South Korea is 98,447 square kilometers (38,004 square miles). The annual average precipitation is 600 - 1500 mm, with two-thirds falling in summer. Temperature in summer ranges from 25°C to 30°C; which is not suitable for the growth of grass, which requires a temperature of 20°C.

Average pH and contents of corrosive material of the soil are 5.3 and 2.2%. Use of calcium and organic fertilizer is required for grass production.

Natural grasslands are able to produce about 3-5 tons of grass per hectare without addition of calcium or organic fertilizer (Kim, Kim and Kim 1976).

B. Management and feeding

Since the number of farm animals per farm household is quite small, most of the herbivorous animals are stall-fed.

1. Areas required for each species

Species	Required grass-land area per head (m^2)	Floor space per head (m^2)
Korean Native Cattle	3,240	6.5
Dairy Cattle	4,880	9.7
Pig	16.2	9.7
Chicken	0.65	0.3

Source: Ministry of Agriculture and Fishery, 1979, Plan for Livestock Improvement.

2. Grazing and housing systems

In large dairy farms (about 50 head), cattle graze freely during the day in summer (mid-May to mid-October) within a fenced pasture, and at night in a shed, where they also go for milking. For seven months (mid-October to mid-May) they are housed. Small dairy farms, however, do not have any pasture for grazing. Pastures consist usually (Kim, Kim and Kim, 1976) of a mixture of orchard grass (gramineous) and ladino clover (legumes).

Supplementary feeding of dairy cattle depends upon body weight and milk production. For a body weight of 550 kg, milk production of 20 kg per day, and milk fat of 3.4%, the supplementary needs are 10 kg as concentrates, rice straw 5 kg, and corn silage 10 kg per day in dairy cattle (Sul 1976).

For sheep, the grazing period is from the end of April to the end of October, the animals being housed for the rest of the year.

3. Stall feeding

(i) Korean Native Cattle: Daytime herding with night housing in the grassy season. During winter, feeding is cooked hay and rice straw, but feeding of fattening cattle depends upon NRC standard (Yook *et al*. 1974).

(ii) Dairy Cattle: Supply additional 2 kg concentrates compared with supplementary feeding of grazing at same production level (Sul 1976).

(iii) Sheep: Roughages are supplied at the rate of 1.2-2.0 kg for Corriedale and 1.0-1.8 kg for Polwarth per day.

(iv) Milk Goats: The Native goat is free 24 hours a day, grazing and browsing in the fields and mountains. A simple thatched shelter must be provided against rain or snow. When milk production of milking goats on stall feeding is 2 kg, they are supplied daily with 7 kg of silage and 400 g of concentrates (Yook 1969).

(v) Pigs and Rabbits: Fed according to NRC feeding standards and by cut grass collected from road sides in villages (Yook 1969).

4. Average size of herd or flock

Species	No. per farm household (heads)	Average herd size (heads) (Commercial enterprises)
Holstein	9	15 - 20
Korean Native Cattle	1.5	20 - 30
Pig	3	50 - 100
Goat	2	50 - 100
Sheep	14	100 - 100
Rabbit	4	1000 - 2000

Source: Livestock Industry Development Corporation 1978. Livestock Statistics

5. Proportions of entire males, castrates and females

No information is available.

6. Water supply

In every species water is free, because sufficient water is supplied for both stall-feeding and grazing.

7. Castration

Species	Age (days)	Method
Korean Native Cattle (Yook *et al*. 1974).	60 - 70	Rubber ring
Dairy cattle (Yook *et al*. 1975).	30	Rubber ring
Sheep	28	Rubber ring or remove testes
Pigs (Lee 1977)	10 - 15	Remove testes

8. Rearing of offspring

Species	Age at Weaning	Supplementary feeding
Korean Native Cattle (Yook *et al*. 1974)	6 months	
Dairy Cattle (Yook 1974)	6 weeks	Calf starter, skim milk, milk whey or buttermilk
Horses (Yook 1974)	4 - 5 mths	
Sheep (Yook 1974)	2 - 3 mths	
Goats (Yook 1974)	2 - 3 mths	
Pigs (Lee 1977)	2 months	Skim milk
Rabbits (Yook 1974)	40 - 50 days	

9. Disease situation - 1977

	Cattle	Horse	Sheep & goat	Pig	Chicken
Digestive	50.7%	43.5%	63.6%	43.7%	27.5%
Respiratory	19.3	13.8	14.7	34.1	55.1
Circulatory	4.1	1.0	2.7	3.4	2.5
Reproductive	11.0	7.6	4.0	3.5	1.4
Nervous	2.9	8.0	4.1	2.1	0.7
Urinary	1.7	1.7	1.3	1.4	0.4
Traumatic	2.7	14.0	1.6	1.6	0.6
Others	7.6	10.4	8.0	10.4	11.9
Total	100.0	100.0	100.0	100.0	100.0
(head)	(229,327)	(934)	(11,677)	(339,066)	(2,550,039)
Cured	2.2%	1.5%	4.2%	4.3%	6.0%
Dead	97.8	98.5	95.8	95.7	94.0

Source: Ministry of Agriculture and Fishery 1978. Yearbook of Agriculture and Fishery Statistics, p. 120.

10. Age (in years) to which animals are kept

Species	Male	Female
Korean Native Cattle (Sul 1976)	3.2	8
Dairy cattle[a]		8
Sheep[b]		5
Goats[b]		5
Pigs[a]		3
Rabbits (Livestock Experiment Station 1977)		2 - 3

(a). Ministry of Agriculture and Fishery 1979. Plan for Livestock Improvement. (b). Nam Won Sheep Experiment Station 1979. Pers. comm.

IV. REPRODUCTION

A. Mating systems

The percentages of A.I. and natural mating for each species are:

Species	A.I.	Natural mating
Korean Native cattle	20	80
Dairy cattle	77	23
Sheep and goats	-	100
Pigs	25	75
Rabbits	-	100

Source: National Breeding Station 1978. The Facts of the A.I. Industry in Korea.

B. Ratio of males to females in natural mating

Species	Ratio
Korean Native Cattle (Yook *et al*. 1974)	1 : 80-100
Sheep and goats (Nam Won Sheep Experiment Station 1979)	1 : 50

C. Age (in months) at first use of males and first parturition of females

Species	First Use	First parturition	Authors*
Korean Native Cattle	18 - 20	31	3 : 6
Dairy cattle	16	27 - 30	4
Horses	15 - 18	-	1
Sheep and goats	12	15 - 18	7
Pigs	9	13 - 14	2 : 5
Rabbits	6	7	1

* 1. Kim 1978; 2. Lee 1977; 3. Livestock Experiment Station 1976; 4. Organization of Rural Development 1977; 5. Shin *et al*. 1974; 6. Yook *et al*. 1974; 7. Yook 1974.

D. Season of birth

The breeding season in milk goats and sheep is in November, and the season of birth is in April-May, but reproduction in the Korean native goat is not influenced by season (Alpine Experiment Station 1978).

E. Females failing to produce young

Species	% failure	Mating system
Korean Native Cattle[a]	26.1	A.I.
Holstein Dairy Cattle[a]	27.3	A.I.
Sheep[b] - Corriedale	7.4	Natural
Polwarth	10.0	Natural
Goats[c] - Native	0.0	Natural
Saanen	14.3	Natural
Pigs[a]	26.2	A.I.

(a). National Breeding Station 1978. The Facts of the A.I. Industry in Korea.
(b). Alpine Experiment Station 1978. (c). Livestock Experiment Station 1976.

F. Average number of offspring per birth

Species	Breed	Number	Authors*
Beef and dairy cattle		1	6
Sheep	Corriedale	1.3-1.5 (27.2% twins)	1 : 5
	Polwarth	1-2	
Goats	Korean Native	1.7 (46.3% twins, 15.5% triplets)	2 : 3
	Saanen	1.44	
Pigs	Native	7.8	4
	Berkshire	10.3	
	Hampshire	8.0	
	Landrace	10.8	
	Duroc	10.8	
Rabbits	Japanese White	7.0	4
	New Zealand White	5.7	
	Californian	5.4	
	Chinchilla	5.5	

*1. Alpine Experiment Station 1978; 2. Kim and Chung 1979; 3. Livestock Experiment Station 1976; 4. Livestock Experiment Station 1977; 5. Nam Won Sheep Experiment Station 1979, pers comm.; 6. Yook 1969.

G. Interval between parturitions (days)

Species	Breed	Interval	Authors*
Beef cattle	Korean Native	443	1
	Aberdeen Angus	368	1
Dairy cattle	Holstein	409	2
Goats	Native	297	2

*1. Livestock Experiment Station 1976; 2. Livestock Experiment Station 1978.

H. Mortality (%)

Species	Breed	Prenatal	To Weaning	Authors*
Beef cattle	Korean Native	-	8.3	1
Dairy cattle	Holstein	-	6.7	2
Sheep	Corriedale	-	18-20	3
	Polwarth	-	19-22	
Pigs	Berkshire	15.3	29.5	1
	Yorkshire	17.6	-	
	Landrace	25.6	16.8	
	Duroc	-	50.0	
	Hampshire	16.7	44.4	
Rabbits	Japanese White	-	30.0	1
	New Zealand White	-	24.2	
	Chinchilla	-	33.7	
	Californian	-	30.3	

*1. Livestock Experiment Station 1977; 2. Livestock Experiment Station 1978; 3. Nam Won Sheep Station 1979, pers. comm.

V. BREEDING

A. Source of males

Breeding males of Korean Native cattle are selected through the National Livestock Show and progeny tests in experimental stations. For Holstein dairy and exotic beef cattle breeds, superior males are imported. In pigs, superior pure-bred males are selected on progeny test or family selection.

B. Age at selection and selection criteria (Animal Improvement Association 1977a)

1. Korean Native cattle

Female and male: At 30-42 months of age. For progeny derived from highly registered male and female, middle registered female and highly registered male, each individual should have more than 80 points through eye evaluation, and have good reproductivity within close relatives of selected male and female. In addition, criteria for males are: above 360 kg of body weight at 12 months and 500 kg at 18 months of age.

2. Holstein

Male: At 13 months of age. Male selected from superior mother producing above 6,000 kg and 3.4% butter fat, under feeding standards, with 305 day lactation and two milkings per day.

Female: Selected healthy cow producing from registered male and female.

3. Pigs

Male: Selection Index = 250 + 110 (daily gain, kg) - 50 (feed efficiency) - 19.685 (back fat thickness, cm), where feed efficiency = feed/gain.

Female: For progeny test (1) above 18 kg at 60 days of age, (2) above 7 head as litter size for Berkshire, Duroc and Hampshire, and 10 for Landrace and Yorkshire, (3) Genetic deformity should not appear in the parents, or sisters and brothers of selected female.

C. Cross-breeding results (Livestock Experiment Station 1977)

1. Korean Native Cattle

Crosses** (♂ x ♀)	Sex	Body weight (12 months) (kg)	Wither height (18 months) (cm)	Chest girth (18 months) (cm)
K x K	F	177	116.7	162
	M	241.3	123.4	175
H x K	F	218.9	118.6	164
	M	373.8	130.5	211.5
C x K	F	263.3	109.9*	158*
	M	444.5	116*	177*
A x K	F	190.7	-	-
C x (CK)	F	278	107.5*	155.5*
	M	444.5	120.5*	183.5*
H x (AK)	F	313.1	120.2	177.6
	M	386.7	124.5	206.5
H x (CK)	M	458	131	198

* Estimation at 12 months of age

** K: Korean Native cattle, H: Holstein, C: Charolais, A: Aberdeen Angus

2. Goats

Crosses* (♂ x ♀)	Milk prod. (kg)	Lactation period (days)	Milk fat (%)	Body Weight: Birth (kg)	Body Weight: Weaning (kg)	Body Weight: 12mth (kg)	Body Weight: 18mth (kg)	Body Weight: 24mth (kg)	Wither height (24mth) (cm)	Chest girth (24mth) (cm)
S x S	432.6	233	4.16	3.24	13.1	28.9	41.0	46.2	68.3	80.8
N x N	90.9	173	5.72	1.83	7.0	22.5	29.0	28.8	50.6	68.6
S x N	288.1	201.5	5.38	2.31	9.13	24.9	34.5	33.3	57.6	75.6
S x (SN)	354.8	244.7	4.30	2.83	11.03	26.9	36.9	37.0	63.2	75.5
S x(S(SN)	372.7	226.2	4.24	3.03	12.18	27.7	40.7	39.8	65.7	76.4

*S: Saanen, N: Native goat.

3. Pigs

Crosses* (♂ x ♀)	Days to 90kg	Feed requirement	Dressing percentage	Backfat thickness (cm)	Body wt. at slaughter (kg)	Area of loin eye muscle (cm^2)
B x H	187	3.16	71.7	3.2	101.5	20.0
B x L	187	4.00	73.9	3.8	113.8	13.7
H x L	166	3.26	79.7	3.1	139.3	21.6
L x H	180	3.66	73.3	3.2	104.8	18.9
L x B	180	3.09	78.7	3.6	116.5	15.1
L x (BH)	182	3.54	60.8	3.1	-	17.7
H x (BL)	175	3.25	60.6	3.0	-	21.3
B x (LH)	179	3.87	57.0	3.5	-	17.9
H x (LB)	181	3.44	63.5	3.1	-	17.2

*B: Berkshire, H: Hampshire, L: Landrace.

4. Rabbits

Crosses* (♂ x ♀)	Body weight at 6 mth (g)	Viability to weaning (%)	Litter size
N x N	2,625	64.5	6.2
Ca x Ca	2,608	77.0	7.0
Ca x N	2,750	87.1	6.2
N x Ca	2,450	81.8	6.6

*N: New Zealand White, Ca: Californian.

VI. PERFORMANCE

A. Special feeding or management

Korean Native cattle are normally tethered with 3-4 m of rice-straw chain, fastened at one end to a nose-ring passing between the nostrils, and to a suitable post or tree at the other (Organisation of Rural Development 1977).

Dairy cattle are milked two or three times a day, either by hand or by machines. Cows normally are dried off artificially 6-8 weeks before parturition and after parturition, colostrum is supplied to the calf for 3-5 days.

B. Production

1. Milk yield

Average yield per lactation and lactation lengths for Holsteins are given in Table 8 and for goats according to breed in Table 9.

Table 8. Milk yields of Holstein cows (Animal Improvement Association 1977b)

Lactation no.	No. of Records	Yield (kg)	Lactation period (days)
1	63	5,148	295.3
2	43	6,108	291.9
3	30	6,750	302.3
4	18	6,750	300.3
5	20	6,562	299.1
6	8	6,987	294.6
7	9	6,628	294.0
8	2	6,288	290.5
Mean (weighted)		6,099	296.0

Table 9. Milk yields of goats (Livestock Experiment Station 1969, 1977)

Breed	Milk yield (kg)	Fat percentage	Lactation period (days)
Korean Native	173.0	5.72	90.9
Saanen	432.6	4.16	223.0
Alpine	221.8	-	99.0

2. Growth rate

(i) Beef cattle (Organisation of Rural Development 1977):

Breed	Sex	Body weight (kg) At Birth	6 mths	12 mths	18 mths	Adult
Korean Native	M	24	115	166	215	370 - 500
	F	22	109	158	207	270 - 340
Korean Native (fattened)	M	24	173	316	489	-
Angus	M	29	196	291	452	770
	F	27	168	224	318	600
Charolais	M	45	298	431	662	1,100
	F	43	257	348	472	800

(ii) Goats (Animal Improvement Association 1979, Livestock Experiment Station 1977):

Breed	Body weight (kg)				
	At Birth (both sexes)	At Weaning (both sexes)	12 mth (females)	18 mth (females)	24 mth (females)
Korean Native	1.83	7.0	22.5	29.0	28.8
Saanen	3.24	13.1	28.9	41.0	46.2

(iii) Pigs (Livestock Experiment Station 1978):

Breed	Body Weight (kg) - Both sexes		
	At birth	At weaning	6 mth
Berkshire	1.36	13.1	85.0
Yorkshire	1.35	13.6	89.0
Landrace	1.50	15.8	90.0
Duroc	2.14	19.8	91.5
Hampshire	1.40	15.2	83.7

(iv) Rabbits (Livestock Experiment Station 1977):

Breed	Sex	Body Weight (g)				
		At Weaning	2 mth	4 mth	6 mth	8 mth
Japanese White	M	694.4	997.5	2079,3	2891.3	3450.0
	F	631.1	993.8	2013.2	2638.0	3060.0
New Zealand White	M	592.3	928.5	1872.5	2348.0	3520.0
	F	595.1	911.7	1878.1	2681.5	2950.0
Californian	M	558.8	898.5	1920.6	2650.0	3700.0
	F	523.0	861.7	1743.2	2083.3	2800.0
Chinchilla	M	597.2	1026.5	1819.4	2716.7	2800.0
	F	575.3	933.2	1640.5	2050.0	2688.0

3. Carcase characteristics (Livestock Experiment Station 1977).

Species	Breed	Dressing percentage	Percent lean meat	Loin eye area (cm^2)	Backfat thickness (cm)
Beef cattle	Korean Native	54.8	47.5	49.8	-
Goats	Korean Native	45 - 50	-	-	-
Pigs	Berkshire	74.7	64.4	22.2	3.3
	Landrace	72.7	62.0	21.8	2.9
	Duroc	73.6	63.3	25.8	2.9
	Hampshire	74.3	61.1	21.3	2.7
Rabbits	Japanese White	48.1	33.8	-	-
	New Zealand White	49.8	33.6	-	-
	Californian	49.7	33.8	-	-
	Chinchilla	50.3	31.5	-	-

4. Draught

Korean Native Cattle are used for cultivation, for drawing a cart and for carrying burdens on the back. Momentary draught power for males and females are 344.3 kg and 271.2 kg respectively, while burden capacities are 1,340 kg for males and 1009 kg for females (Yook et al. 1974).

5. Fleece

Average production values for Corriedale sheep are (Alpine Experiment Station 1975):

Sex	Fleece weight (kg)	Length (cm)	Fineness (count)
Male	5.06	13.9	50 - 58
Female	3.74	12.3	50 - 58

VII. POULTRY

A. Description

Species	Breed	Body weight (g)	Feather colour	Comb type	Author*
Chickens	White Leghorn	1964 (72 wks)	White	Single	1
	Dual purpose	2240 (72 wks)	Brown	Single	1
	Heavy breed	3625 (64 wks)	White	Single	4
	Broiler	1704 (8 wks)	White	Single	2
	Silky breed	100	Black or white	Crest	3

*1. Korean Poultry Association 1978a; 2. Korean Poultry Association 1978b; 3. Lee and Ohh 1975; 4. Ohh 1976a.

Temperament: All breeds are mild and docile (Lee and Ohh 1975).

Reaction to heat and direct solar radiation: Weak.

Resistance to parasites and disease: There are no special breeds or strains which have developed resistance to parasites and diseases.

B. Environment, management and feeding

The environment for poultry is as already described for other species.

1. Areas allowed per bird (Lee and Ohh 1975)

Standard rearing space per 36 square feet (1 pyong) in floor system:

White Leghorn	20 - 25 birds
Dual purpose type	20 birds
Broiler	40 - 50 birds

30 - 40 birds are able to be reared in cage house per 36 square feet.

2. Management systems (Lee and Ohh 1975, Ohh 1976a)

Broiler (floor management):

Pen size - 91.2 m^2 (30 pyong)
No. of birds/pen - 1200 - 1500

Layer (Cage management):

Size of cage - width 60 cm, depth 36 cm, height 41 cm.
Each cage is divided into three blocks, with 2-3 birds/block for light breeds, and 1-2 birds/block for heavy breeds during the rearing stage.

3. Quantities and types of feed (Lee and Ohh 1975, and feeding standards of the Han Hyup Poultry Breeding Farm)

(i) Quantities of feed per bird (kg):

Breed	Broiler (0-8 wks)	Rearer (9-22 wks)	Layer (23-72 wks)
Egg type	2.10	8.58	38.72
Meat type	3.13	9.31	53.59
Dual purpose type	2.18	9.27	45.56

(ii) Types of feed:

Brooding period:	Starter (0-6 weeks)
Rearing period:	Grower diet (6-13 weeks), Pullet diet (14-22 weeks)
Laying period:	Phase I (23-42 weeks), Phase II (43-62 weeks), Phase III (above 63 weeks).

(iii) How fed:

Egg and dual purpose type birds:	ad libitum.
Parent stock of meat type birds:	Restricted feeding according to feeding standard.

4. Water supply

Free supply through water container or waterer.

5. Average size of flock

Average number of birds per farm household 35 birds
Average flock size (commercial enterprises) 3,000 birds

6. Rearing methods (Lee and Ohh 1975)

Brooding period: Oil brooder is mostly used, however battery and cage brooders are used for small flocks.

7. Disease situation (Korean Poultry Association 1978a, Park 1979)

(i) Diagnosis of diseases observed in Korea (1970-1975):

Diseases	1970	1971	1972	1973	1974	1975	Average
Bacterial	25.9%	24.2%	42.3%	25.7%	33.5%	29.1%	28.1%
Fungus	0.7	4.5	1.5	9.5	6.3	9.7	3.0
Virus	57	50	41.6	64.8	43.4	36.8	52.8
Parasite	16.3	11.7	14.6	24.0	16.8	24.3	16.8
Total	100	100	100	100	100	100	100

(ii) Prevention and treatment (1971-1976):

		Pullorum		Mycoplasma		Newcastle	
Year	No. of birds	No. Inspected	% Infected	No. Inspected	% Infected	No. Infected	(%)
1971	25,903,000	1,913,507	1.15	15,310	1.34	9,622	(0.04)
1972	24,537,000	1,977,521	0.70	34,493	12.88	9,696	(0.04)
1973	23,071,000	1,789,342	0.59	40,679	4.61	63,008	(0.27)
1974	18,814,000	1,596,189	0.54	36,898	2.03	23,734	(0.13)
1975	20,939,000	1,196,551	0.46	73,078	2.34	19,258	(0.09)
1976	26,352,000	877,317	0.59	117,894	23.30	119,709	(0.45)

(iii) Vaccine production (1971-1976):

(Unit: 1,000 birds)

	Newcastle				
Year	Dead	Live	Fowl pox	Marek	Avian Encephalomyelitis
1971	34,355	64,065	2,213	200	41
1972	10,326	31,352	10,790	5,847	185
1973	32,399	59,447	20,562	9,335	-
1974	48,296	48,642	15,878	7,171	-
1975	29,734	63,189	14,074	9,079	100
1976	42,968	70,129	-	16,686	230

8. Age to which birds are kept (Korean Poultry Association 1978a)

Layers are kept until about 70-75 weeks of age. Broilers are kept until 7-10 weeks of age.

C. Reproduction

With natural mating under floor management, males and females are run together in the ratio of 1 male: 7-8 females in heavy breeds and 1: 10-12 in light breeds. Under cage management, artificial insemination is used with 1 male: 30-50 females, and in both management systems, both sexes are first used for reproduction from 28 weeks of age for layer breeds and from 30 weeks of age for meat breeds (Lee and Ohh 1975). The age at first egg is 160 days for layer breeds, 165 days for dual purpose breeds (Kim 1978) and 179 days for meat breeds (Livestock Experiment Station 1969).

The fertility of eggs set averages 88-90% while the hatchability of fertile eggs averages 91-92% (Ohh 1976a). About 10% of chickens are produced by natural incubation in villages from March to May. Artificial incubators consist of two units (setter and hatcher) and vary in size from 10,000 to 100,000 egg capacity.

Mortality during various periods is as follows:

Breeds	Brooding period (0-8 weeks)	Rearing period (9-22 weeks)	Laying period (23-72 weeks)
White Leghorn[a]	2.80%	4.53%	18.25%
Heavy breed[b]	1.80	0.87	7.43 (23-64 wks)
Dual purpose type[a]	3.33	3.45	13.75

(a) Korean Poultry Association 1978a, (b) Ohh 1976b.

D. Breeding

1. Source of males

Parent and grand-parent stock of male lines which are imported or domestically developed are reared in breeding farms, for production of commercial chicks.

2. Age at selection and selection criteria (Ohh 1976b)

Superior males and females are selected on the basis of family performance, which is recorded up to 40-42 weeks of age.

(i) Egg type: Selection criteria for each character on annual records in egg-type chicks are as given below:

(ii) Meat type: The most important character in meat type chicks is not only the performance of parent stocks but also the growth rate of progeny (broiler) derived from selected parents. To produce superior progeny (viability 99%, body weight 1.8 kg, feed efficiency 2.1 for a period of 8 weeks), selection criteria of parent stocks are as follows:

Characters	Egg type	Meat type
Viability during laying period	Above 90% to 72 weeks	Above 90% to 60 weeks
Sexual maturity	165 days	190 days
Hen-day egg production	70%	68%
Hen-housed egg production	230 eggs	145 eggs (to 60 weeks)
Egg weight	60 g	60 g
Adult body weight	1.9 kg	Below 3.5 kg
Feed efficiency	Below 2.8	

3. Extent of cross-breeding

Commercial chickens of White Leghorn type are produced from single and double crosses among lines within the same breed. Commercial chickens of brown egg type are derived from incross or incrossbred, and broiler type chickens are crossbreds of White Plymouth Rock female line and Cornish male line (Ohh 1976b).

E. Performance

1. Special feeding or management

Some of the Korean poultry farms practise restricted feeding and forced moulting. Artificial illumination is generally used for layers.

2. Egg production

Breed	Number per year	Egg weight (g)	Age of birds kept for eggs (wks)
White Leghorn[a]	212	58.9	72
Heavy breed[b]	144	62.0	64
Dual purpose type[a]	204	58.4	72

(a) Korean Poultry Association 1978a, (b) Ohh 1976b.

3. Meat production (Korean Poultry Association 1978b, Ohh 1976b).

Breed	Sex	Body weight (g) 2 wks	4 wks	6 wks	8 wks	Age at slaughter (wks)	Dressing percent (N.Y. dressed)
Broiler	M	223	590	1,204	1,824	8	80.4
	F	221	552	1,070	1,557	8	79.5

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Discussion

Hardjosubroto: You mentioned the increase in growth rate and in carcase percentage in the F_1 cross between exotic beef breeds and Korean Native Cattle. Is there any problem with this cross and any data on reproduction rate of the crossbred?

Ohh: Not much work has been done on this crossbreeding, but because of possible calving difficulties in the Native cows, only those on their second or third calving have been used. There is no data on reproduction rate of the crossbred, because they have been produced only for slaughter.

Mukherjee: Is there any market for goat milk in Korea?

Ohh: No. The goat milk is used only by the farmer and his family.

Bhat: In the Saanen x Native goat crossbreeding work, how many animals have been used.

Ohh: Not many yet, but the work is continuing. So far, we have data only for about 12-14 F_1, 7-9 first backcross, and 5-6 second backcross.

ANIMAL GENETIC RESOURCES IN MALAYSIA

T.K. Mukherjee

I. INTRODUCTION

Being centrally located inside the Indonesian Archipelagos, Malaysia covers an area of about 327,000 sq km, occupying the Malay Peninsula and the states of Sabah and Sarawak in north western Borneo island. The two regions are separated by about 640 km of the South China Sea. Peninsular Malaysia, covering 132,000 sq km has its frontiers with Thailand, while Sabah and Sarawak, about 200,000 sq km, border the territory of Indonesia's Kalimantan.

All the Malaysian territories lie between 1^{o} - 7^{o}N parallels. The lengths of days at such latitudes vary little throughout the year. At Alor Star, which lies just north of 6^{o}N latitude, the difference between the longest and shortest days of the year amounts to 37 minutes while at Johore Bahru, the southern-most part of Malaysia, bordering Singapore, the difference is reduced to only nine minutes.

Uniformly high temperatures are also typical of the region, as part of the equatorial belt. However, owing to the high incidence of cloud, which reduces the average number of sunshine hours received, temperatures over 34^{o}C are rare. The high summer maxima characteristics of the subtropics are seldom experienced and mean yearly temperatures range between 25^{o}C and 31^{o}C. Diurnal ranges of temperature are characteristically much larger (avg. 8^{o}C). Like other equatorial countries, Malaysia is to be reckoned among regions with the highest and most regular rainfall in the world. Large areas have annual totals well in excess of 300 cm a year. The relative humidity ranges from 60 to 80%.

The tremendous genetic resources of animals in Malaysia are widely acknowledged, because it possesses some of the world's richest and unique animal treasures. There are over 2000 species of mammals, 600 kinds of birds, scores of amphibians, reptiles and molluscs and thousands of kinds of insects and other invertebrate animals. In spite of the presence of enormous numbers of different faunal species in Malaysia, the numbers of livestock species are limited. The present report has been mainly confined to livestock. The term "livestock" covers a very long list of animals which are of value to man. In Malaysia this list may include different kinds of animals that cater for man's material, cultural and recreational needs. An elaborate discussion of these animals is not the present objective of this workshop. As livestock production is primarily directed towards fulfilling the material needs of man, this paper is restricted to those farm animals which are of economic significance within the framework of agriculture.

A. Livestock species

The farm animal genetic resources of Malaysia include ruminants such as cattle, buffalo, sheep and goat, poultry (chicken, ducks, turkeys and geese) and pigs. These resources may be broadly divided into two categores: (i) indigenous and (ii) non-indigenous. Malayan jungle fowls, wild pigs, swamp buffaloes, Kedah-Kelantan cattle, local goats (Kambing Katjang) are probably true indigenous animals of Malaysia. Other farm animals such as LID (Local Indian Dairy) cattle, Kelantan sheep, local Chinese pigs, Canton type chickens, some local ducks and geese, and local Bronze turkeys may be termed as quasi-indigenous because over the generations, their habitats have perhaps modified their genome to a considerable extent for their adaptation to the new environment, and the gene pools within each of the populations have been stabilized long ago.

Non-indigenous animals are mainly breeding chickens, pigs, cattle and goats, which have been imported to Malaysia from many corners of the world. Importation of these animals has considerably enriched the gene pool of different species. It is especially true for chickens and pigs, because the physical and nutritional environments required for the maintenance of these animals are easier as compared with those for ruminants. Importation of these animals in large numbers has also created greater genetic variability within each species, mainly due to differences in gene frequencies amongst the breeds and varieties imported, and partly due to the increase in numbers in most of the livestock species.

Other livestock species present in Malaysia include ducks, geese and turkeys. Pigeon farms are rarely seen in Malaysia, although there are houses in which the pigeons are sheltered. Recently, there has been an increasing interest in the consumption of pigeon meat. The game department of the Government is contemplating opening up deer and mouse-deer farms as tourist attractions as well as for meat production.

B. Breeds and strains within species

There are many wildlife species which are of aesthetic value. Although they may not be of direct economic significance to man, yet their value as a tourist attraction indirectly earns money and particularly foreign exchange. The magnificent seladang, tapir, elephant, pangolin, proboscis monkey, orang-utan, gibbons, siamang, leaf monkeys, macaques, hornbills, pheasants and hosts of other animals always attract the human spirit, but these are not discussed in view of the guidelines given by the Workshop Chairman. Table 1 lists only those species of animals which are conventionally known as domesticated, and have always been associated with the socio-economic development of human beings.

1. Cattle

Breeds listed under *Bos taurus* or *Bos indicus* include the Local Indian Dairy and Kedah-Kelantan. These are nondescript local breeds. The LID is a mixture of several Indian breeds of cattle such as Sahiwal, Red Sindhi, Tharparkar, Hallikar and Ongole. Indian settlers who had migrated to Malaysia, starting from the beginning of this century, brought with them some animals, which were allowed to mate randomly amongst themselves. The present LID is a product of such random mating; hence variation in conformation, type and colour is seen in any herd of LID in any part of the country.

Similarly, Kedah-Kelantan or Kedah-Thai cattle are of Zebu ancestry. Their origin is not quite certain but it is believed that they came from Thailand, especially from the southern parts where similar cattle are found. High concentration of these animals in the States of Kedah, Kelantan and Trengganu further stresses the fact that these animals have been well adapted to the environment for a long period and hence they are considered indigenous to these parts of the country. Initially, however, it appears that this breed owes its ancestry to the humped Chinese yellow cattle or South Chinese Zebu cattle comparable to the cattle of Hongkong, since the breed description is similar (Epstein 1969). The migration route into China started eastwards from Western Asia initially, and then south-west and eastwards into Burma, Thailand, Vietnam and Laos (Payne 1970) and therefore also Malaysia.

Bali cattle are believed to have descended from the Banteng (*Bibos banteng*), the indigenous cattle of Indonesia by domestication. The Banteng has also been called *Bos sondaicus*, the names being synonymous. The association by name to Banteng places more emphasis on the popularity of the former name. According to Allen (1955), Bali cattle entered Malaysia from the island of Bali, as animals escaping slaughter. This point stems from the fact that it was the practice of merchants in Singapore to import Bali cattle from that country for the supply of beef prior to the Second World War.

Although crossbreeding by means of artificial insemination, using imported frozen semen or a few imported bulls, has been practised since 1960, the actual importation of purebred animals in fairly large numbers started only in the seventies. At present, purebred Holstein-Friesian, Jersey, Santa Gertrudis, Brahman, Australian Milking Zebu (AMZ), Droughtmaster, Hereford and Braford can be seen, although these purebred animals are mostly kept in Government farms mainly for research purposes and for their utilization in future crossbreeding work. The Veterinary Department of the Ministry of Agriculture has recently embarked on a program of fairly massive importation of crossbred dairy cattle from overseas, with the view of distributing these animals to small farmers, whose income is expected to be substantially raised from the sale of milk. The massive importation of these crossbreds has increased the numbers of cattle in the country, and has further widened the gene pool of this species.

2. Buffaloes

There are two distinct types in Malaysia - the swamp and the river buffaloes. Although they belong to the same genus (Bubalus bubalis), they differ in both morphological and physiological respects. The swamp buffaloes are mainly found in the rice growing areas of Malaysia, whereas Murrah and Ravi are widely distributed throughout the country, being located near cities and towns to supply milk.

The swamp buffaloes are considered to have been present in Malaysia for centuries, and to have originated from Java. According to reports of some anthropologists, when Professor Du Bois found the fossils of the Java man, Pithecanthropus erectus (1890) in Trinil (East Java, Indonesia), he also found the fossils of the fore-father of the swamp buffalo, which he named Bos bubalus palaeo Kerabau. He also estimated the period as the old and middle Pleistocene. Perhaps the Kerabau made its way to Malaysia along with the settlers from Java.

3. Sheep

Most of the sheep in Malaysia are of the indigenous Kelantan type, which probably owe their origin to the Tibetan sheep from the Yunnan province in China. In the recent past, Government farms have imported a few Dorset Horn, Merino and Wiltshire Horn from the United Kingdom. The former was introduced in early 1950 to upgrade the quality of the indigenous sheep, but the project was a failure because of the poor heat tolerance of this breed. The Merino is a more recent introduction (Devendra 1975).

4. Goats

The domestic goat belongs to the genus Capra and is in all probability descended from the species C. aegagrus, although the ancestors of the wool-bearing types of goat may have been C. falconeri. The indigenous Kambing Katjang is numerically the most important goat breed in Malaysia. In the Central Animal Husbandry Farm, Kluang and in the Agriculture Station, Serdang, imported Anglo-Nubians and Jamnapari have been used to upgrade local animals for the last two decades. Other breeds mentioned in Table 1 are recent introductions.

5. Chickens

From time immemorial, chickens have been reared in Malaysia. In fact the ancestors of the modern breeds of poultry are descendants of the Red Jungle Fowl (Gallus gallus), which originated from this region. Although it is believed that the missionaries who worked in Malaysia during pre-war days introduced breeds of chickens which are high producers of egg and meat, yet not until the introduction of Ranikhet (Newcastle disease) vaccine in 1947 by the Veterinary Department did poultry farming become popular. In the 1950's, various breeds as listed in Table 1 were imported into this country, and during the last two decades the production pattern has changed from the backyard type to a commercialized multi-million dollar

Table 1. Species and breed of animals indigenous to or introduced into Malaysia

Species	Breed	Origin
Cattle	Kedah-Kelantan (KK)	Indigenous
(*Bos taurus*	Local Indian Dairy (LID)	Quasi-indigenous
or	Bali	Quasi-indigenous (Bali)
Bos indicus)	Holstein Friesian	Introduced (Australia)
	Angus	Introduced (Australia)
	Jersey	Introduced (Australia)
	Santa Gertrudis	Introduced (U.S.A.)
	Brahman	Introduced (U.S.A.)
	Australian Milking Zebu (AMZ)	Introduced (Australia)
	Charolais	Introduced (Australia)
	Droughtmaster	Introduced (Australia)
	Hereford	Introduced (England)
	Braford	Introduced (Australia)
	Sahiwal	Introduced (India, Pakistan)
	various crossbreds*	
Buffalo	Swamp	Indigenous
(*Bubalus bubalis*)	Murrah, Ravi (Nili)	Introduced (India)
Sheep	Kelantan	Indigenous
(*Ovis aries*)	Dorset Horn	Introduced (Australia)
	Merino	Introduced (Australia)
	Wiltshire Horn	Introduced (England)
Goat	Kambing Katjang	Indigenous
(*Capra aegagrus*)	Jamnapari	Introduced (India)
	Anglo Nubian	Introduced (England &
	Saanen	" Australia)
	Alpine	"
	Toggenburg	"
	Ettawa ($\equiv$ Jamnapari)	Introduced (Indonesia)
Chickens**	Red Jungle Fowl	Indigenous
(*Gallus domesticus*)	Cantonese Fowl	Indigenous
	Silky	Introduced (U.K.)
	White Leghorn	Introduced from U.S.A.
	Rhode Island Red	England, Continent
	New Hampshire	
	Light Sussex	
	Australorp	
	Barred Plymouth Rock	
	White Plymouth Rock	
	White Cornish	
	Red Cornish	

Table 1 continued

Species	Breed	Origin
Ducks (Anus platyrynchos or Cairina moschata)	Itik Jawa (Jawa Duck)	Indigenous
	Chinese Pekin	Introduced (China)
	Indian Runner	Introduced (England)
	Khaki Campbell	Introduced (England)
	Muscovy	Introduced (England)
Geese	Toulouse	Introduced (England)
	Chinese Brown	Introduced (China)
	Chinese White	Introduced (China)
Turkeys (Mexicana meleagridis)	Broad Breasted Bronze	Introduced (origin not known)
	Beltsville Small White	Introduced (" " ")
Pigs (Sus vittans or Sus scrofa)	Wild Pig	Indigenous
	Landrace	Introduced (U.K.)
	Large White	"
	Duroc Jersey	Introduced (U.S.A.)
	Hampshire	Introduced (U.K.)
	Chesterwhite	Introduced (U.K.)
	Lacombe	Introduced (Canada)
	South China	Introduced (China)
	South China Black or Canton	Introduced (China)

* Crossbreds have either been directly imported or have been locally produced by crossing the local breeds (LID and KK) with imported animals or by inseminating LID or KK

** Commercial strains include grand-parent and parent stocks of Shaver, Hyline, Arbor Acre, Dekalb, Ross, Babcock, Hubbard, Heisdorf-Nelson, Lohman, Steggles and many other commercial breeding farms

Table 2. Utilization of various breeds or strains of domestic animals

Species	Breed/Strain	Product	Miscellaneous contributions
Cattle	LID, Kedah-Kelantan	Milk and milk products, meat and meat products, leather, fats, fibre, fertilizer, fuel, horn, blood (for blood meal and serum)	Traction, transport, sport (bullock cart racing) and prestige
	Friesian, Jersey, Sahiwal, AMZ, various crossbreds	- same -	Prestige
	Angus, Santa Gertrudis, Brahman, Charolais, Droughtmaster, Hereford and various crosses.	Meat and meat products, leather, fats, fibre, fertilizer, fuel, horn, blood and skin	Prestige
Buffaloes	Swamp	Meat and meat products, leather and horn	Traction, transport, threshing, sport and prestige
	Murrah, Ravi	Milk and milk products, meat and meat products, leather, horn	- same -
Goats	All breeds listed in Table 1	Meat and meat products, milk and milk products, leather, bristle, fibre, mohair, fertilizer, horn	Prestige and experimental animal (e.g. milk fat synthesis and vaccine production)
Sheep	All breeds listed in Table 1	Meat and meat products, blood, fats, leather, fur, fuel, fertilizer, horn	Prestige, experimental animals (e.g. balance trials)
Pigs	All breeds listed in Table 1	Meat and meat products, blood, bristles, fur	Prestige, experimental animals (e.g. nutritional trials, reproductive physiology)
Chickens	White Leghorn	Egg and egg products, manure, feathers, blood	Experimental animal (e.g. in toxicological experiments)
	Ayam Hutan (Jungle fowl)	Meat and meat products, egg and egg products, feathers	Cockfighting, aesthetic
	Ayam Kampong and Cantonese	Meat and meat products, eggs and egg products, manure, feathers, blood	Cockfighting, prestige

Table 2 continued

Species	Breed/Strain	Product	Miscellaneous contributions
	Other exotic breeds listed in Table 1	Meat and meat products, eggs and egg products, manure, feathers, blood	Prestige and experimental animals
	Strains: Ross, Hubbard, Peterson, Kabir, Cobb 100 Plus, Arbor Acre, Euribrid Hybro	Broiler, manure, blood, feathers	-
	Strains: Shaver Starcross 579, Babcock B-380, H-N Nick Chick, Lohman, Fisher 107, Fisher 505, Hyline and Dekalb X-L Link	Eggs and egg products, manure, blood, feathers	-
	Silky	Eggs, feathers	Medicinal value to the local Chinese, prestige
Ducks	All breeds listed in Table 1	Meat and meat products, eggs and egg products	Prestige, aesthetic
Geese	All breeds listed in Table 1	Meat and meat products, feathers	Prestige, aesthetic
Turkeys	All breeds listed in Table 1	Meat and meat products, blood, manure, feathers	Prestige, aesthetic

industry. Since the late 1960's the breeding farms in Malaysia have become very dependent on the overseas commercial breeders, who sell grand-parent and parent stocks to local breeders. As a matter of fact, Malaysia must now possess a wide variety of commercial strains, particularly from U.S.A. and U.K. Imports from the Continent, Japan and Australia are comparatively less.

6. Ducks

The indigenous breed of duck in Malaysia is Itik Jawa (Jawa Duck). This breed is small, but fits well into the backyard system of farming under Malaysian conditions. Although the Chinese Pekin, from China and the Indian Runner, Khaki Campbell and Muscovy from U.K. are seen in Malaysia, they are very few in numbers. Similarly, breeds of geese and turkeys listed in Table 1 do exist but the numbers are small.

7. Pigs

The extensive use of various exotic breeds of pigs has been one of the major hallmarks of success of the pig industry in Malaysia. The liberal importation policy of the Government enabled high quality pigs from Europe, U.S.A. and Australia to be introduced. According to Mahendranathan (1972), 85% of the pig population of the country consists of various exotic crossbreds, and the purebred local varieties are fast becoming a rarity.

Two distinct domesticated breeds of pigs commonly referred to as the Local Chinese pig are to be found in this country (Fischer and Devendra 1963). They are the South China breed and South China Black or Canton. Exotic breeds listed in Table 1 have been imported during the past two decades, and at present there are many crossbreds involving in most cases Landrace as one of the parents.

C. Uses of various breeds and strains

The use of various breeds or strains of animals is listed in Table 2. The maximum use is of two local cattle breeds. Modern transportation systems and the use of tractors for ploughing have minimized the importance of these animals to a certain extent; however, one may still find many farmers ploughing their fields with KK bullocks, and occasionally a few bullock carts are seen on the roads.

Cockfighting is still a very important sport in villages. Selection for fighting ability and the fighting type has been carried out by farmers themselves for many generations. Silky chickens, having medicinal value to the local Chinese, fetch a premium price in the local markets. Geese and turkeys have long been kept mainly for prestige, but during the Christmas season these can be sold in the neighbouring market.

D. Numbers of animals within species

The livestock census of 1976, which is the latest, was taken by the Veterinary Department of the Ministry of Agriculture. The method of obtaining the figures starts at the district level. The Veterinary Officer of the district collects information by sending field assistants to various villages, and subsequently passes the collected information to the State Veterinary Officer. The Federal Directorate of Veterinary Services collects the information from the State Veterinary Offices and from the Federal Territory of Kuala Lumpur.

Unfortunately, the livestock census in Malaysia does not include numbers by breeds; Table 3 presents species numbers for each State. The 1976 census did not cover the number of chickens in two states - Kedah and Perlis - and in the Federal Territory. Hence an earlier census on chickens (1973) has been presented (Table 4) in which the ratio of human population to poultry has been shown. Table 5 shows the total land area, human and livestock population of Peninsular Malaysia. No

Table 3. Livestock census of Malaysia (1976)

State	Swamp Buffalo	Murrah buffalo	Cattle (Agric. & Draught)	Cattle (Milch)	Goats	Sheep	Pigs
Kedah	54,642	12	68,699	8,489	71,710	4,883	21,643
Perlis	4,889	143	6,628	1,357	10,043	322	1,169
Kelantan	54,488	-	116,308	1,276	31,607	19,973	7,511
Trengganu	27,054	-	55,159	499	12,262	3,247	961
Pulau Pinang	3,680	235	11,814	3,132	12,946	-	216,166
Perak	11,547	920	8,847	20,634	42,767	1,076	369,104
Selangor	913	720	5,931	17,137	23,318	589	337,209
Pahang	23,788	10	17,822	2,588	18,770	4,636	31,939
Negri Sembilan	9,042	-	18,429	9,084	31,780	11,946	150,812
Melaka	17,466	-	9,846	1,840	19,227	162	27,081
Johor	2,556	279	20,574	4,077	57,222	183	102,071
Federal Territory	-	130	-	1,665	984	-	42,599
Total	210,055	2,349	340,067	71,778	332,636	47,017	1,308,265

Source: Federal Veterinary Department, Ministry of Agriculture

Table 4. Poultry statistics obtained from census of 1973

States	Total No. of Poultry	% of Total	Rank	Ratio of human to poultry population
Perlis	25,919	0.34	11	4.9
P. Pinang/P.W.	1,818,405	23,86	2	0.5
Melaka	367,304	4.82	5	1.2
Negri Sembilan	442,041	5.80	6	1.2
Selangor	1,711,370	22.45	3	1.0
Kedah	199,016	2.61	8	5.1
Trengganu	46,601	0.61	9	9.2
Kelantan	40,747	0.53	10	17.8
Johor	1,842,356	24.17	1	0.7
Perak	908,894	11.92	4	1.8
Pahang	219,994	2.89	7	2.4
Peninsular Malaysia	7,622,647	100.0		

Source: Federal Veterinary Department, Ministry of Agriculture

Table 5. Total land area, human and livestock* population of Peninsular Malaysia

State	Total area of state (sq. km)	Human population 1972	Livestock population 1972	Livestock density per sq. km	Ratio of human to livestock population
Perlis	795	127,862	19,624	25	6.5
P. Pinang/P.W.	1,033	819,472	194,517	188	4.2
Melaka	1,650	427,084	82,858	50	5.2
Negri Sembilan	6,643	508,832	222,694	34	2.3
Selangor	8,200	1,723,305	178,642	22	9.6
Kedah	9,425	1,008,963	232,185	25	4.3
Trengganu	12,955	428,567	79,818	6	5.4
Kelantan	14,931	725,234	197,145	13	3.7
Johor	18,985	1,349,480	166,501	9	8.1
Perak	21,005	1,658,265	160,614	8	10.3
Pahang	35,965	533,570	100,912	3	5.3
Peninsular Malaysia	131,587	9,310,634	1,635,510	12.4	5.8

* Figures include ruminants and pigs.

Source: Federal Veterinary Department, Ministry of Agriculture

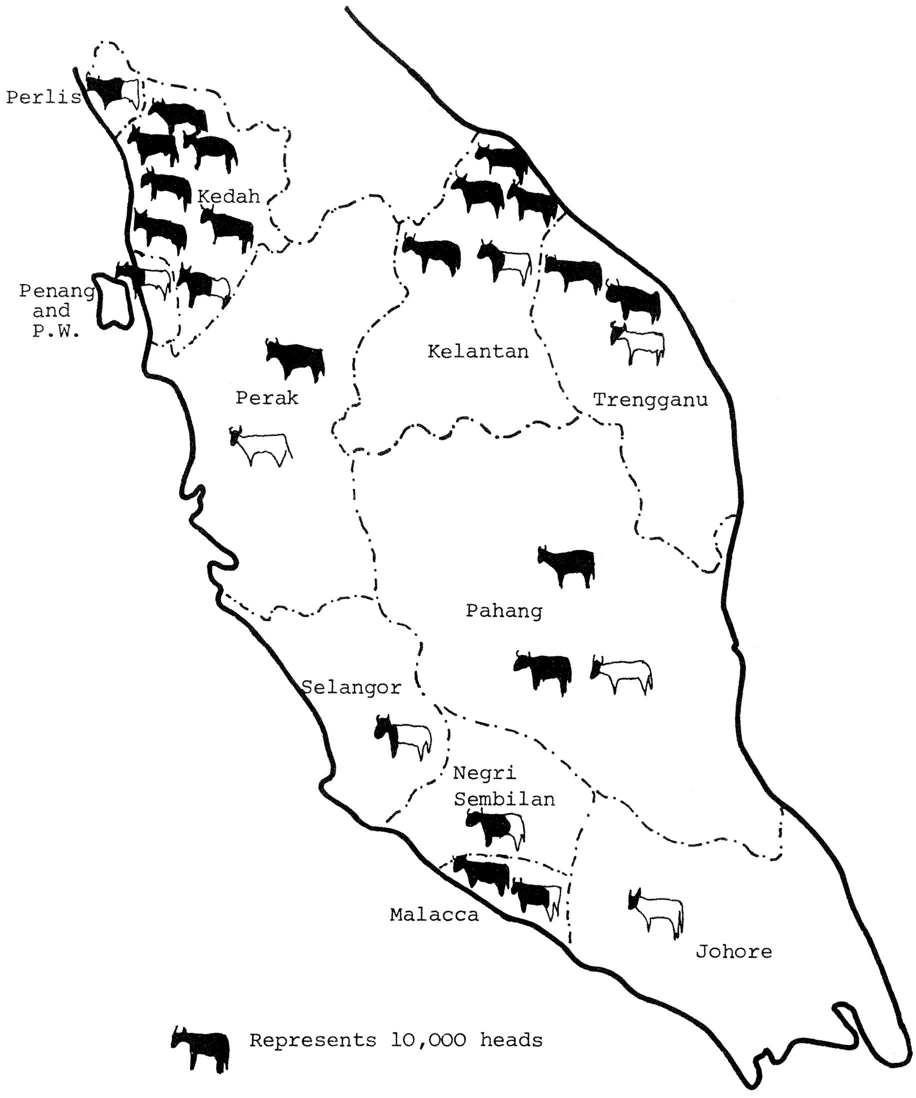

Fig. 1 - Distribution of buffaloes in various states of Peninsular Malaysia (Mahendranathan and Leong 1974).

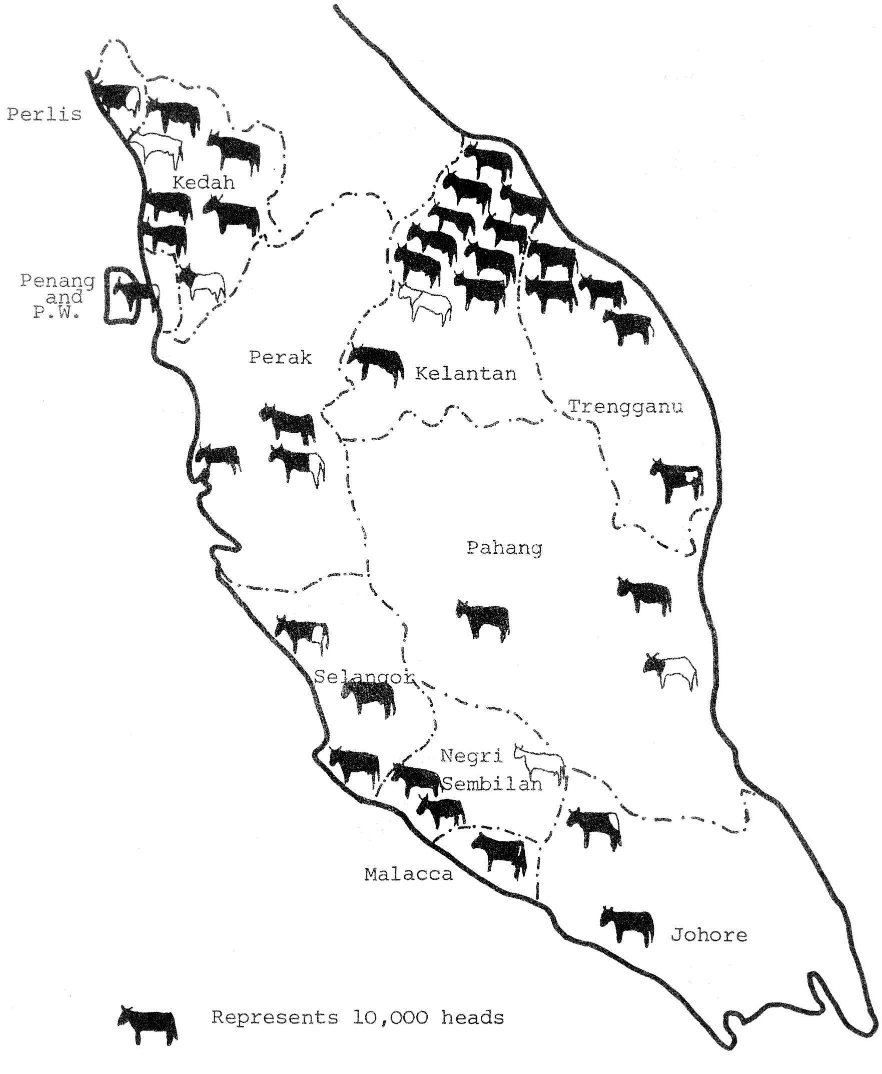

Fig. 2 - Distribution of cattle in various states of Peninsular Malaysia (Mahendranathan and Leong 1974).

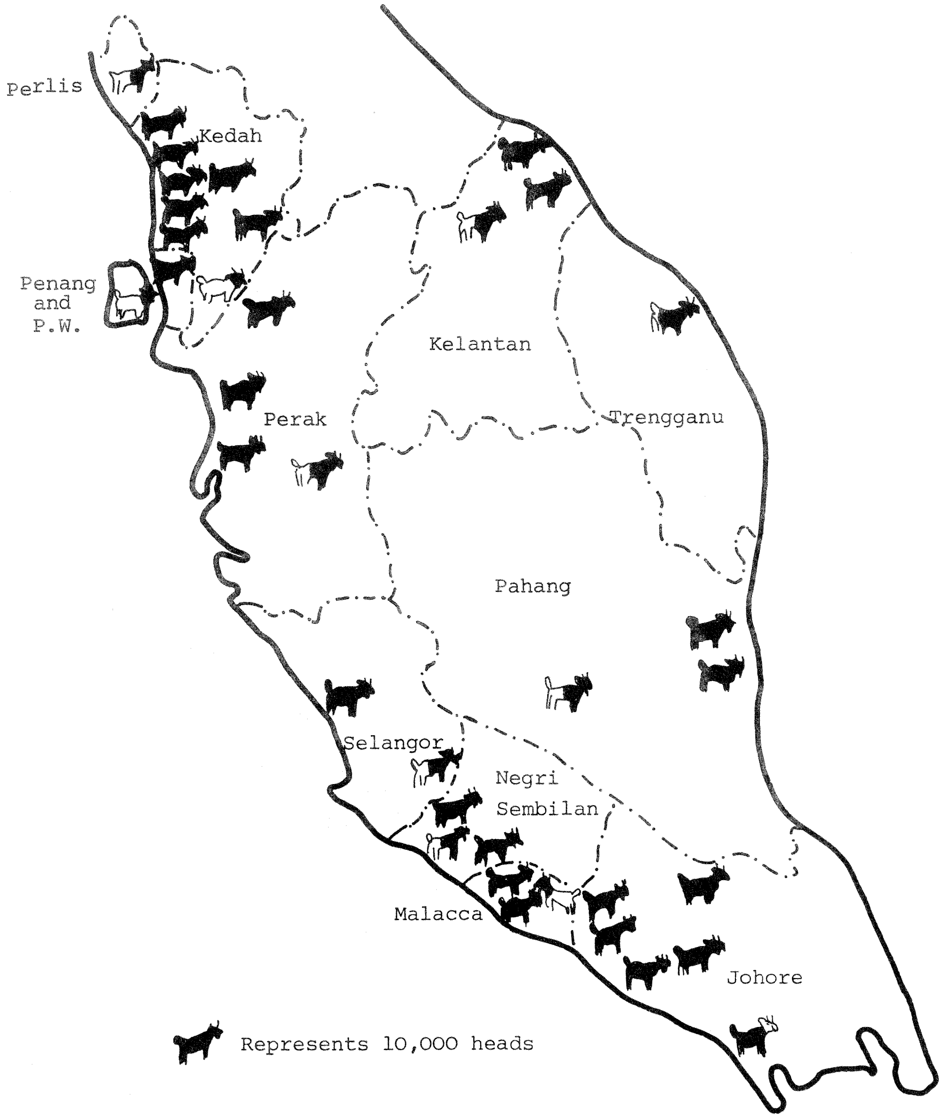

Fig. 3 - Distribution of goats in various states of Peninsular Malaysia (Mahendranathan and Leong 1974).

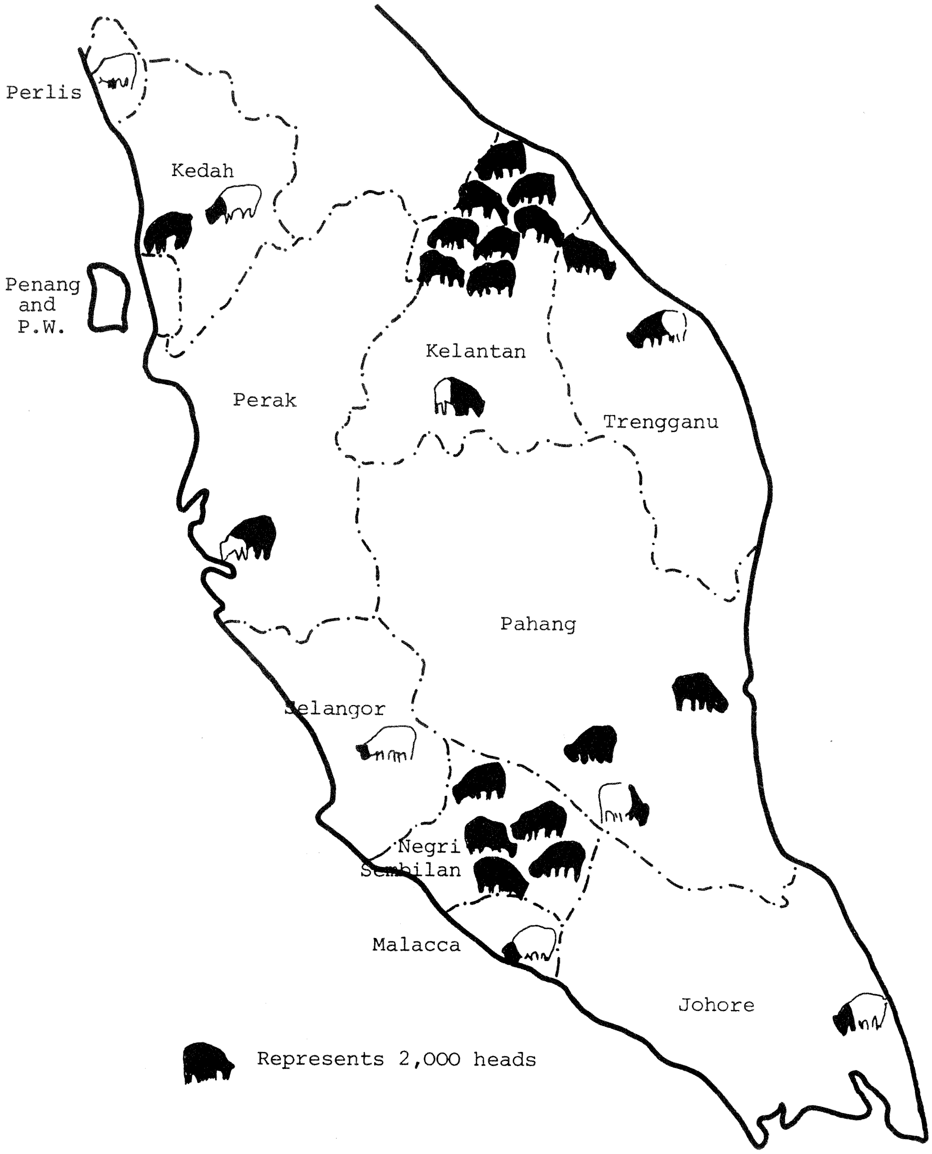

Fig. 4 - Distribution of sheep in various states of Peninsular Malaysia (Mahendranathan and Leong 1974).

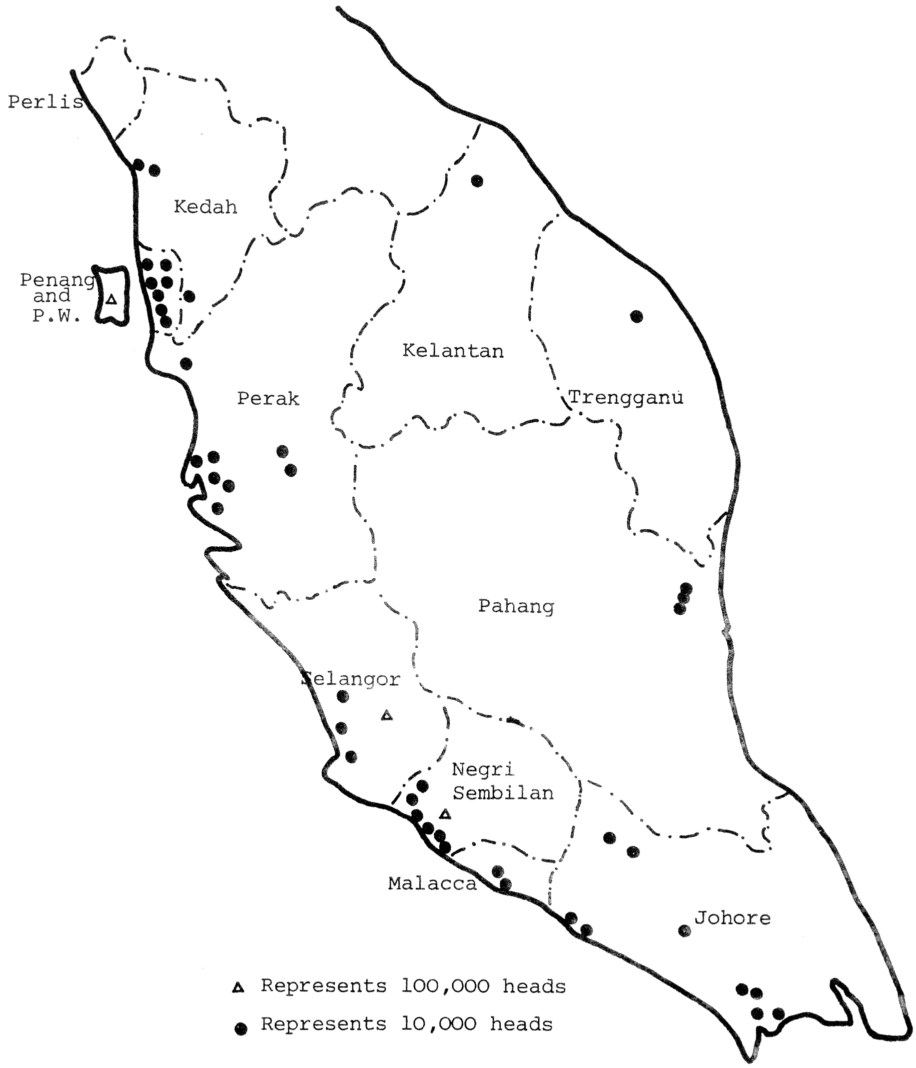

Fig. 5 - Distribution of pigs in various states of Peninsular Malaysia (Mahendranathan and Leong 1974).

Fig. 6 - Distribution of poultry in various states of Peninsular Malaysia (Mahendranathan and Leong 1974).

attempts have been made during any of the above censuses to record the number of ducks, geese and turkeys.

E. Distribution Maps

The distribution maps of buffaloes, oxen, goats, sheep, pigs and poultry based on the 1973 statistics are shown in Figures 1-6.

II. DESCRIPTION

A. Size

Body weights, wither heights and chest girths are presented (Table 6) for those breeds/species which have been recorded. Unfortunately no comparison between breeds within species for any characteristic could be made because of the non-availability of data at a uniform age. In many cases, data on wither height and chest girth are too few to be reported.

B. Colour

The colour patterns of the well-known breeds have not been described here, as they are available in text-books. This section refers mainly to local indigenous animals.

1. Cattle

Local Indian Dairy Cattle, being a heterogenous mixture of several Indian breeds, exhibit variation in colour. A predominance of Ongole characteristics is manifested in some herds by the presence of light grey coat colour, but in many herds the fawn and dun colours typical of many North Indian breeds predominate. In some herds the colour varies from shades of red and white to almost black and white or entirely red or entirely white.

The colour of the Kedah-Kelantan cattle is usually light to dark brown. Occasionally darkish brown to black colours occur, as also light shades of white and grey but brown is the most predominant colour. The belly and inside of the legs are invariably paler than the rest of the body. A dark brown line often runs all along the dorsal part of the body. The colour variation in Kedah-Kelantan cattle in two herds at Serdang and Kluang and the distribution of various forms are as follows: brown 61.1%, dark brown 17.7%, black 11.5%, brownish grey 6.2% and greyish white 3.5%.

Bali cattle have a most attractive and striking appearance with a tanned brown colour being conspicuous. The lower part of all four legs is white as also a white oval patch on the rump. A thin black line runs from the tail through the dorsal part of the body to the head. These features help to distinguish them from other cattle. Another feature specific to this breed is that bulls when young are distinctly brown in colour, but with age acquire a jet black colouration. Castrated bulls on the other hand retain their brown colour, suggesting that this feature is hormonal in origin.

2. Buffaloes

The colour of the swamp buffalo is slated blue or black. The frequency of albinos in the population is about 5%. Young swamp buffaloes have a gray-brownish hair which is 2-3 cm long and lies near the skin to provide an almost complete cover. As the animal grows the hairs become more widely separated, so that the adult hairs (3 to 5 cm long) are scattered sparsely and provide no insulation. Sometimes the adults are completely hairless.

Table 6. Size of males and females of different breeds/strains within species

Species	Breed	Body weight (kg) (Age at measurement)	Wither height (cm) (Age at measurement)	Chest girth (cm) (Age at measurement)	Reference
Cattle	LID	Males: 398 (A)* Females: 330 (A)	117.2 (A)	152.0 (A)	Mukherjee, Rajagobal and Gomez (1976)
	K.K.	Males: 300 (A) Females: 240 (A)	102.3±0.32 (A)	144.0±0.32 (A)	Devendra and Lee (1975)
	Bali	Females: 318 (A)	108 (A)	144 (A)	Devendra, Lee and Pathmasingam (1973)
	Red Sindhi	Males: 100 (1 yr) Females: 98 (1 yr)	-	-	Mukherjee (1972)
	Friesian	Males: 150 (6 mths) Females: 130 (6 mths)	-	-	Mukherjee (1972)
	Jersey	Males: 120 (1 yr) Females: 115 (1 yr)	-	-	Mukherjee (1972)
	Brahman	170 (6 mths)	-	-	Pathmasingam (1975)
	Hereford	174 (6 mths)	-	-	Pathmasingam (1975)
	Santa Gertrudis	Females: 417 (4 yrs)	-	-	Baharin (1974)
Buffaloes	Swamp	Males: 350-500 (A) Females: 300-500 (A)	Males: 130 (A) Females: 125 (A)	Males: 188 (A) Females: 182 (A)	Camoens (1976)
	Murrah	Males: 500 (A) Females: 480 (A)	Males: 142 (A) Females: 133 (A)	Males: 223 (A) Females: 220 (A)	Omar (1975)
	Ravi/Nili	-	-	-	-
Goats	Jamnapari	Males: - Females: 40-45 (A)	Males:- Females: 70-80 (A)	-	Khairudin (1978)
	Anglo-Nubian	Males: - Females: 45 (A)	Females: 75 (A)	-	Khairudin (1978)
	Kambing-Katjang	Males: - Females 23 (A)	Males:- Females: 55-65 (A)	-	Devendra (1967)

Table 6 continued

Species	Breed	Body weight (kg) (Age at measurement)	Wither height (cm) (Age at measurement)	Chest girth (cm) (Age at measurement)	Reference
Sheep	Kelantan	Females: 30 (A)	Females: 60 (A)	88 (A)	Mukherjee (1979)
Pigs	South China	25.63 (8 wks)	-	-	Mahendranathan (1970)
	Landrace	34.32 (8 wks)	-	-	Mahendranathan (1970)
	Landrace	70 (9 mths)	-	-	Wong (1979)
	Duroc	75 (9 mths)			
	Wild Pig	Males: 72 (not known) Females: 80 (not known)	-	-	Mahendranathan (1971)

*A = Adult weight

Table 7. Descriptive characteristics of indigenous breeds

Species Breed	Ears	Hump	Horns	Udder and teats	Tail
CATTLE					
LID	Pendulous and short; some have small and sharp ears	Prominent hump in majority of the cattle; some have comparatively small hump	Long, curvy horns; some have stumpy horns showing Sahiwal characteristics. Long curvy horns usually emerge outwards and slightly curved upwards and inwards	Capacious udder with teats 4 to 10 cm long. Teats are straight and pointed at the end	Tail long and whip-like with black switch reaching almost to ground
Kedah-Kelantan	Ears are small and pointed; tending to droop	Presence of smaller inconspicuous hump which is characteristically cervicothoracic. In bulls the hump is moderately developed	Horns are small and of varying shapes	Small udder with small teats 1 to 3 cm long	Tail is long with the switch reaching to fetlock
Bali	Ears are small, pointed upwards and backwards	Not very well developed in females but conspicuous in males	Horns grow upwards and backwards; less well developed in females	Udder and teats are small compared to Kedah-Kelantan	Tail of medium length and reaches to the hock joint
BUFFALOES					
Swamp	Medium sized and pointed; spread sidewise	Small hump extends over the first eleven thoracic vetebrae, abruptly terminating at the 11th	Widely spreading and broad; some polled; horns grow out horizontally, curling into a semicircle with advancing age, but always remaining on the same plane	Small udder with small teats	Tail is of medium length, the switch reaches to the hock joint
SHEEP					
Indigenous Kelantan	Small; pointed sidewise	-	Present in rams but seldom in ewes	Small udder and teats	Small

Table 7 continued

Species / Breed	Ears	Hump	Horns	Udder and teats	Tail
GOATS					
Kambing-Katjang	Short, pricked and upright	-	Scimitar-shaped, curved upwards and backwards	Udder is well developed with small teats but very little milk is produced	Very short tail
PIGS					
Wild pig	Small, pointed backwards and upwards	-	-	Small	Thin, medium sized tail ending up with switches. Projected towards the back making an angle of 60^{o} with the hind-quarter of the body
South China and South China Black	Small, pointed towards the two sides	-	-	Udder usually hangs very low. In pregnant sows and sows in milk, the udder often rests and trails on the ground	Small

The colour of Murrah buffalo is jet black, with white markings on tail, face and extremities. The colour of the Nili/Ravi is usually black, but brown is not uncommon. Pink markings are sometimes seen in the udder and brisket. White markings on the forehead, face, muzzle and legs are also seen.

3. Sheep

Indigenous Kelantan sheep are white to biscuit in colour, but brown and grey are also common. Skin and mucosae are yellowish white. The wool is greyish white to yellowish white, and in the adult animal grows to 12-15 cm long, but it is not utilized for any purpose.

4. Goats

The Malayan Kambing Katjang is usually black, sometimes with a few white patches. However, colour variations showing dark brown to brownish coats are also seen.

5. Pigs

The upper part of the body including the head of the South China breed is black, while the abdominal part, including the legs, is white. The forehead often has a white patch. The texture of the skin is fine and sparsely covered with hair; there is also a mane.

The South China black, or Cantonese, which is popularly known as the local Chinese pig, is entirely black in colour.

Wild pigs found in the jungles are black in colour, with densely thick long hairs around the body and legs.

C. Other characteristics

Descriptions of the ears, humps, horns, udder and teats, and tails of indigenous breeds are in Table 7, while details of temperament, reaction to heat and direct solar radiation and resistance to parasites and diseases are in Table 8. These characteristics for other breeds may be obtained from standard text-books; the importation of these breeds to Malaysia is of recent origin, and no mutation has been observed locally.

III. ENVIRONMENT, MANAGEMENT AND FEEDING

A. Environment

Peninsular Malaysia, covering an area of 132,000 sq. km, enjoys an equatorial climate with high rainfall, high humidity and temperatures ranging from 25° to 31°C. There are three main types of vegetation - lowland, hill and mountain, and swamp and low-lying. Of these, the lowland is the most important for livestock farming. Although small scattered herds of cattle may be found in the hilly regions, there are hardly any cattle in the fresh alluvial and mangrove swamp forests. Most of the buffaloes, almost all pigs, sheep and goats also are distributed in the lowlands.

B. Management

1. General

The ruminant industries in Malaysia today are undeveloped and rather backward in their production capabilities to meet the requirements of the country. This is because of the better return obtained by the farmer if he chooses to invest

Table 8. Temperament and reactions of indigenous breeds

Species Breed	Temperament	Reaction to heat and direct solar radiation	Resistance to parasites and diseases
CATTLE			
LID	Docile; mostly hand-milked without any disturbance	Highly resistant to heat and direct solar radiation; show least stress to forced exercise	Highly resistant to babesiosis and to some extent resistant to other tick-borne diseases
Kedah-Kelantan	Moderately docile; reacts sharply to strangers	Highly resistant	Resistant to tick-borne diseases
Bali	Easily excited; despite exposure to controlled management, excitability is not reduced	Highly resistant	Resistant to tick-borne diseases
BUFFALOES			
Swamp	Docile	Highly resistant	Highly resistant to tick-borne and parasitic diseases
SHEEP			
Indigenous Kelantan	Very docile	Highly resistant	Highly resistant
GOATS			
Kambing Katjang	Docile	Highly resistant	Highly resistant
PIGS			
Wild pig	Ferocious but when domesticated becomes milder	Highly resistant	Highly resistant
South China	Mild	Highly resistant	Highly resistant
South China Black	Mild	Highly resistant	Highly resistant

in rubber and oil palm. Moreover, the land allocated for grazing by ruminants is usually of low quality, and growing grass is sometimes a problem. Hence the status and place of ruminants in the production system is very low.

In contrast to the above situation, the poultry and pig industries in Malaysia enjoy a better status. They have adopted modern husbandry methods and techniques which have beneficially influenced their development along progressive lines.

Perhaps the best status in the livestock industry is enjoyed by the feed millers, who are currently producing more than 500,000 tonnes of livestock feeds. These feed mills not only ensure quality production of feeds but are also selling their products at competitive prices.

Peninsular Malaysia possesses a cattle population of approximately 350,000 head. With a few notable exceptions, in the Government farms and recently established private farms, very little specialization for beef or milk has taken place among the native cattle. They are accordingly of dual or multi-purpose type. Small holders usually keep very few animals in their farm. In a recent study (TUB 1977) it has been reported that the numbers of cows kept by estate workers, Malays in villages and non-estate non-Malays averaged 4.75, 3.77 and 12.0 respectively. Similarly, the numbers of calves kept by the above three groups of people were 2.60, 2.39 and 5.58 respectively. Most of the smallholders keep their cattle in sheds which are built on some inferior piece of estate land near the housing area. They allow their cattle to graze in any place, which could be their own land, on estate plantation land or by the roadside. Some farmers who are of non-Malay non-estate category cut grass and bring it to the stalls where the animals are kept.

The management of buffaloes, sheep and goats by these small holders follows a similar pattern, whereby a shelter in the form of a shed is given to the animals; when the animals are not grazing outside, they usually enter the shed and take a rest.

This system of management, known as extensive production, is quite common in Malaysia. The animals are usually herded by one or two individuals, or unpaid family labour including children. The ruminant animals selectively graze on what grasses exist, but these are invariably of poor quality, and it is doubtful if the animals consume sufficient quantity.

Besides the above system, which is practised by the majority of the farmers, there are three other systems: semi-intensive, mixed farming and intensive production. In the semi-intensive system, ruminants are grazed for a short time (about 4 hours) and then stall-fed. This system is particularly applicable to dairy animals, which are milked twice daily. Since some form of stall feeding is necessary, cut grasses are fed, often with limited concentrates.

The mixed farming system involves keeping animals within other cropping systems or in estates. Presently a considerable number of swamp buffaloes, beef cattle and goats are kept in the rice growing areas. Local Indian Dairy cattle and goats are found in estates and plantations, where they are reared by the tappers to supplement their income and also to meet domestic needs of meat and milk.

Intensive production of ruminants is of very recent origin; increased interest in it has been shown by the creation of large beef-dairy cattle multiplication centers and intensive growth and fattening of ruminants at various Government farms. In this system, ruminants are fed with cut grasses with or without concentrates. The system is highly specialized as the whole objective is to grow the ruminants quickly, consistent with efficient nutritional management.

Herd size: The average size of herd or flock in cattle, buffaloes, sheep, goats and pigs is 10, 4, 6, 6 and 40 respectively. The last mentioned figure for pigs is usually for the technologically advanced farmers.

Male:female ratio: For ruminants, a ratio of 1 male to 5-20 females is usual; where artificial insemination facilities are available, the male:female ratio is low. The number of castrates in large breeding farms, where they are used as teasers, is usually 1 castrate:10 females.

Castration: Castrations are only performed by a veterinarian or his assistants at the request of the farmers. This is usually done between 8-10 weeks of age for calves, about 2 weeks for lambs and about 1 week for pigs. The common method of castration is by using a Burdizzo's castrator. Operation on the scrotum whereby the vas deferens is cut is also performed.

Rearing of offspring: At birth all new born ruminants (calves, kids and lambs) are fed for the first three days on colostrum to confer immunity on them, and also to utilize the rich nutrients. Two to three months after birth they are given digestible feed. There is no clear-cut age for weaning of ruminants kept by small holders. The calves or lambs continue to suck mother's milk as long as the milk is available.

Age at slaughter: There is no specific age for the slaughtering of ruminants. During festival time or when the farmer needs some cash, the animals are slaughtered for meat consumption. Dairy animals are slaughtered after their productive period is over. Pigs are sent to market when they attain a body weight of 50-60 kg.

2. Feeding

The type and quantity of feed depend on the type of production and the ruminant species. In most cases, grass represents the main feed ingredient, from which the animal meets most of its requirements for both maintenance and production. Dairy animals usually need concentrate supplementation. The proportion of total costs attributable to feed for individual animal species in Malaysia is presented in Table 9 (Devendra, 1975). Feed costs as a proportion of total costs were found to be highest in poultry, followed by pigs, dairy cattle, milch goats, beef, buffaloes (milk) and meat-producing goats and sheep.

3. Diseases

Malaysia is fortunate in being free of the major tropical diseases such as foot and mouth, rinderpest and anthrax. Parasitic diseases, however, are common throughout Malaysia, and seriously lower production.

Haemorrhagic septicemia in cattle and buffaloes, melioidosis in goats, nutritional deficiencies in all ruminants, contagious ecthyma in sheep and goats are common. External parasities are also common but the animals have developed some resistance to them.

Swine fever has existed in an endemic form in the country for many years. Transmissible enteritis, brucellosis, melioidosis, salmonellosis, colibacillosis, lameness and parasitism (Ascarops and Physocephalus) are common pig diseases.

IV. REPRODUCTION

A comprehensive study of the reproductive performance of the local breeds of cattle and buffalo is yet to be made. Rajagopal (1969) and Sivarajasingam et al (1972) compared the performance of the local and various crossbreds at the Central Animal Husbandry Station, Kluang. However, much remains to be known of the reproductive performance of ruminants kept by farmers in the villages. Private pig farmers have information on the reproductive patterns of pigs, but the data collected by them have never been published.

Table 9. Proportion of total costs attributable to feed for individual animal species in Malaysia (Devendra, 1975)

Species and product	Diet	Feeding system	Feed cost as % of total cost
Buffaloes			
Milk	Grass + concentrate	Mainly grazing + some concentrate	11.4
Cattle			
Beef	Grass	Grazing	40.7
	Grass + concentrate	Stall feeding	56.1
Milk	Grass + concentrate	Stall feeding + limited grazing	69.5
Goats			
Meat	Grass	Grazing	2.8
	Grass	Stall feeding	23.0
Milk	Grass + concentrate	Stall feeding	48.2
Sheep			
Mutton	Grass	Grazing	2.8
Mutton	Grass	Stall feeding	23.0
Pigs			
Pork	Roots + concentrate	Confined feeding	57.3
	Concentrate	Confined feeding	69.1
Poultry			
Meat and eggs	Concentrate	Confined feeding	78.2

The meagre information available on factors associated with reproduction of animals is given in Tables 10 and 11.

V. BREEDING

A. Cattle

1. Pure breeding

Pure breeding of LID and Kedah Kelantan has never been practised on a large scale in any of the Government farms. Only recently one of the private farms (Pahang Beef, Pahang, Malaysia) has established a Kedah-Kelantan herd. The Malaysian Agriculture Research Institute (MARDI) also possesses a Kedah Kelantan herd, but no breeding work is practised there. Purebred herds of Holstein-Friesian, Jersey and AMZ are now in the possession of Maju Ternak, a Government organization to promote the development of animals, mainly cattle. As far as the author knows, no systematic approach has been taken yet in any of the above herds for the production of home-bred males. Since the acquisition of these purebred herds is of recent origin, it is quite likely that in future home-bred males based on their own and progeny performance will be selected for the improvement of the respective breeds.

Small holders of dairy cattle, either in villages or living in the outskirts of cities and towns, select their males on the type of the animals. Usually they take precautions not to use those males which have failed to pass their selection criteria.

A few small holders of LID cattle interviewed by the author mentioned that they use males for breeding purpose when these attain at least 3 years of age, and discard them when they are 5-6 years old. Criteria for selection of breeding stock by these small holders mainly depends on the milk production records of the dam and sibs of the individuals.

2. Crossbreeding

Crossbreeding has been practised in the Central Animal Husbandry Station, Kluang, since 1960. Originally an upgrading program to improve the local LID cattle was initiated in early 1950's. LID cows were randomly mated to Red Sindhi bulls in 1952, the first group of crossbreds being born in 1953. The first generation crossbreds were backcrossed to different Red Sindhi bulls to obtain 1/4 LID 3/4 Red Sindhi grades. The backcrossing of cows to Red Sindhi bulls was repeated, so as to establish a 1/8 LID 7/8 Red Sindhi crossbred combination. These LID x Red Sindhi of various grades have been inseminated since 1960 with semen from imported dairy breeds such as Holstein-Friesian and Ayrshire, and from beef breeds such as Angus, Charolais and Hereford. Many of the progeny resulting from these crossbreds have been distributed to different villages for testing their performance under various Government schemes.

Crossbreeding of cattle has been taken up in a much larger scale by Maju Ternak. Table 12 shows the livestock census of all Maju Ternak farms in which either purebred exotic or crossbred animals are kept. These animals will perhaps be the basis of future development plans.

B. Buffaloes

In about 80% of the herds, 4.1% of the females were culled as unproductive, while in the other 20%, 14.3% of the females were removed. Culling was positively correlated with herd size; as herd size increased, the proportion of animals culled increased. Most of the animals culled from breeding stock were

Table 10. Factors associated with reproduction for various species: up to parturition

Species and breed	Mating system	Ratio of males to females	Age at first use - males (days)	Age at first parturition-females (days)	Seasonality of oestrus	Season(s) of births
CATTLE						
LID	Small holders practise either free (males always with females without restraint) or controlled natural mating. There are very few cows which are artificially inseminated, the exception being on Govt. farms	No clear-cut trend in natural mating, depends on number of males available in the herd	550-1500 (Sivarajasingam 1975)	1452 (Sivarajasingam *et al* 1974)	Aseasonal	Aseasonal
Kedah-Kelantan	Same as LID	No clear-cut trend	600-1500	1332 (Devendra 1973)	Aseasonal	More calves are born during the wet than dry season; Feb-June (36%) July-Jan. (64%). Highest numbers of births recorded in July and January (Devendra 1972)
Bali	Same as LID and Kedah Kelantan	Same as LID and Kedah Kelantan	1000 +	1200±21 (Devendra 1973)	More calves are born during wet months; 39.7% born between February and June; 60.3% between July and January (Devendra 1973)	Aseasonal

Table 10 continued

Species and breed	Mating system	Ratio of males to females	Age at first use - males (days)	Age at first parturition-females (days)	Seasonality of oestrus	Season(s) of births
CATTLE						
Red Sindhi	Artificial insemination at Central Animal Husbandry Station, Kluang	Not known	Not known	1527 (Sivarajasingam & Mukherjee 1975)	Aseasonal	Aseasonal
Australian Milking Zebu (AMZ)	Artificial insemination	-	-	-	-	-
BUFFALOES						
Indigenous		The sole male in the herd becomes established as the herd sire. His undisputed claim over all the females he makes known in no uncertain terms to all the pubescent males (Camoens 1976)	540 + (Camoens 1976)	Range: 780-3030 Mean:1620 (Camoens 1976)	Aseasonal	Aseasonal
Murrah			500 +	1400	Aseasonal	Aseasonal
SHEEP	Free	1:5	?	600 +	Aseasonal	Aseasonal
GOATS						
Kambing Katjang	Free; controlled matings in experimental farm	1:5 to 10	365 +	575 +	Aseasonal	Aseasonal
Anglo Nubian		1:5 to 10	-	455 (Devendra 1962)	-	-

Table 11. Factors associated with reproduction for various species. Parturition - weaning

Species and breed	Infertile females %	% females producing one, two, three or more offspring/birth	Interval between parturitions (days)	Mortality %
CATTLE				
LID	30-40 (Das 1975)	Mostly single birth; negligible proportion of twins	First calving interval (423)	Prenatal 5% To weaning 10% Post-weaning 2% Adult 1% Records for males, females and castrates separately are not available
Kedah-Kelantan	Better percent fertility than LID (Das 1975)	Mostly single birth	451±8 (Devendra 1973)	Up to 1%-15%; 52% of these deaths occurred up to weaning at 6 months and 42% up to 1 year of age
Bali	?	Mostly single birth	476±12 (Devendra 1973)	20% up to the weaning age of 6 months; post weaning and adult mortality figures not known (Devendra 1973)
Red Sindhi	20 to 25% (Sivarajasingam & Mukherjee 1975)	Mostly single birth	522 (Sivarajasingam & Mukherjee 1975)	-
Australian Milking Zebu (AMZ)	-	-	423 (Mak *et al* 1978)	-
BUFFALOES				
Indigenous	Not known	Mostly single birth	645 (Camoens 1976)	More than 30% mortality occurs below 1 month of age; between 1-3 months - 32.4%; 3-6 months-15.9% (Camoens 1976)
Murrah	15%	Mostly single birth	580	?

Table 11 continued

Species and breed	Infertile females %	% females producing one, two, three or more offspring/birth	Interval between parturitions (days)	Mortality %
SHEEP	30%	5-6% twins (Devendra 1975)	248 (Devendra 1975)	Mortality 15% up to weaning age of 3 to 6 months
GOATS				
Kambing Katjang	15%	Average litter size: 1.65 (Devendra 1962) 60% twins; rest single birth. Multiple births higher than twins were found in first cross (KK x Anglo-Nubian)	240 (Devendra 1962)	Up to 6 months - 35%; adult mortality - 13% (Wahid 1979)
Anglo-Nubian	-	Average litter size: 1.43 (Devendra 1962)	480 (Devendra 1962)	?

Table 12. Livestock census from Maju Ternak farms (March, 1978)

<table>
<tr><th></th><th colspan="3">Purebreds</th><th colspan="7">Crossbreds</th></tr>
<tr><th>Farm</th><th>Friesian</th><th>Jersey</th><th>AMZ</th><th>Fr-LID</th><th>Jersey-LID</th><th>Brown Swiss x LID</th><th>Simmental x LID</th><th>Braford</th><th>Drought-master</th><th>Beef crosses</th></tr>
<tr><td>Behrang Ulu</td><td>30</td><td>60</td><td>580</td><td>15</td><td>80</td><td>15</td><td>10</td><td>240</td><td>-</td><td>340</td></tr>
<tr><td>Batu Arang</td><td>35</td><td>210</td><td>310</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Air Hitam</td><td>450</td><td>-</td><td>-</td><td>1370</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Padang Hijau</td><td>100</td><td>310</td><td>180</td><td colspan="4">480</td><td>-</td><td>-</td><td>870</td></tr>
<tr><td>Jelai Gemas</td><td>40</td><td>-</td><td>-</td><td>-</td><td>-</td><td>140</td><td>-</td><td>-</td><td>330</td><td>870</td></tr>
<tr><td>Ulu Lepar</td><td>-</td><td>-</td><td>85</td><td>33</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>990</td></tr>
<tr><td>Tersat</td><td>-</td><td>-</td><td>-</td><td colspan="4">120</td><td>-</td><td>-</td><td>470</td></tr>
<tr><td>Sg. Karabunga</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>1800</td></tr>
<tr><td>Total</td><td>655</td><td>580</td><td>1155</td><td>1418</td><td>80</td><td>155</td><td>10</td><td>240</td><td>330</td><td>5340</td></tr>
</table>

Source: Maju Ternak Headquarters, Jalan Selangor, Petaling Jaya about 6 years old (Camoens 1976).

C. Sheep and Goats

No attempt has been made so far for systematic genetic improvement of local Kambing Katjang or Indigenous Kelantan sheep.

Crossbreeding of Kambing Katjang with Anglo-Nubians has been practised at the Federal Experimental Station, Serdang (Anuwar and Devendra 1966), and with Anglo-Nubian and Jamnapari at the Central Animal Husbandry Station, Kluang. The former project was terminated long ago, but the latter is being continued. Recently MARDI has initiated a project of crossbreeding involving Anglo-Nubian, Jamnapari, Alpine, Saanen and local animals.

D. Pigs

Most of the pig farmers do not maintain adequate records of the performance of their stock, and consequently often have unproductive and poor performing animals. The absence of adequate record keeping as an invaluable aid to selection in the breeding programme is a major deterrent to efficient swine production.

Selection of boars is usually done at 6 months on the basis of their phenotype. Farmers who select the animals are usually very well experienced, and their services are utilised by other farmers venturing into pig breeding. Many boars are used as studs for many years, thus retarding genetic progress.

Most of the pigs produced for the market result from the crossbreeding of Landrace with other breeds, such as Large White and Duroc Jersey. Pig breeders usually import new stock from overseas from time to time.

VI. PERFORMANCE

Small holders do not provide any special management conditions for ruminants in production, although progressive farmers do realize that productive animals need extra rations for production as well as maintenance. As such, a concentrate mixture of some grain, bran, husk or cake is provided to the productive animal. The quantity of concentrate given is usually determined by the farmer from previous experience. Animals kept in the Government farms are usually managed following standard systems of management and feeding.

A. Milk

Milk production data and associated traits for cattle are given in Table 13. The performance data for recently imported and crossbred animals (Table 14) was obtained from the Maju Ternak headquarters at Petaling Jaya, Selangor. Milk production data for buffaloes and goats are listed in Table 15.

Except for a few Government farms where machine milking is practised, hand milking is the most common method. Frequency of milking is usually twice a day, although some small farmers milk only in the afternoon.

B. Meat

Body weights and rates of growth of different purebred and crossbred cattle at the Central Animal Husbandry Station, Kluang, are presented in Table 16 (Mukherjee et al 1976). Of the different groups, Charolais ♂ x (Sindhi x KK) ♀

Table 13. Milk production and associated traits in different breeds of cattle

	Lactation Yield (kg)					Lactation length (days)		
Breed	1st	2nd	3rd	4th	5th	1st	Average of five lactations	Reference
LID	684	809	896	938	877	249	230	Sivarajasingam, Mukherjee and Jaffar (1974)
LID	612	-	-	-	-	271	-	Samuel (1974)
LID	480	-	-	-	-	259	-	Rajagobal (1969)
Red Sindhi	835	-	-	-	-	231	-	Sivarajasingam and Mukherjee (1975)
AMZ	1180-1443 (different age groups)					261-306 (different age groups)		Mak, Kassim and Yap (1978)
Kedah-Kelantan	641*	-	-	-	-	185*	-	Lee (1977)
LID x Jersey	1189	-	-	-	-	317	-	Samuel (1974)
1/2 Red Sindhi x 1/2 LID	689	758	776	785	819	224	218	Sivarajasingam and Mukherjee (1975)
3/4 Red Sindhi x 1/4 LID	678	763	800	823	808	238	225	Sivarajasingam and Mukherjee (1975)
7/8 Red Sindhi x 1/8 LID	712	760	691	680	623	245	237	Sivarajasingam and Mukherjee (1975)

* Experimental animals fed a diet containing 12% to 24% crude protein. The above data are the average of six treatments.

Table 14. Average performance of purebreds and crossbreds in all Maju Ternak farms and Institute Haiwan

	Maju Ternak Farms				Institute Haiwan, Kluang		
Trait	Friesian	Jersey	AMZ	Friesian crosses	Friesian(I)	Friesian(L)	Friesian crosses
Lactation yield (kg)	1898 (307)*	1406 (281)	1315 (714)	1449 (336)	1583 (198)	811 (49)	1695 (297)
Lactation length (days)	302 (208)	294 (57)	270 (455)	218 (145)	261 (198)	189 (49)	255 (61)
Calving interval (days)	481 (127)	405 (127)	402 (164)	391 (3)	521 (93)	506 (30)	405 (31)
Dry days (range)	0-453	0-404	0-407	-	-	-	-

* Figures in parenthesis indicate number of records

(I) - Friesians imported as in-calf heifers

(L) - Friesians locally born

Table 15. Milk production and associated traits in buffaloes and goats

Species/Breed	Lactation yield (kg)					Lactation length (days)		Reference
	1st	2nd	3rd	4th	5th	1st	Average of five lactations	
Buffaloes								
Swamp	3 pints (daily)	-	-	-	-	180	-	Lee (1957)
Goats								
Kambing Katjang	97	95	106	66	83	167	126	Anuwar and Devendra (1966)
1/2 Anglo-Nubian x 1/2 Kambing Katjang	295	288	290	-	-	220	235	Anuwar and Devendra (1966)
3/4 Anglo-Nubian x 1/4 Kambing Katjang	242	222	-	-	-	227	207	Anuwar and Devendra (1966)

Table 16. Body weights of different crossbred groups at the Central Animal Husbandry Station, Kluang

Pure or Crossbred group	Body weights (kg)			
	at birth	6 months	12 months	18 months
Hereford ♂ x (Sindhi x KK) ♀	19.60* (9.55)**	74.03 (3.77)	123.01 (7.48)	178.44 (4.17)
Hereford ♂ x KK ♀	18.71 (6.05)	69.97 (7.87)	123.83 (7.87)	178.71 (7.48)
Friesian ♂ x (Sindhi x KK) ♀	22.41 (6.91)	76.52 (7.35)	143.79 (8.31)	194.59 (3.77)
Angus ♂ x (Sindhi x KK) ♀	19.55 (6.63)	79.83 (9.21)	131.49 (6.46)	169.39 (6.98)
Charolais ♂ x (Sindhi x KK) ♀	20.87 (3.76)	92.48 (6.52)	164.70 (5.99)	208.31 (9.07)
KK (male progeny)	22.16 (1.36)	75.64 (4.99)	136.08 (6.80)	- -
KK (female progeny)	20.12 (4.54)	67.28 (5.90)	94.80 (13.15)	- -

* Mean body weight

** Coefficient of variation

Table 17. Body weights, growth rates and carcase characteristics

Species and breed	Sex	Body wt. (kg) Birth	Weaning (Age)	24mth	Daily gain (g) to 6mth	Weight (kg) at slaughter (Age)	Dressing %	Reference
Cattle								
LID	M	20.2	-	-	320	-	-	Sivarajasingam (1975)
	F	19.0	-	-	280	-	-	"
	Overall	15.0	-	-	300	-	49-52	Camoens (1978)
Kedah-Kelantan	F	-	-	201	339	201 (24 mth)	55	Devendra and Lee (1975)
	Overall	15.2	73 (6 mth)	-	-	-	-	"
Bali	Overall	16.5	-	-	264	-	36-44	Devendra *et al*. (1973)
Brahman	M	28.4	182 (6 mth)	-	502	-	-	Pathmasingam (1975)
	F	24.4	164 (6 mth)		464	-	-	"
Santa Gertrudis	M	25.3	-	-	443	-	-	Baharin and Mak (1975)
	F	23.6	-	-	430	-	-	"
Brahman x KK	M	18.9	106 (6 mth)	-	-	-	-	Devendra and Lee (1975)
	F	17.7	92 (6 mth)	-	-	-	-	"
	Overall	-		214	-	-	54	"
Buffaloes								
Swamp	Overall	36	-	-	-	-	45-58	Camoens (1976)
Murrah	Overall	41	-	-	-	-	45-48	Payne (1970)

Table 17 continued

Species and breed	Sex	Body wt. (kg) Birth	Weaning (Age)	24mth	Daily gain (g) to 6mth	Weight (kg) at slaughter (Age)	Dressing %	Reference
Goats								
Kambing Katjang	Overall	1.5	-	-	-	25	44-51	Devendra (1966)
Pigs								
Native	Overall	-	12 (8wk)	-	-	-	-	Mahendranathan (1970)
Landrace	Overall	-	15 (8wk)	-	-	-	-	Mahendranathan (1970)

crosses showed the highest growth rate up to 18 months. Table 17 lists the body weights of other purebred and crossbred animals maintained at other stations.

C. Draught

Bullocks and castrated male buffaloes are used for draught purposes. They start ploughing the field from as early as their second year of life. Other uses have been mentioned earlier.

D. Fleece

Smith and Clark (1972) gave the following estimates of skin characteristics of Kelantan sheep: Number of follicles/mm^2, 5.1-7.3; secondary/primary follicle ratio 1.0-1.2; overall average fibre diameter 46-49 μm; percent medullated fibres 33.8-60.2. Devendra (1975) gave an estimate of 0.8-1.4 kg for greasy fleece weight. The fleece is a coarse carpet wool type with staple length 5-10 cm. It covers only the upper part of the body, and the head, underside of the neck, brisket, belly and legs are bare.

VII. POULTRY

A. Description

Until about 10 years ago, the system used in Malaysia for broiler production was mainly breed crossing, involving crosses between two or, on rare occasions, between three breeds. The common breeds involved were White Cornish, Red Cornish, White Plymouth Rock and New Hampshire. However, recently the commercial breeders tend to favour importation of parent stocks of different commercial strains from overseas, and to make appropriate crosses which result in the production of commercial broilers. Similarly, except for the experimental farms, egg-laying breeds are seldom produced on the farm. Here again the trend is to import parental strains, which on crossing produce commercial progeny.

It is thought that a description of pure exotic breeds of chickens, as well as of the different commercial strains, would be redundant. Except for size, which may vary with different environments and feeding regimes, all other descriptive characteristics would be the same as in other countries. Hence, under the heading "description", only local animals such as Jungle Fowl, Canton Fowl, Ayam Kampong and Itik Java have been described. Breeds of turkeys and geese present in Malaysia are also not of local origin; hence their descriptions have not been presented. Tables 18 and 19 describe the various local breeds within each species.

B. Management and Feeding

1. Management systems

There are three major management systems that are followed by various types of farmers. These are:

i) Extensive system: Here the farmers keep a few chickens in the backyard of their house and manage them on a free range system. The production is usually for home consumption; however, those who are interested to expand may do so by collecting eggs and hatching them under mother hens. As a night shelter, these birds are provided with some sheds and chicken coops.

Usually there is no standard feeding system. Birds are scavengers and are given supplementary food (usually excess of home cooked rice or anything else) once a day. At 5 to 6 weeks, they are released in the paddy fields to pick up spilled paddy. At 4 to 5 months, the farmers may sell the birds for meat consumption or may use these for home consumption. Disease is a major problem with these birds, because they are usually not vaccinated.

ii) Semi-intensive system: This is usually a combination of intensive brooding and range rearing during the growing period. Proper brooding boxes or tier brooders are used for artificial brooding of chicks. The chicks are purchased in large numbers and reared intensively for about 4 to 5 weeks, and then released in the open range during the day and housed at night. This system is commonly practised for table birds and broiler production in young rubber and coconut areas in Province Wellesley and Johore. The feeding system begins with a starter mash, and then switches to a broiler finisher until they reach a marketable age.

iii) Intensive system: This system is adopted mainly for the production of commercial broilers, replacement pullets and layers. In this system broilers are reared in well built houses which usually have a cement floor, zinc roof and concrete walls up to 60 to 70 cm. On top of the walls, thick wire mesh surrounds the entire house to prevent predators from entering. Layer birds are reared in three phases (starters, growers and layers). Deep litter floors, raised wire, slatted floors and laying battery cages may be used for specific rearing of broilers, pullets and layers, depending on the initial capital investment.

Feeding usually consists of starter and finisher mash, or pellets or crumbles for broilers. Layers usually begin with starter mash or pellets, followed by grower mash or pellets and then by layer mash. Similarly, breeders have three-phase feeding.

The diets of layers and breeders are quite similar in composition, except that extra minerals and vitamins are supplemented in the breeder's diet to ensure that shell texture, fertility, hatchability of eggs and health of the chicks are not jeopardised.

2. Quantity and type of feed and water supply

Under the extensive system, the quantity and type of feeding are not fixed because they depend on the availability of excess food after home consumption. Under the semi-intensive and intensive systems, standard feeding practices are adopted.

Usually the source of water is from taps. Water is either given in water troughs or, under the intensive system, running water is provided by automatically controlled water troughs.

3. Average size of flock

The percentages of poultry farms of different sizes are given in Figure 7.

4. Flock structure

In production flocks kept on floor, usually there are no males. An experiment in the University of Malaya (1973 - unpublished) revealed that egg production was not increased by keeping males in the production flock. The ratio of males:females in this experiment was 1:10.

5. Age to which birds are kept

Broilers are marketed at between 8 to 10 weeks of age. Layers are usually sold as meat birds after their first year's laying, although in some farms, layers are kept for a second year. Breeders usually keep the parent stock of different commercial strains for two laying seasons, after which fresh stock is again imported.

Table 18. Description of local chickens and ducks

Species/Breed	Body Weight (kg)	Feather colour(s)	Colour pattern	Feather length and extent of body cover	Comb type
CHICKENS					
Jungle Fowl	M: 1.8 F: 1.2	Golden red, red, grey, reddish brown	Sexually dimorphic; males have two dorsal black stripes; females have black lacing with feathers	Covers the body well; primary - 5cm, secondary - 10 cm	Single
Canton	M: 2.2 F: 1.5	Buff, brown	Black lacing of the feathers	same	Single
Ayam Kampong	M: 1.8 F: 1.1	Heterogeneous, colour grey, buff, red, golden red	Pattern more or less same as Jungle Fowl	same	Usually single but of different type if crossbred with some breeds of different comb type
DUCKS					
Itik Java	M: 2.2 F: 1.8	Grey Buff	-	Small feathers	-

Source: Data from University of Malaya Farm

Table 19. Features of local chickens and ducks

Species/Breed	Special features	Temperament	Reaction to heat and direct solar radiation	Resistance to parasites and diseases
CHICKENS				
Jungle Fowl	Some males have a bigger spur	Very hardy but difficult to keep in confinement	Highly resistant	Resistant to parasites
Canton	-	Frequency of broodiness very high	Resistant	Resistant
Ayam Kampong	-	-	Resistant	Resistant
DUCKS				
Itik Java	-	Very hardy	Highly resistant	Highly resistant to internal and external parasites

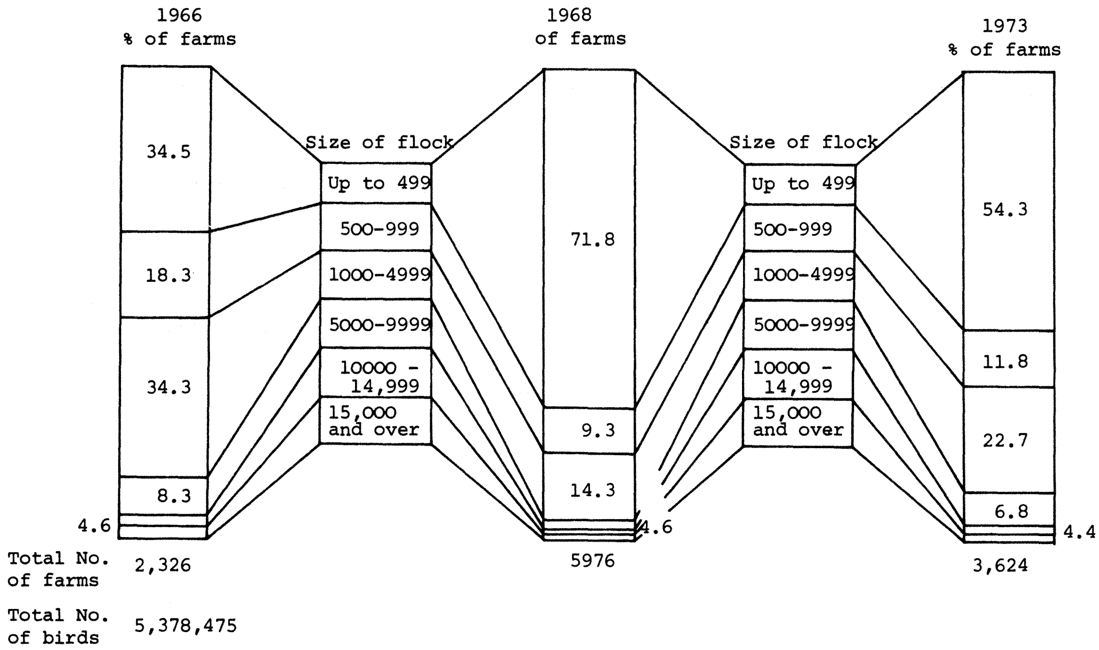

Fig. 7 - Analysis of flock size in relation to the percentage of poultry farms.

6. Artificial brooding

In many small farms artificial brooding involves the supply of low hanging infra-red lamps or carbon lamps. Large farms mainly use either battery brooder or electrically heated brooders placed on the floor. Usually after 2-3 weeks, the heating source is removed.

C. Diseases

The following diseases have been reported by the Veterinary Research Institute, Ipoh, over a period of 6 years (1965-1971): Ranikhet or Newcastle disease, Marek's disease, salmonellosis, pasteurella, mycoplasma (CRD), infectious coryza, infectious laryngotracheitis, coccidiosis, plasmodium, leucocytozoon, avian encephalomyelitis, infectious bronchitis, fowl pox, helminthiasis, ectoparasites, aspergillosis and others (*E. coli*, Streptococcal and Staphylococcal infections).

Vaccinations against Ranikhet and Fowl Pox are routinely made in all the semi-intensive or intensive farms. Vaccination against Marek's disease, infectious bronchitis and infectious laryngotracheitis is also made routinely in some farms.

D. Reproduction

1. Mating systems

In the extensive system, males always move freely with the females. Controlled natural matings are practised in the intensive and semi-intensive systems when the birds are kept on floor, while caged hens are always artifically inseminated.

For turkeys, artificial insemination is practised at the University of Malaya Farm. Ducks usually are mated free but controlled mating or AI may be very successful.

The ratio of males to females in most of the farms practising controlled natural mating is usually 1:10. Breeders practising AI usually reduce the number of males used.

In turkeys a 1:2 to 1:4 male-female ratio is maintained.

In chickens the females are invariably about 5-6 months old when they come into production. However, to get better semen and sperm quality from males, it is desirable to wait for another month.

2. Fertility and hatchability

Data on fertility of eggs set and hatchability on either total eggs set or fertile eggs are very few because the private hatcheries seldom release their figures. In an experiment conducted at the University of Malaya, Mukherjee (1974) showed that the average percent fertility and percent hatchability on total eggs set of three breeds of chickens (White Leghorn, White Plymouth Rock and Red Cornish) were about 80% when weekly inseminations were made using undiluted semen. Fortnightly inseminations reduced both fertility and hatchability by 8-10%. When the semen was diluted with Wembeke's diluent, the fertility and hatchability percentages were found to be further reduced, using the same volume of semen as control.

Experiments conducted at the University of Malaya on fertility and hatchability of turkeys indicate the magnitude of the problem concerning turkey breeding in the tropics. Usually egg production from the turkey breeders (imported or local) is very low (70-80 per laying period of 300 days). Fertility and hatchability on total eggs set are normally 60% and 50% respectively.

3. Incubator

In the extensive system, farmers place the eggs under mother hens. The hatchability percentage in this type of incubation is very high. Other systems mainly use incubators for hatching. Modern incubators with a capacity of 40,000 to 100,000 eggs are kept by breeding farms. These incubators are purchased from renowned firms overseas.

4. Mortality

The mortality percentage to 5-6 weeks of age was 2-3% in different breeds/strains of broilers (Wahid et al 1974; Wolf et al 1976). The mortality of layers observed in the University of Malaya farm from 5 weeks to sexual maturity is about 2%.

E. Breeding

1. Source of breeding stock

To an ordinary farmer in Malaysia today, the source of the chicks does not matter. As long as he can get good economic returns, he is quite satisfied with the breed and strain he is using. This phenomenon has retarded the progress of genetic improvement of chickens in Malaysia.

Two decades ago the main aim of poultry breeding was to develop stock efficient in the production of eggs and meat. Usually White Leghorn, New Hampshire and Rhode Island Red were the breeds of choice for producing eggs through either purebred or crossbred progeny. For broiler production, White Cornish, White Plymouth Rock, Red Cornish, Barred Plymouth Rock and Australorp have been used. During the above period, efforts were made by private breeders to produce homebred males and females.

The concept of breeding locally, however, has been changed drastically during the last 10-12 years. Easy availability of commercial strains due to the liberal importation policy of the Government has prompted local breeders to stop developing good purebred animals for future crossbreeding. Instead, they have been importing parent stocks from almost all parts of the world just to produce commercial progeny. Their job starts with the rearing of the parental strains; these strains are then crossed to produce progeny, which are sold for commercial use. In a way this process is detrimental to the long term national interest, and a program has been started at the University of Malaya to develop a local broiler strain by combining the good qualities of certain commercial strains.

2. Source of males

In the villages, high quality males have been distributed in the past from Government farms to improve kampong chickens.

3. Age at selection

Usually the age at selection for both males and females is 20 weeks. The selection criteria vary from farm to farm. Usually males are selected on the basis of body weight and body conformational traits. Females are selected on the basis of sibs' egg production, egg weight and egg quality records.

4. Extent of crossbreeding

Crossbreeding was very extensive during the sixties. The Poultry Development Institute, Johore Baru and many private farms imported purebreds from overseas and maintained them for a few generations for the production of crossbreds. However, recently the breeders are mainly involved in strain crossing as recommended by the well known commercial breeding firms from overseas, which operate on a global basis.

A crossbreeding program with turkeys has recently been begun at the University of Malaya farm.

F. Performance

Unfortunately, the performance data of various commercial firms are never published. In general there is a reduction of approximately 10 to 15% in the performance of production strains in Malaysia as compared with the performance of the same strain in the supplier's country. An experiment at the University of Malaya and the Technical University of Berlin to assess the magnitude of the effect of environment on the body weight, egg production, average egg weight and breaking strength of eggs in a commercial egg laying strain (Lohman) revealed significant differences of performance in favour of Berlin (Table 20, Mukherjee, Horst and Hussain 1979). Productive performance of some broiler breeds and crossbreds resulting from the mating of these breeds and of some commercial strains (Table 21) would reveal that for traits associated with meat production, commercial strains are far superior to the local purebreds and the crossbreds.

Indigenous fowls such as Kampong fowl and Canton are very low producers of meat (Table 18) as well as eggs. Kelley (1972) reported the annual numbers of eggs of Kampong fowl and Canton as 50 and 70 respectively, although they were placed under better management and feeding conditions. In view of this, these two breeds are now being gradually replaced in the countryside by well known breeds of chickens. Hence, there is a danger of extinction of these breeds in future, which may be prevented by maintaining flocks of them at different experimental farms.

Experiments conducted at the University of Malaya on imported strains of turkeys showed that the turkeys attain an average body weight of 4.5 kg at 16 weeks (Mukherjee 1978). This suggests the possibility of rearing turkeys on a commercial scale.

Table 20. Mean and coefficient of variation (c.v.) of some important traits in the Lohman breed in two locations

	Berlin		Kuala Lumpur	
Traits	Mean	c.v.	Mean	c.v.
Body weight at 40 weeks (g)	2607	6.81	2190	8.10
Egg production (Number from 20-68 weeks)	216	13.25	171	7.95
Av. egg weight (g)	60.90	2.42	58.75	2.75
Breaking strengh of eggs	3.02	6.85	2.50	7.67

Table 21. Performance of some purebreds, crossbreds and strain crosses as broilers

Strain/Breed	Body weight (g) 0 wk	4 wk	8 wk	10 wk	12 wk	Eviscerated weight	Weight of meat	Meat to bone ratio	Reference
Kampong Fowl	Male	Adult wt: 1066							
	Female	" " : 1041							
Canton	Male	Adult wt: 2300							
	Female	" " : 1065							
White Cornish (WC)	M: 34	286	871	1286	1646	1116	521	2.40	Wahid, Mukherjee and Jalaludin (1973, '74, '75)
	F: 32	276	783	1103	1396	966	442	2.58	
Red Cornish (RC))	M: 34	281	813	1199	1583	1166	528	2.43	"
	F: 33	255	755	1076	1376	889	412	2.49	
New Hampshire (NH)	M: 33	219	647	940	1233	853	381	2.25	"
	F: 32	217	578	797	965	658	289	2.35	
White Plymouth Rock (WPR)	M: 33	221	639	902	1185	827	371	2.24	"
	F: 31	204	588	798	1015	702	312	2.26	
WPR x WC	M: 33	245	774	1145	1513	1103	519	2.39	"
	F: 33	231	700	986	1249	861	407	2.46	
NH x WC	M: 34	268	797	1152	1461	1016	468	2.32	"
	F: 33	251	722	1022	1294	909	423	2.42	
WPR x RC	M: 34	262	787	1170	1501	1054	512	2.41	"
	F: 33	251	722	1022	1294	909	423	2.42	
NH x RC	M: 34	300	813	1145	1462	1077	503	2.37	"
	F: 34	262	720	981	1189	859	374	2.37	
RC x WC	35	248	888	1142	1370	-	-	-	Lim (1975)
Gold Kabir x Kabir 70	36	408	991	-	-	-	-	-	Lim (1975)
Arbor Acre	-	-	1460						Wolf, Mukherjee and Jalaludin (1976)
Ross	-	-	1470						
Inra-Vedatte	-	-	1350						
Shaver	-	-	1360						

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Discussion

Bhat: While you have given some data on the milk yield of various breeds, I understand they are not truly comparable because they were not collected concurrently for animals run together. However, do you have any idea how the Local Indian Dairy breed would compare with exotic breeds when under the same conditions?

Mukherjee: I do not know, because there has not been any properly conducted experimentation to compare these breeds under identical management and feeding regimes.

Turner: For meat production, your data indicate that Kedah-Kelantan cattle show performance that is as good as any crosses with exotic breeds. Why then is the Malaysian Government encouraging the importation of exotic beef breeds? Also, from the conservation viewpoint, is any encouragement being given to the maintenance of purebred Kedah-Kelantan?

Mukherjee: I believe the Government of Malaysia is encouraging importation of exotic beef breeds for two reasons - (a) to rapidly increase the numbers of beef animals and at the same time, to create greater genetic variability in the population and (b) to make cross-bred animals available to small-scale farmers, so as to increase their income.

No specific encouragement is being given to the maintenance of purebred Kedah-Kelantan, but some large-scale enterprises are using, and intending to improve, the purebred Kedah-Kelantan cattle.

Eusebio: In terms of movement of animals from country to country, and restrictions placed on such movement, I am concerned by the classification of "disease-free zones" as a basis for such restriction. Malaysia has had foot-and-mouth disease, but will not allow importation from other countries where foot-and-mouth has occurred.

Mukherjee: I am not qualified to give an opinion on this. However, I believe that foot-and-mouth has been controlled in Malaysia, and it is Government policy to keep the country free of this disease.

Rendel: If I may comment on this point, it must obviously be the privilege and right of any country to determine from what other countries it will permit importation of animals. Quite understandably, authorities in importing countries will be conservative when they estimate the risks of introducing disease by animal importation.

ANIMAL GENETIC RESOURCES IN THE PHILIPPINES

A.N. Eusebio

I. INTRODUCTION

A. Livestock data collection

The method of livestock data collection in the Philippines consists of joint annual sample surveys by the bureaus of Agricultural Economics and Animal Industry of the Ministry of Agriculture. The survey for each type of livestock and poultry (cattle, hog, chicken and duck) employs an independent frame. Farms are grouped according to size, in terms of the number of livestock raised. With large commercial farms, complete enumeration is made; for small commercial farms, simple random sampling is made using a variable sampling fraction, i.e. a heavier sampling rate for medium-size farms. Each province is considered an independent domain of study. The survey covers 4,000 sample farms out of 8,000 commercial farms.

For small or backyard farms the survey employs a two-stage sampling design with the village and household as the primary and secondary sampling units, respectively. A minimum of 50 sample villages is drawn for each province. All households in the sample village are classified into farming and non-farming. A 10 percent sample is enumerated for each sample village. A total of about 400,000 sample households in about 3,800 sample villages out of a total of 33,000 villages are enumerated for the whole country.

B. Livestock numbers and distribution

Results of the livestock census for 1977 and 1978 are given in Table 1, and distributions of the various species in Figures 1 - 6.

C. Environment

As an indication of average climatic conditions, data on rainfall, temperature, relative humidity and wind velocity are given in Table 2.

D. Status of the livestock industries

1. Pigs and poultry

Production of pork, poultry and eggs is very much improved to the point that local demand is now being met. Pork has been the major source of meat accounting for 50 percent of total meat requirement while poultry is supplying 26 percent.

Hogs and chickens are raised both on commercial and backyard scales. Except for breeder hogs, pork importation has been greatly reduced as a result of the present stage of development of the local swine industry. In fact, exportation of live hogs to Hongkong has been initiated since 1975. The situation is encouraging for increased production of pork and pork products.

In the case of poultry, there is an impressive widespread shift from backyard or small scale to commercial production. There are eleven large agri-business firms engaged in broiler and egg production; one of these has expanded its broiler housing capacity to 270,000 birds. Most of the large poultry farms enjoy economy of production through integration with commercial feed mills.

Table 1. Philippines animal population as of January 1978 and 1977 by species
(000 head)

Species	Backyard raisers			Commercial raisers			Total		
	1978	1977	% Increase (Decrease)	1978	1977	% Increase (Decrease)	1978	1977	% Increase (Decrease)
Cattle	1,324	1,458	(-9.1)	495	376	31.6	1,820	1,835	(-0.8)
Carabao	2,908	2,890	0.6	49	21	133.3	2,958	2,920	1.3
Hog	5,681	4,966	14.4	1,228	768	59.9	6,909	5,734	20.6
Goat	-	-	-	-	-	-	1,239	1,103	16.9
Chicken	41,415	33,700	22.9	17,476	14,084	24.0	58,992	47,784	23.2
Duck	3,526	3,755	(-6.0)	1,838	439	318.7	5,365	4,195	27.9

Source: Joint survey by the Bureau of Animal Industry and Bureau of Agricultural Economics.

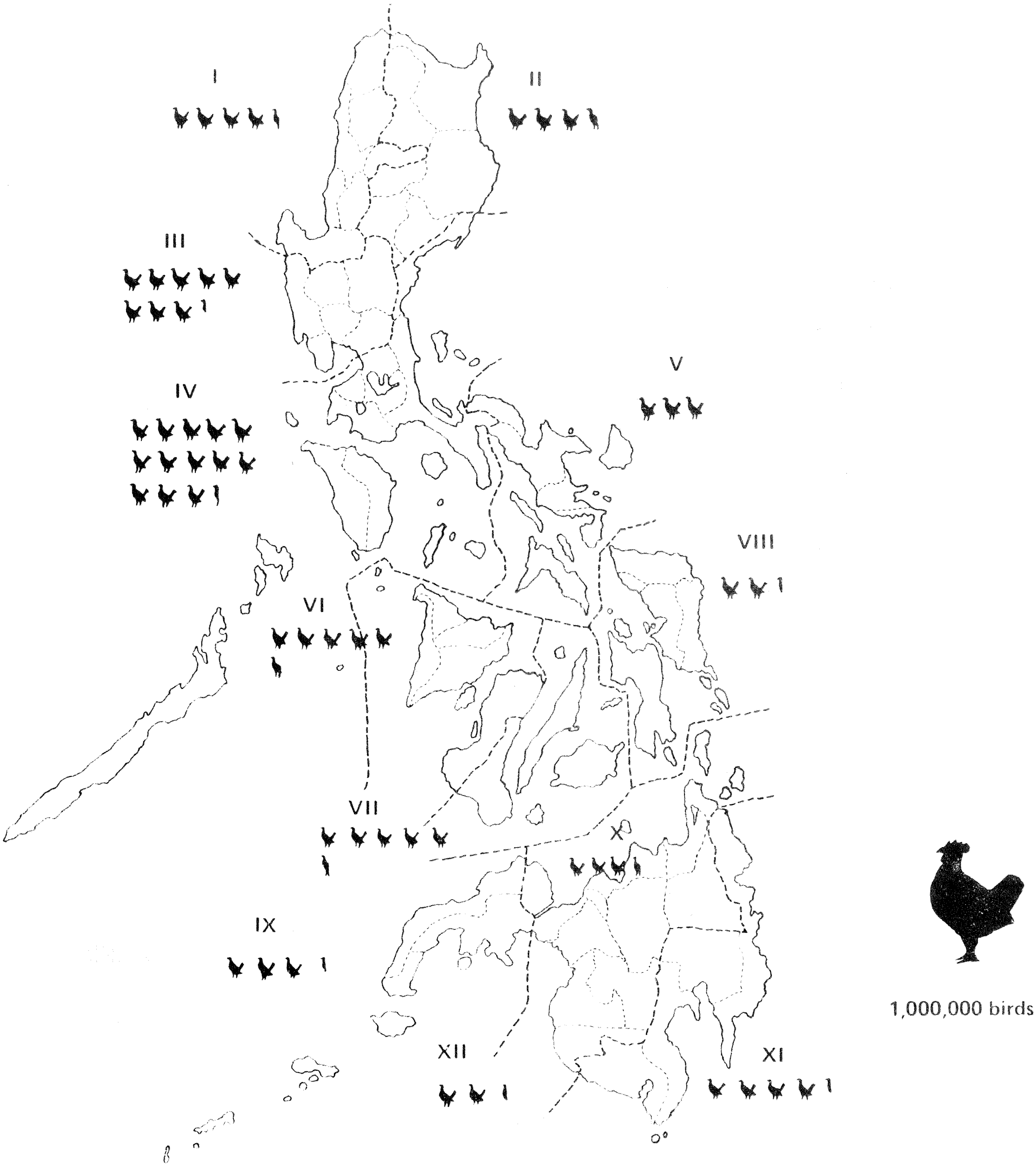

Fig. 1 - Regional distribution of poultry population in the Philippines, 1978.

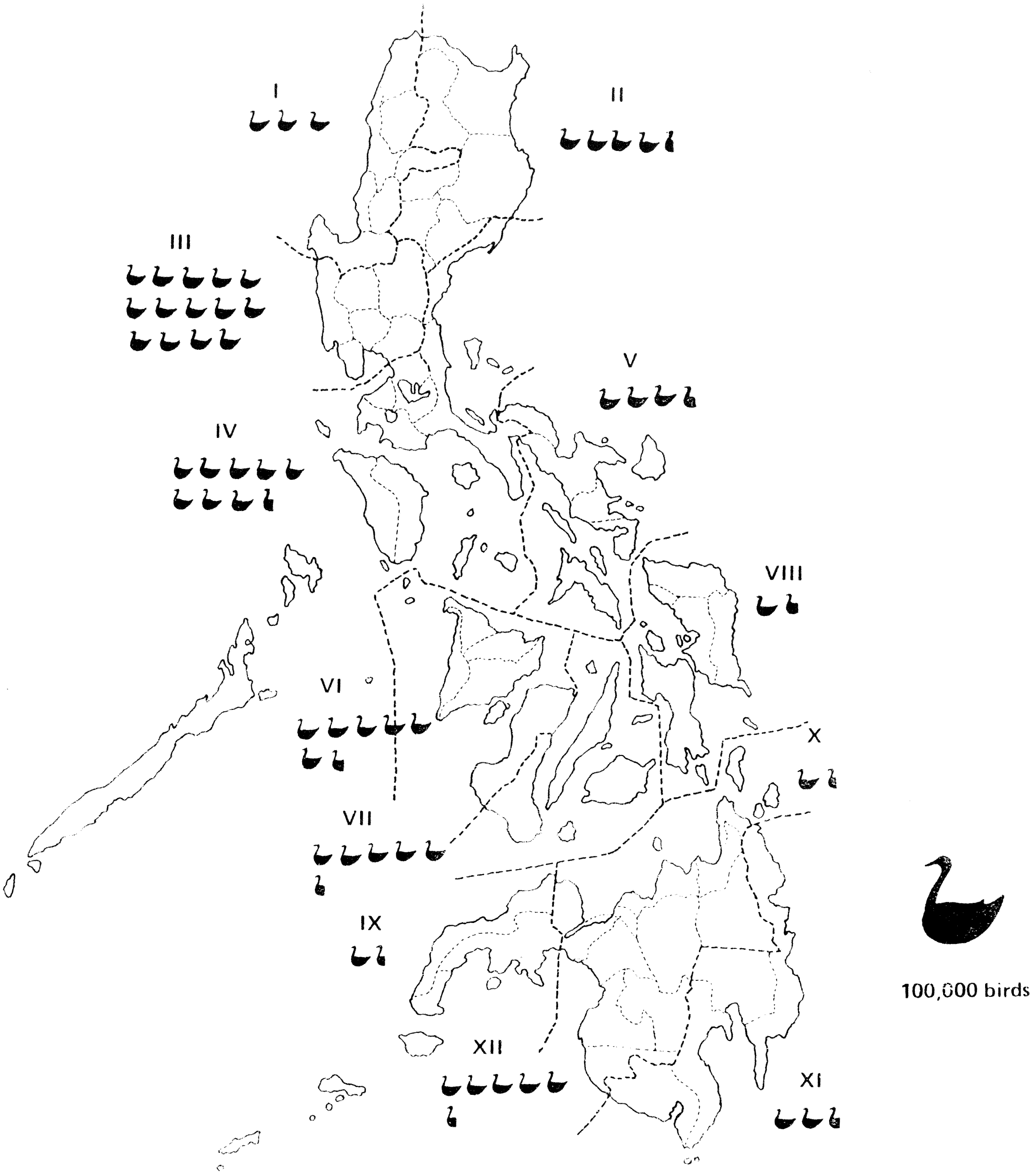

Fig. 2 - Regional distribution of duck population in the Philippines, 1978.

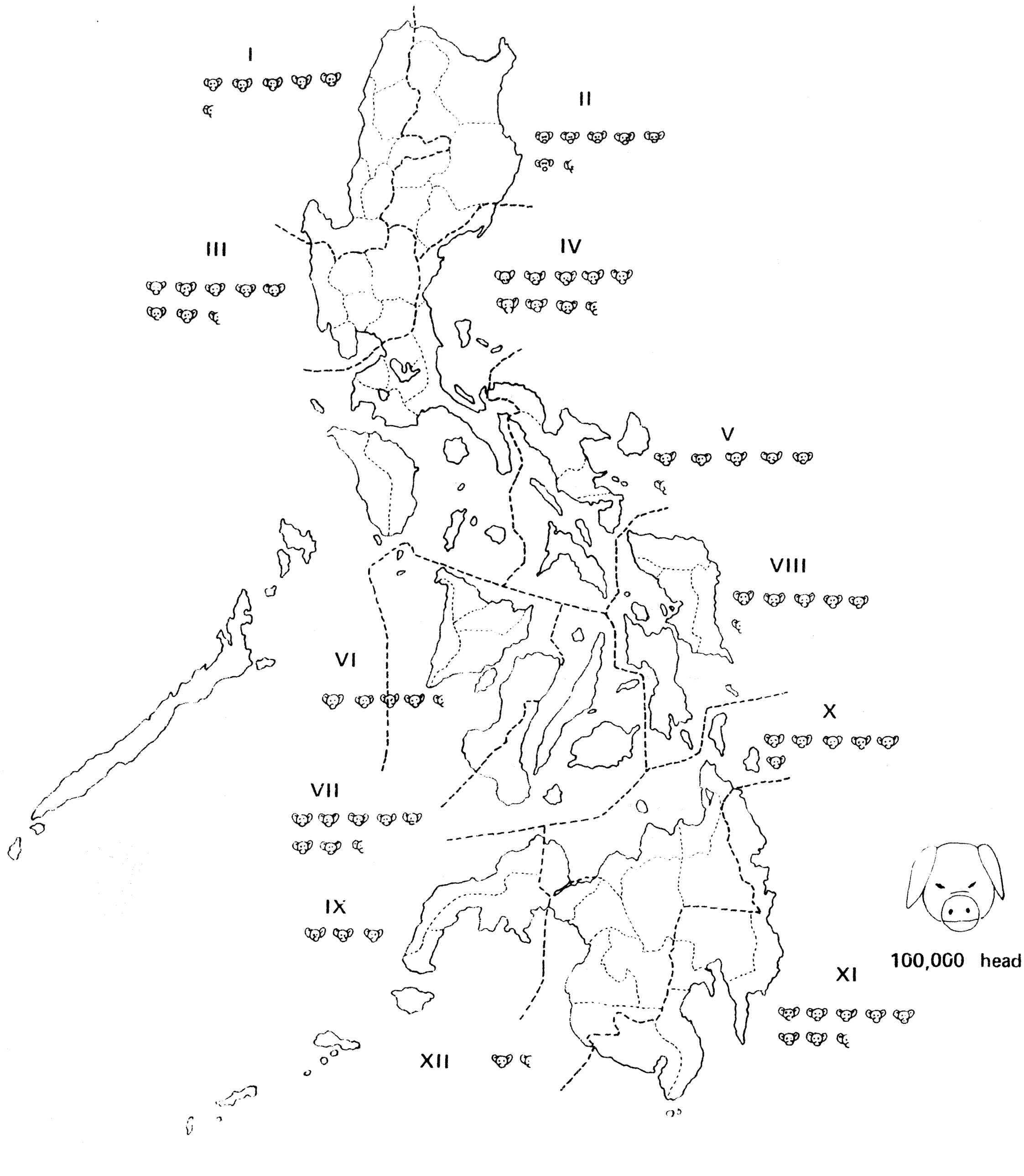

Fig. 3 - Regional distribution of hog population in the Philippines, 1978.

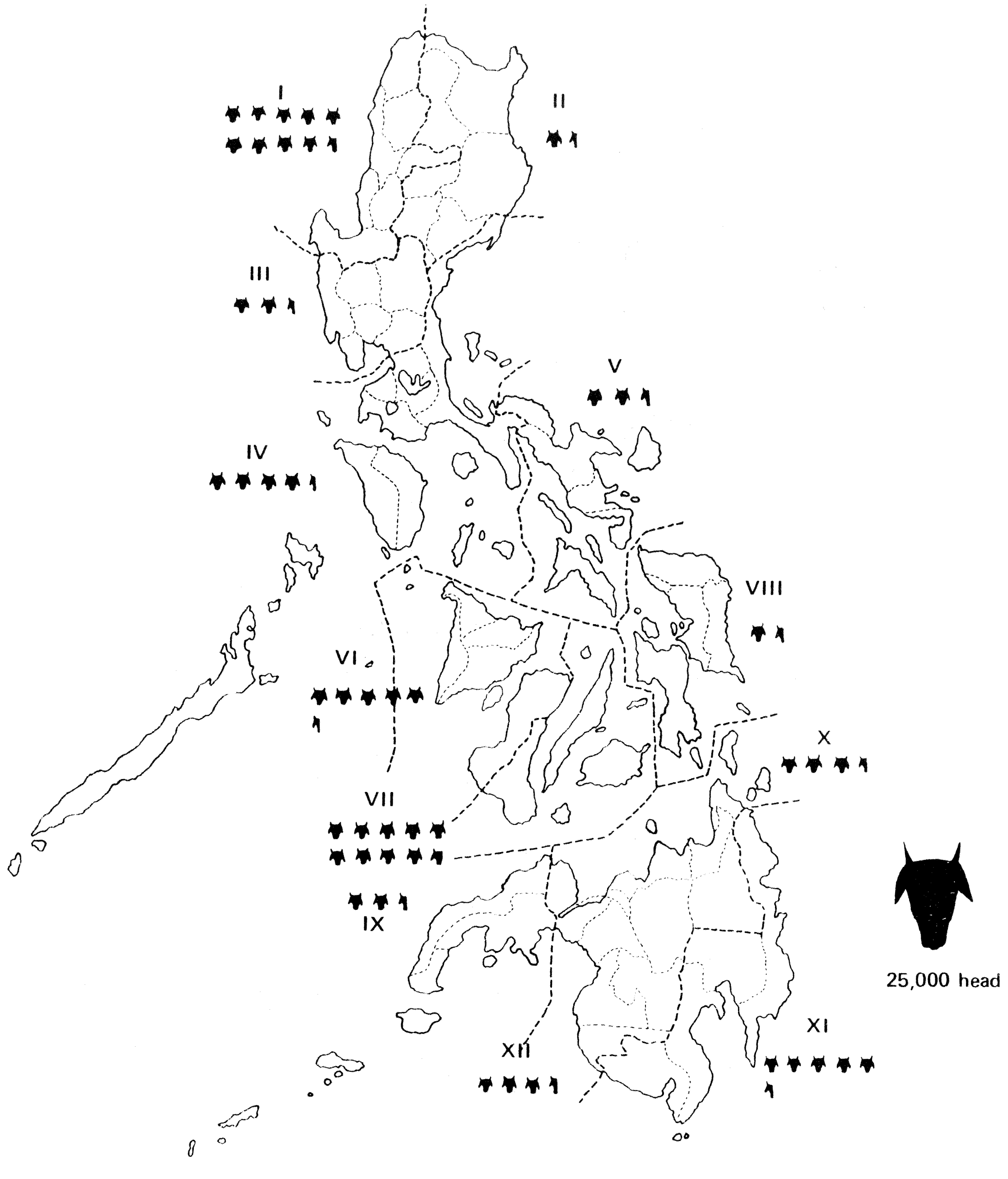

Fig. 4 - Regional distribution of goat population in the Philippines, 1978.

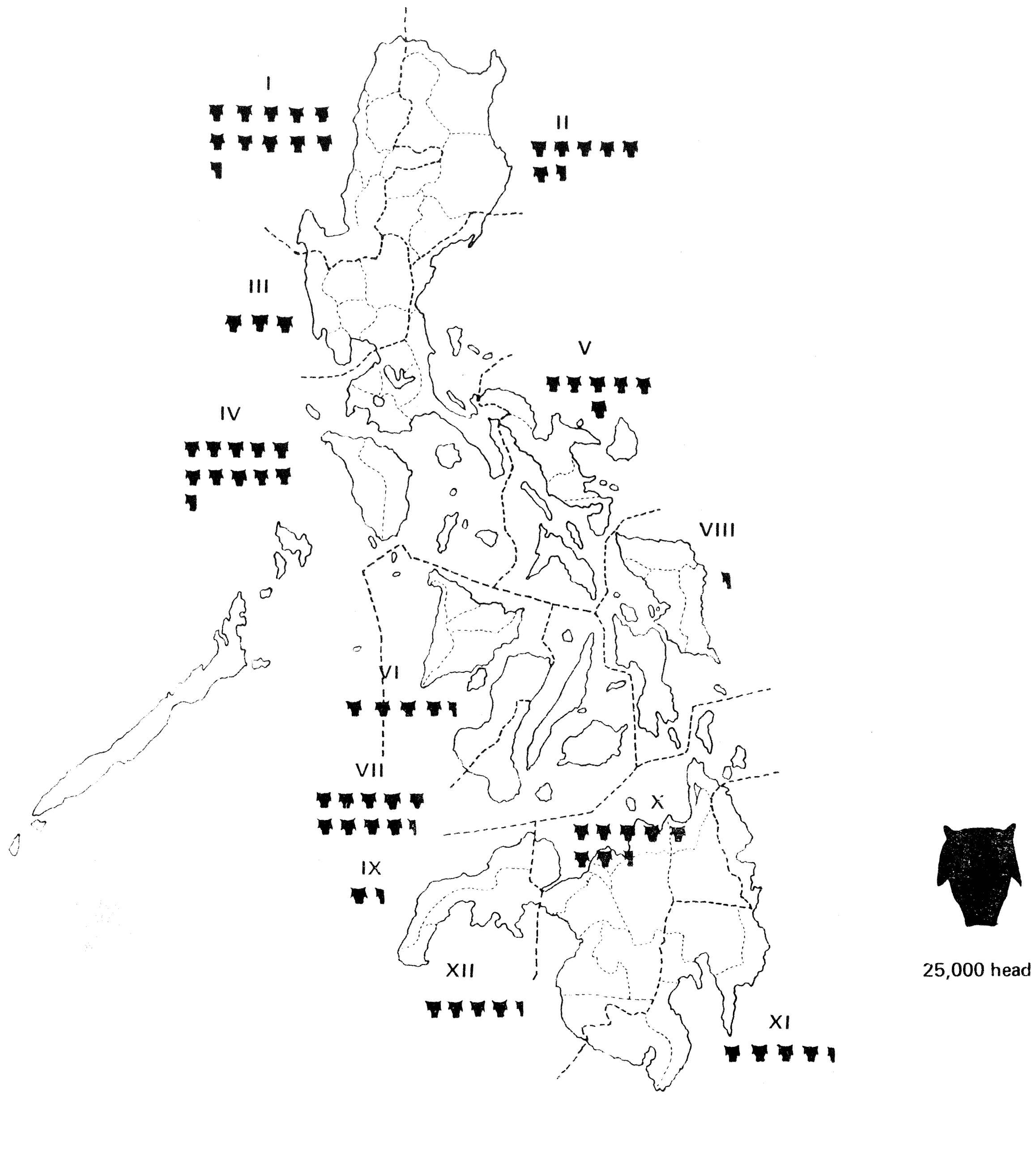

Fig. 5 - Regional distribution of cattle population in the Philippines, 1978.

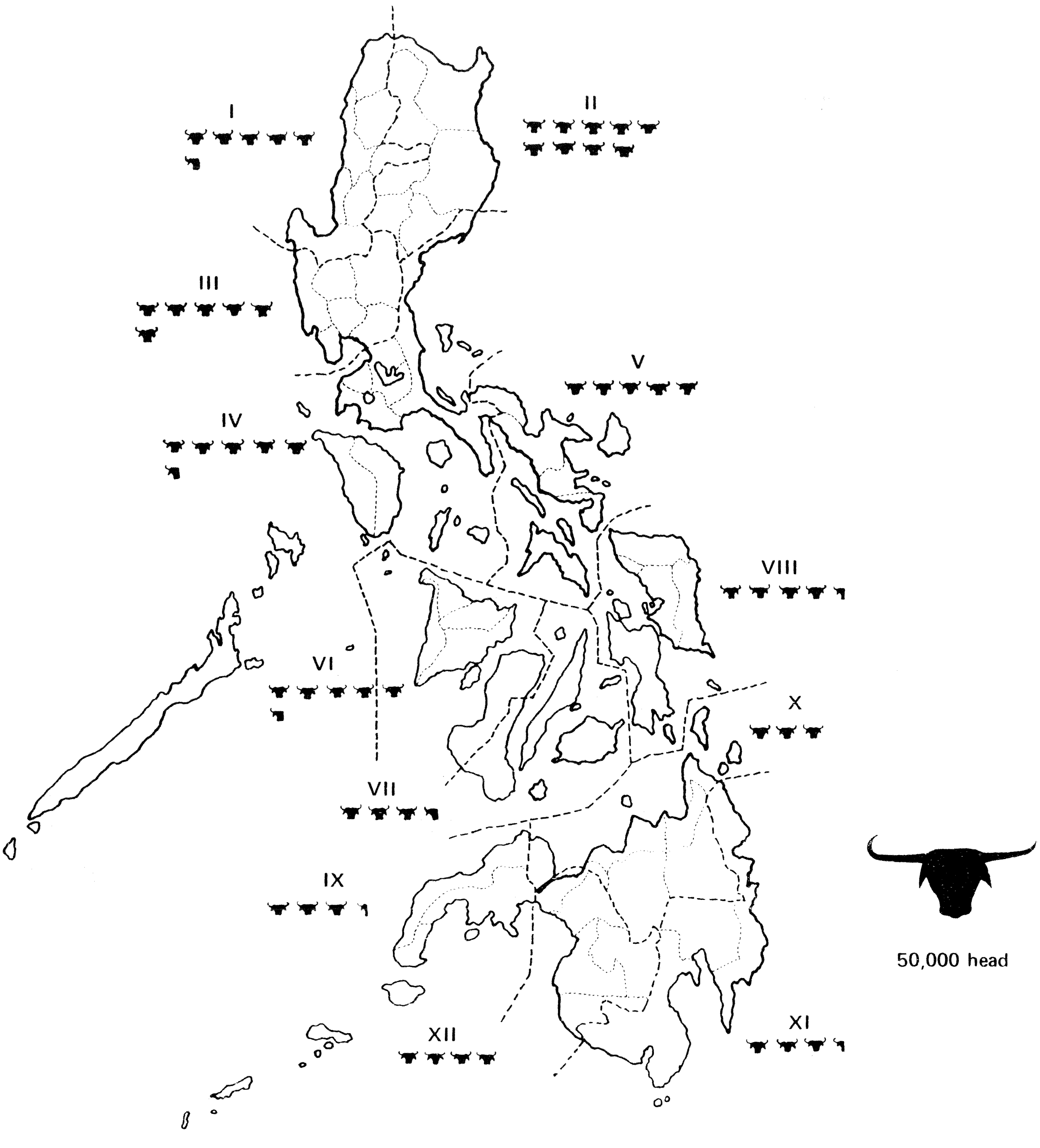

Fig. 6 - Regional distribution of carabao population in the Philippines, 1978.

Table 2. Some meteorological parameters in the Philippines (1950-1970)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
Rainfall (mm)	192.8	107.2	98.7	107.1	184.3	249.4	283.1	311.3	280.0	246.7	251.4	212.3	210.3
Temperature (^{o}C)	25.4	25.6	26.5	27.6	27.6	27.6	27.3	27.2	27.1	27.0	26.5	25.9	26.77
Relative humidity (%)	81.4	79.9	78.2	77.2	78.9	81.5	82.7	83.3	83.2	83.0	82.6	82.6	81.20
Wind velocity (kph)	6.4	9.7	6.4	6.4	6.4	4.8	6.4	6.4	4.8	6.4	6.4	6.4	6.4

Table 3. Numbers of actual arrivals, quota and certification for duty free importation of livestock and poultry breeding animals in 1978

	Chickens	Ducklings	Turkey	Swine	Cattle	Goats	Rabbits	No. ampoules semen	
								Cattle	Swine
Actual arrivals	588,749	3,541	2,152	1,669	160	623	32	4,400	336
Quota	700,000	30,000	2,000	2,000	2,000	1,500	1,500	15,000	
Certified	558,908		2,152	1,669	160	623	32	4,400	336

Source: Bureau of Animal Industry, Philippines.

There are nineteen commercial hatcheries operating with a total capacity estimated at 14 million eggs. These hatcheries have franchise arrangements with recognized poultry breeding establishments in the U.S., Canada and Europe, which altogether account for practically 100 percent of the commercial egg-type and broiler-type chicks raised in the Philippines today. Breeds used on commercial farms are all derived from imported parent and grandparent stock. More than half a million breeding chicks are imported annually (Table 3).

2. Cattle and carabao (buffalo)

Livestock production is generally low, particularly for beef, carabeef (buffalo meat) and milk and milk products. Thus, imports of beef and milk products have been substantial in quantity and value. Imports not withstanding, per capita consumption of beef/carabeef and milk lags behind recommended nutritional requirements.

Cattle production in the Philippines is carried out under three systems, namely:

(i) Extensive ranching is the pattern in the rolling and hilly country areas of Northern Luzon, Mindoro, Masbate and Mindanao. Ranching areas are generally leased from the government. The major grasses are predominantly Imperata cylindrica and Themeda triandra, with a carrying capacity of 1/4 to 1/2 animal unit per ha.

(ii) Grazing under coconuts has been generally related to the control of weeds and undergrowth, and is considered as a supplemental enterprise. Coconut areas are in general privately owned and frequently operated under the legal framework of a corporation.

(iii) Backyard cattle raising consists of breeding and/or fattening one or a few head of cattle or carabaos. Animals are fed primarily on crop residues, weeds, roadside grasses and some feedgrain substitutes available on the farm.

It is of interest to note that, of the total cattle population, about 73 percent are backyard raised, while only 27 percent are being reared in commercial farms throughout the country.

The annual growth rate of cattle population from 1977 to 1978 was a decrease of 0.8 percent.

On the other hand, about 98 percent of carabao production is in the hands of small or backyard producers, only 2 percent being contributed by medium and commercial farms. This is attributed to the fact that the carabao has always been associated with the peasant economy and considered as the small farmer's partner in his farming activities. Thus, of the total carabao population about 73 percent are used for farm work. In practice, the Philippine carabao is put to continuous work from the age of four to fifteen years or over, after which the animal is slaughtered for meat.

In the Philippines, carabao meat has been popularly known as "carabeef" and this farm animal has been the traditional meat resource. It is now increasingly being reared for meat production. Under good feeding and management, and when slaughtered at a comparable age with cattle (at two to three years of age), carabeef quality is hardly distinguishable from good beef.

In 1978, the estimated number of carabaos slaughtered in the Philippines was about 271,200 head, yielding 47,752 M.T. of carabeef. This constituted about 49 percent of total domestic beef produced. It is of serious concern, however, that while the annual extraction rate of carabao is about 9 percent, its population growth rate is only 1.3 percent.

Carabaos are also common sources of milk in the country. A caracow with a nursing calf can produce from 300 to 800 kg of milk during a lactation period of 180 to 300 days. In fact, carabaos constitute the bulk of the milking animals in the existing milk collecting schemes in the country today.

Carabao milk is rich in dry matter and butterfat. It contains 22.34 percent dry matter or total solids, 10.17 percent butterfat, 5.98 percent proteins, 4.93 percent lactose and 0.87 percent mineral matter.

Dairy farming is still a very minor sector of Philippine agriculture. The existing dairy production is mostly small scale, with only very few farms operating commercially. Thus, the over-all production of milk is negligible, being approximately four percent of total yearly requirement (Table 4). The balance is imported (Table 5). Thus, economic surveys conducted by the Special

Table 4. Local milk production (in M.T.)

Year	Production	Year	Production
1953	7,204	1964	8,128
1954	7,954	1965	8,229
1955	8,704	1966	8,998
1956	8,840	1967	9,000
1957	8,874	1968	9,400
1958	9,240	1969	10,000
1959	9,328	1970	25,254
1960	9,713	1971	26,094
1961	8,812	1972	27,132
1962	8,615	1973	28,768
1963	8,030	1974	33,874

Source: Food Balance Sheet, Philippine Statistical Reporter, National Economic and Development Authority.

Studies Division of the Ministry of Agriculture have shown that the weighted average consumption per capita per year of milk and milk products is 25.68 kg in milk equivalent (Table 6), which is only 78 percent of recommended intake of 32.85 kg by the Food and Nutrition Research Council (FNRC).

Table 5. Volume and liquid milk equivalent (in thousand metric tons) and value (CIF in Million US$) of milk and milk products importation, 1972-1976

	1972	1973	1974	1975	1976
Milk and cream fresh:					
Quantity	(1)	(1)	-	-	-
Liquid milk equivalent	-	-	-	-	-
Value	-	-	-	-	-
Milk and cream, condensed, evaporated or powdered:					
Quantity	70.55	56.28	65.97	49.56	73.36
Liquid milk equivalent	606.70	519.71	649.89	457.41	659.33
Value	37.97	39.43	66.35	54.17	52.10
Butter including anhydrous milkfat:					
Quantity	4.48	4.39	3.82	3.51	4.62
Liquid milk equivalent (2)	-	-	-	-	-
Value	4.94	5.08	5.79	5.26	6.06
Cheese and Curd:					
Quantity	2.99	3.14	3.98	2.63	2.78
Liquid milk equivalent	29.89	31.42	39.81	26.31	27.78
Value	2.10	2.75	4.56	3.69	3.54
Other Dairy products:					
Quantity	2.91	2.73	-	-	-
Liquid milk equivalent	7.58	7.09	-	-	-
Value	2.58	2.79	-	-	-
Total quantity	80.93	66.54	73.77	55.70	80.76
Liquid milk equivalent	644.17	558.22	689.70	483.72	687.11
Value	47.59	50.05	76.70	63.12	61.70

(1) Less than 10,000 kg. (2) Included in liquid milk equivalent of skim milk powder.

Table 6. Per capita consumption per year of milk and dairy products by income groups (in kg)(1)

Milk products	Per capita income: Less than ₱400	₱400-799	₱800-1,499	₱1,500 and over	Weighted Average Consumption(2)
Evaporated	1.36	2.99	5.47	8.08	3.97
Condensed	2.35	3.22	3.77	3.16	3.15
Powdered	0.12	0.27	0.69	1.59	0.59
Fresh	0.15	0.22	0.39	0.48	0.26
Others(3)	0.18	0.34	0.79	1.91	0.61
Total dairy products	4.16	7.05	11.11	15.22	8.58
Total in milk equivalent	11.17	19.16	32.64	52.67	25.68

(1) Per capita consumption per year was derived from the Income and Food Consumption Survey. (Summary of 15 Economic Surveys from August-September, 1972 to June 1, 1976), Special Studies Division, Department of Agriculture.

(2) Represents the weighted average of the four income groups.

(3) Includes cheese, butter, ice cream and margarine.

II. ANIMAL GENETIC RESOURCES

The pressing need for staple food as a result of the unprecedented increase in human population in the Philippines has led to a situation where most governmental efforts at agricultural development in the past have essentially been crop-oriented. Thus farm inputs, resources and services in the agriculture sector have always been geared in that direction. It is, therefore, a regrettable fact that very little attention had been given to the improvement of animal production and even less to the evaluation, conservation and effective utilization of the available animal genetic resources. Fortunately, the current five-year development plan of the government has now recognized and given support to the badly-needed development strategies for uplifting and modernizing the country's animal industry, consistent with programmed national development goals.

A. Poultry

In order of their importance, the poultry species that are found in the Philippines are chickens, ducks, quail, pigeons, turkeys and geese. Other species of poultry such as guinea fowl, pheasant, peafowl and ostrich have been introduced into the country at one time or another but have not been reproduced in any significant quantity to become permanently established.

Chickens, ducks, quail and pigeons are endemic in the Philippines. The other poultry species are exotic. The wild Philippine chicken or Red Jungle Fowl (*Gallus gallus*) is even believed to be the progenitor of the modern breeds of chickens (*Gallus domesticus*). Wild ducks, quails and pigeons are still visible in the forests, and fields in the countryside. However, it is not known whether present domesticated breeds of ducks (*Anas platyrhynchos*), quails (*Coturnix coturnix japonica*), and pigeons (*Columbia livia*) have originated from these wild endemic species.

1. Chickens

Originally, the chicken stocks in the Philippines consisted of domesticated Red Jungle fowls. As the early Chinese, Spanish and Dutch settlers and traders introduced Chinese and European stocks into the islands, they interbred among themselves and perhaps with the Red Jungle fowl. This indiscriminate interbreeding of the domesticated Red Jungle fowls with the various exotic breeds of chickens resulted in the present backyard fowls with various plumage patterns and physical characteristics, but unknown ancestry. They are commonly called "native" chickens.

Before World War II, and during the first half of the American regime, different breeds of chickens from America, China and Japan were introduced. Among these were the Rhode Island Red, New Hampshire and the White Leghorn. These Americans breeds were found to thrive and perform well in this country. The University of the Philippines College of Agriculture (UPCA) also imported the Cantonese breed from China and the Nagoya breed from Japan. These two Asiatic breeds were improved as a dual-purpose chicken. In spite of these importations, eggs and chicken meat were mostly derived from the so-called native backyard fowl. Very few raised purebreds on a commercial scale, simply because they were unable to compete with farmers raising native chickens with practically no invested capital. In the meantime, some enterprising farmers bought purebred cockerels and used them to upgrade the native birds.

The Second World War saw the poultry population drastically reduced to 7.5 million, or about only 30 percent of the population just before its outbreak. The few improved stocks such as the Los Baños Cantonese and Nagoya, and other purebred stocks raised by commercial producers, were practically wiped out.

Immediately after World War II, there was a great demand for poultry and eggs by the American soldiers, and the stocks were even further reduced as farmers needed cash very badly. Although commercial poultry raising was already then recognized as a very lucrative business, there was a dearth of foundation stocks. To alleviate the situation purebred stocks were imported from the United States and other countries. For this purpose, the government made available ₱1,000,000 for the purchase and production of breeding animals. In the latter part of 1946, the Philippine government negotiated the importation of 100,000 baby chicks at the cost of ₱2.00 per chick. These were distributed to government stock farms, agricultural schools and the Sta. Maria Poultry Cooperative Association. While the government practically stopped importation after 1946, private parties continued importing until 1950, mostly purebred White Leghorn stocks and some dual-purpose breeds such as the New Hampshire, Rhode Island Red and Barred Plymouth Rock.

Under the FOA-PHILCUSA (Foreign Operations Administration-Philippine Committee on U.S. Aid) program, a total of 5,334 White Leghorns and 5,355 New Hampshire chicks were distributed to government stock farms and various agricultural schools. Later in the same year, 4,840 White Leghorn and 4,370 New Hampshire chicks were again distributed to various provincial nurseries throughout the Philippines and all rural and agricultural schools.

In the meantime, research and development in the United States had produced significant breakthroughs in poultry breeding and genetics. It was shown that crossing of different breeds and inbred lines of chickens resulted in increased production in eggs and meat. American breeders then quickly developed hybrid strains that were bred especially for egg and meat production. The egg-type hybrids were basically derived from the White Leghorn breed; the broiler-type hybrids, from the meat-type Cornish breed and several dual purpose breeds.

The early 1960's marked the beginning of the establishment of franchised hatcheries in the Philippines. Franchised hatcheries have exclusive rights to buy male and female parent stocks from foreign breeder farms and produce and hatch the hybrid commercial chicks locally. Since the genetic quality of the male and female parent stocks could not be duplicated locally, regular importations continue (Table 7).

Table 7. Importation of parent stock of egg type and meat type breeder chicks (females)

	Year	Parent stock	Increase
Egg type	1973-74	116,244	
	1974-75	394,824	240%
Meat type	1973-74	1,214,991	
	1974-75	1,258,996	3.6%

Source: Department of Economic Research, Central Bank of the Philippines.

The advent of the commercial use of hybrid stocks for egg or broiler production has practically wiped out the breeding and production of purebred chicken stocks such as the White Leghorns, the New Hampshires, Rhode Island Reds, Cornish and Plymouth Rocks, which used to be produced in large quantities for commercial production of eggs and meat. On the other hand, the ubiquitous grade and mongrel backyard chickens have persisted in the rural areas and have continued to exist on practically self-supporting basis.

It appears that no deliberate attempt was ever made to maintain a germplasm resource for chickens in the Philippines. Instead, the poultry industry was made to depend entirely on the genetic development in foreign countries. This trend has been true in other poultry species such as ducks, quails and turkeys.

2. Ducks

Today, while duck producers are still raising the native Pateros mallard ducks for eggs, new egg-type breeds such as the Khaki Campbell and Indian Runner have been introduced, mainly to up-grade the native ducks. Muscovy ducks, which do not interbreed with the mallard, were introduced into the Philippines from South America, and are widely distributed throughout the country, but raised only in the backyard both for meat and eggs. In the early sixties the U.P. College of Agriculture imported Pekin ducks from the United States and has since distributed them in limited numbers to various private raisers. Recently, the growing demand for duck meat has encouraged raisers to import several varieties of Pekin ducks from Europe, United States and Australia. There are now about ten or so commercial raisers of Pekin ducks close the Metro Manila area.

3. Quail

Imported varieties of quail such as Japanese Seattle, Negro and Silver, which exhibit different plumage patterns, are already raised in commercial quantities by several producers, for both eggs and meat.

4. Turkeys

Limited numbers of Broad-breasted White and Bronze turkey breeds from the United States have also been periodically imported by private producers in the Philippines, primarily to supply the needs of foreign tourists and Americans in the country.

B. Swine

Domestic swine come under the zoological name Sus domesticus Gray. Breeds of Asia are presumed to be descendants of the Collared Malayan pig Sus vittanus Muller and Schlegal. These pigs are small, refined and fine-haired. Philippine swine may have come from wild species namely, Sus celebensis philippensis Nehring in Luzon, Sus celebensis mindanensis Major of Mindanao, Sus celebensis negrinus Sanborn of Negros Island and Sus barbatus ahoenobarbus Huet of Palawan.

Hogs in the Philippines might have been brought in by the early Chinese traders, and during the Spanish colonization by the Spaniards from Mexico. It is also believed that some enterprising Filipinos might have domesticated hogs from the wild type, which are small but prolific and well adapted to local conditions.

During the early American Regime in the Philippines, improvement of the local stock was initiated. From 1903 to 1905 the Bureau of Agriculture imported Berkshire boars from the United States. Subsequent importations were then made, consisting of Black and Spotted Poland China, Duroc Jersey, Hampshire, Berkshire and Chester White. The Chester White was found to be not well adapted to local conditions.

In 1916 the Berkjala breed, developed from crossing the Berkshire and the indigenous Jalajala breed, was developed at the U.P. College of Agriculture. It is a medium size meat-type hog and solid black in color. The sow is prolific and a good nursing mother.

During the Second World War, the hog industry was totally neglected and the country's hog population of 4.4 million head was reduced by 75 percent. The reduction included slaughter of selected stocks of Berkjala intended for propagation purposes. Attempts to propagate the few remaining Berkjala seedstock in the late 50's were abandoned because the animals no longer possessed the standards of the prewar Berkjala breed.

Immediately after liberation (from 1945 to 1950) a total of 1,534 head of hogs consisting of Berkshire, Poland China, Duroc Jersey and Hampshire were imported by the government from the United States. Also in 1952, 654 Berkshire boars and 98 Berkshire sows were imported from Australia and Japan. These hogs were distributed to different government breeding stations/centers, agricultural schools, private farms and 4-H clubs, mainly to upgrade the native hogs in order to improve their size and feed efficiency.

The introduction of these standard breeds greatly influenced the development of the existing stock of hogs raised in the Philippines. At present, the Philippine swine raised in backyards consist of several strains which are widely distributed in the country.

There are four common strains of swine in the Philippines, the "Kaman" and "Koronadal" hogs which are red, and the "Diani" and "Ilocos" strains which are black. The "Kaman" is common in the province of Batangas and the "Koronadal" in the province of Cotabato. The "Kaman" is an upgraded native pig with Duroc Jersey blood. The "Koronadal" pig is an amalgamation of Berkjala, Poland China and Duroc Jersey and is red with dark spots all over its body. The black strains of hogs in the Philippines have either the Berkshire or Poland China blood.

The first importation of European swine into the Philippines was in 1957, by a private buyer. Since then, other private individuals have brought to the Philippines the European Landrace breed, with Norwegian and Swedish Landrace blood. Other standard breeds introduced into the country were Tamworth, Yorkshire, Minnesota No. 1, Saddleback, and lately, the Hypor. These breeds were either European or American breeds.

The mid 1960's marked the beginning of the establishment of integrated commercial piggeries in the Philippines. Dominantly, these commercial raisers are using purebreds or crosses of the following: Yorkshire, Landrace, Duroc, Hampshire and Hypor.

In late 1960's, an attempt was made by the National Science Development Board (NSDB) and the U.P. College of Agriculture at Los Baños (UPLB-CA) to develop a breed of swine highly suited to Philippine conditions. The bloodlines used were Large White (Yorkshire), Landrace and Philippine native pig. The offspring are presently under field testing for production performance.

At present, no attempt has ever been made to maintain a germplasm resource for swine in the Philippines. The swine industry entirely depends on the genetic development in other countries. The primary reason for this is the lack of financial resources to establish a Center for the maintenance of swine germplasm.

C. Goats

Some data on production performance of purebred and crossbred goats is given in Table 8.

Table 8. Production performance of goats on the Selecta Farms, Novaliches, Quezon City, Philippines

	Breed	
	American Nubian	Anglo-Nubian
Purebreds		
Birthweight	3.2-3.5	2.9-3.5
Weight (kg) at:		
1st month	10	10
7-7.5 months	-	26-28
1 year old	60	-
Milk production*	3.5	3.2-3.5
Lactation period	120	120-150
Grades	Saanen x Native	Toggenburg x Native
Birthweight	2.6-2.7	2.3-2.8
Weight (kg) at :		
3rd month	22	-
7th month	36	32
Milk production*	2.5-2.8	1.5-2.3
Lactation	120	120

* Twice a day milking. Cost at farm gate is ₱6.00/lit.

D. Beef cattle

Numerous breeds of beef cattle have been introduced to the Philippines, and these have had a remarkable influence on our cattle. From 1950 to 1967 alone, about 18 breeds of cattle, totalling 8,336 animals, were introduced. It is therefore difficult to distinguish the indigenous types from the crossbreds. The most prominent type of local cattle is the Batangas, believed to be of the *Bos brachyceros* type and originally introduced from the Chinese mainland. The type is closely related to the yellow cattle of China. It is also possible that there are some strains of Zebu in these cattle, since Zebu and crossbred Zebus are found in Southern China; hence some of our indigenous types are humped, especially the male.

There are four distinct types of local cattle recognized in the Philippines, namely, the Batangas, the large-type Ilocos, the small type Ilocos and the Iloilo.

These cattle are widely used and are the major source of beef and/or draft power on the farms. Due to their adaptability and maternal characteristics, several breeding schemes were established to upgrade these cattle. Santa Gertrudis, Hereford, and Brahman breeds are the common exotic breeds used. Results have indicated improved performance relative to the predominant local cattle.

E. Buffalo

The breeds of domestic water buffalo Bubalus bubalis Linn. found in the Philippines are the swamp type, or carabao, and the river type or Indian buffaloes, mostly of the Murrah breed (Table 9).

Table 9. Production performance of the Carabao and Murrah buffalo in the Philippines

Parameters	Philippine Carabao	Murrah Buffalo(1)
Liveweight at various ages (kg)		
At birth	32	35
At 6 months	93	135
At 12 months	133	193
At 24 months	272	306
At 36 months	367	382
Average milk production (kg)	500	1,384
Average lactation period (days)	250	287

(1) Based on performance of CLSU herd of Murrah buffaloes.

The Philippine carabao, a term evolved from the Malay word "Kerbau", as the water buffalo of Malaysia is known, possesses a body that is robust and muscular and better suited for draft and meat purposes than for milk production. The mature male weighs from 425 to 500 kg, while the female ranges from 400 to 425 kg. It is smaller than either the imported Cambodian carabaos or the Indian Murrah buffaloes. The height of the male carabao at the withers is from 127 to 137 cm; for the female, 124 to 129 cm.

The average age of puberty in a carabao is 2 years and 154 days, in the purebred Murrah buffalo 2.5 to 3.5 years (depending on feeding and management) and in the Murrah carabao grade, 2 years and 114 days. The duration of the oestrous cycle in the Philippine carabao ranges from 27 to 46 days with an average of 33.6 days. Among the crossbreds the range is from 20 to 39 days, with a mean of 31.3 days.

In general the Philippine carabao is a poor milker. However, the crossbreeding of Indian Murrah buffalo with Philippine carabao produces crossbreds which are superior for both milk and for work purposes. The crossbreds are larger than the Philippine carabao and are willing and diligent draft animals. They produce from 866 to 1,067 kg of milk per lactation period of 294 to 578 days.

There have been cases where the Indian buffalo and Philippine carabao did not interbreed. This occurs when they are kept in separate herds. Assimilation between the two breeds is necessary and it can be accomplished by associating them from calfhood to maturity. Philippine caracows can also be inseminated artificially with semen from Indian buffalo bulls. Results of recent studies indicate that oestrus and ovulation can be synchronized in the carabao, using prostaglandin F_2-alpha.

A wild type of buffalo known as the tamaraw is indigenous only to the island of Mindoro and is also called the Mindoro buffalo. In many ways it is intermediate between the anoa (Bubalus depressiocornis) found in Indonesia and the Indian wild buffalo, the arni (Bubalus arnee Kerr) and, hence, classified as a separate species Bubalus mindorensis Heude.

The tamaraw is a small animal, 100-120 cm high at the withers, grey-black or dark brown in color with white marks on the head, neck and legs.

The mating season of the tamaraw is from April to July. After the mating period they go in small herds of up to 11 head, herded by a male. In their natural environment the life span is about 20 years, but this may be reduced to 3-5 years in captivity, depending on management.

The tamaraw is one of the rarest mammal species in the world and its numbers are fast dwindling, partly through uncontrolled hunting. The Government has taken measures for its conservation, but the animal is now so rare that, if it is to survive at all, it must receive more effective protection.

III. SOME MAJOR RESEARCH AND DEVELOPMENT PROJECTS

The national research program in livestock addresses itself to supporting and effectively developing the animal industry in the country in order to: (i) attain ultimate self-sufficiency in animal protein foods such as meat, milk and eggs for proper nutrition, especially for the vulnerable sector of the human population; (ii) improve production efficiency in order to bring the cost of meat, milk and eggs well down within the buying capacity of the low income group; (iii) increase farm family income through the raising of livestock and poultry, and also increase the supply of animals for farm work and transport. In the light of these objectives, some of the major research and development projects geared to the efficient utilization of the appropriate animal resources and relevant to current national development programs are as follows:

A. Chickens

Genetic development of high performance Philippine commercial broiler chicken as an aim. The University of the Philippines College of Agriculture-Department of Animal Science (UPLB-CA/DAS) is the proponent agency with fund support from the National Science Development Board (NSDB).

The breeding plan aims to develop two genetic products. One is a commercial hybrid between male and female parent lines, and another is a meat strain that would breed true to type and perform well under conditions prevailing in the rural areas.

The breeding scheme of the project involves three phases. In the first phase performance tests of existing broiler strains were made. Stocks that showed superior performance were selected and used as seedstocks for the breeding of two female lines. In the second phase, two selected commercial hybrid seedstocks were bred to relatively high egg-producing breeds such as the Leghorns and the New Hampshires. Meanwhile two male lines also were being developed by up-grading a commercial broiler stock with a meat-type stock. This up-graded stock was further improved by individual selection for eight-week body weight. At present, only two generations of inter se mating coupled with selection have been made on the various experimental lines. The third phase involves a program of test-crossing between male and female lines. So far only one test-cross has been made. Results of performance tests showed that:

(i) the quality and performance of the various imported stocks vary from one period to another and from one system of management to another.

(ii) the prices of day-old chicks are not directly related to their performance.

(iii) among the broiler characteristics, rate of growth is the one most highly correlated to profitability.

In the development of the parent lines, the following results were observed:

(i) Inter se mating of selected individuals from commercial hybrid stocks resulted in wide segregation of colour and reduction of body weight and low egg production in the progeny generation in spite of selection.

(ii) Egg production in the inter se mated hybrids was increased by crossing with either Hampshire or Leghorn breeds.

(iii) The application of continuous up-grading of segregating hybrid stock to an imported exclusive male line could improve rate of growth.

At present the project is maintaining two experimental female lines and two experimental male lines. So far only a few generations of inter se mating and selection have been made and they are still admittedly unstable. They have not as yet been subjected to recurrent selection for combining ability. An initial test cross between the male and female lines still produced slightly inferior progeny as compared with the imported stocks.

At this stage, however, the project has been able to develop one relatively stable meat strain of chickens which has shown a relatively fast rate of growth and resistance to disease. It can tolerate low quality feed and appears resistant to adverse environmental conditions. It is superior to the standard meat type Cornish breed in terms of rate of growth and egg production.

The plan of activities for the next two or three years is:

(i) Test-crossing and recurrent selection with the various experimental lines thus far established.

(ii) Field testing of the various experimental lines under commercial and backyard conditions.

(iii) Field production test of the experimental meat strain under countryside backyard conditions.

B. Beef cattle

Beef cattle breeding and management studies are in progress in South Cotabato. The proponent agency is UPLB-CA Department of Animal Science with fund support from the Philippine Council for Agriculture and Resources Research.

Three separate projects were integrated, with the general objective of understanding some of the more intricate and sensitive aspects of beef cattle breeding and management. The program was directed towards increased calf crop, feed efficiency and rate of gain. The crossbreeding program was designed to determine the performance of the crossbreds and combining abilities of ten exotic cattle breeds. In addition, synchronization of oestrus and ovulation was effected in cattle to determine and develop a subsequent high degree of conception among the hormonally tested cows when bred. Furthermore, the effects of nutritional supplementation on the reproductive performance of beef cattle and growth of young animals at some stage of their growth process were studied.

Based on the results, a well organized and permanent breeding program for the improved performance of Philippine cattle can be developed. Crossbreds suitable for our beef cattle production can be identified, to include adaptive characteristics under the prevailing environment, and tests of performance. Accordingly, information on practical and economical feeding and management practices can be provided.

Weight records collected from 188 crossbred calves over a period of two years at the ANSA beef cattle ranch at T'boli, South Cotabato, were used to evaluate the performance of the progeny and relative worth of different exotic breeds. The calves were produced from high grade American Brahman cows bred artifically with frozen semen of exotic beef cattle breeds (Table 10).

Table 10. Average birthweight and weaning weight of crossbreds

Sire breed	Average birth weight (kg)	Average weaning weight at 210 days of age (kg)
Chianina	32.2	180.7
Simmental	30.6	187.3
Charolais	30.2	176.3
Holstein	29.4	167.6
Beefalo	29.0	173.3
Limousin	29.1	175.2
Maine Anjou	31.0	181.7
Brahman	29.4	153.5

Source: PARRS Project No. 390. "Beef Cattle Management Studies in South Cotabato".

The highest mean birthweight was observed in female and male calves out of Marchigiana sires, 35.9 and 32.8 kg respectively and the lowest was observed in Holstein and Brahman female crossbred calves (28.7 kg). The overall advantage of the male over female calves was only 0.2 kg.

Results for 210 day weaning weight indicated calves produced from Brahman sires were the lightest (153.5 kg for both sexes), almost 20 kg below the average for all crossbred calves. Calves out of the Simmental sires were the heaviest, 194.5 kg for male and 180 kg for female calves. The Chianina and Maine Anjou crossbreds were almost equal in weaning weight.

At 365 days of age, the Simmental crossbreds were the heaviest, with 268.9 kg and the Limousin female crossbreds the lightest, at 188.7 kg.

Based on the performance of the crossbreds, the Simmental, Chianina, Maine Anjou and Marchigiana are the probable exotic breeds that can be used in a single- or two-breed rotational crossbreeding program.

Normally cycling cows treated with cloprosterol (Estrumate) had a higher heat occurrence percentage with a shorter induction period than those cows treated with prostaglandin (PGF_2 alpha). The conception rate was also highest (80 percent) in the Estrumate treated cows, followed by the prostaglandin group (73 percent), the control having the lowest rate (62 percent). Cows injected with Estrumate on a six hours predicted ovulation had a higher percentage of heat occurrence than the 12, 18 or 24 hours ovulation groups. However, only 62.5 percent conceived as compared with 75 percent for the 18 hours predicted ovulation group. Estrumate seems to be more effective than prostaglandin for synchronization of oestrus and ovulation.

Weanlings given trace minerals and energy feeds gave better weight gains than those fed mainly with forage. After a six-month feeding trial, the average daily gain for weanlings mainly on forage feed, without energy or trace mineral supplementation, was 0.37 kg, compared with 0.47 kg for those with energy feed and 0.52 kg for those given energy and trace minerals.

The results indicated that the response to supplemental feeding was higher for the first four months after weaning, and that there existed a complementary effect between energy and trace minerals supplementation and liveweight gains of weanling calves.

The two-year results of the program identified the exotic breeds that can be used in a systematic crossbreeding program to produce heavier calves at weaning. To prevent any loss of weight, weanlings should be fed for four months with energy and trace minerals supplementation to produce heavier calves at one year of age.

Cows can be synchronized to come in heat using Estrumate and bred on an 18 hours predicted ovulation. The period of calving interval can be reduced and an increased calving rate can be expected.

C. Carabao

1. Reproduction

Factors affecting reproduction in caracows are under investigation. The proponent agencies are UPLB-CA Department of Animal Science and Central Luzon State University (CLSU), with fund support from PCARR.

The project is designed primarily to establish the behavioural patterns of the caracow in relation to breeding and reproductive physiological norms under field conditions and to evolve a management system which will obviate altogether the need for oestrous detection by synchronizing ovulation and inseminating at a predetermined time.

Data on oestrous cycle length, duration of oestrous and time of ovulation were obtained on 40 caracows manifesting natural heat and on 67 whose heat period was induced through the administration of PGF_2 (Prostaglandin). The average heat durations were 23.8 and 26 hours in caracows manifesting natural heat and induced heat, respectively. The average heat cycle was 27.86 days. Ovulation on induced oestrous started 19 hours after the cessation of heat compared to 7.17 hours on natural heat.

Optimal time of artificially inseminating caracows (Table 11) appears to be between 3 and 18 hours from the onset of heat where an average conception rate of 67 percent was recorded when refrigerated semen was used. Conception rate when frozen semen was used was 58 percent.

Table 11. Optimal time of artificially inseminating the female Caracow using refrigerated and frozen semen

Hours from onset of heat	Number of Caracows bred	Pregnancy Status			
		Pregnant	Open	Not Palpated	Percent Conception
Refrigerated semen					
3-10	31	12	5	14	70
11-18	15	8	2	5	80
19-25	8	1	3	4	33
Total	54	21	10	23	Ave. 67
Frozen semen					
3-10	22	12	8	2	60
11-18	14	6	4	4	60
19-25	26	10	8	8	55
Total	62	28	20	14	Ave. 58

Source: PARRS Project No. 354. "Some Factors Affecting Reproduction in Caracows."

With respect to the morphological, histological and histochemical characteristics of the caracow's reproductive organs, slide section preparations have been done but the interpretation of them is still in progress.

2. Philippine Carabao Research and Development Center

This is being strengthened in a proposed five-year project of the Government of the Philippines with UNDP/FAO assistance. The project is currently being evaluated and negotiations for its implementation are in progress.

The over-all objective of the project is to strengthen the main research station at two sites: UPLB-CA/DAS for small scale carabao production, integrated with the dominant farming system of small farmers, and CLSU for ranch type or commercial carabao production. The latter is under agri-silviculture schemes of pasture management on hilly land, in order to exploit fully the utility of this animal resource for draft-meat-milk production through strongly coordinated and sustained research and development and technology packaging/dissemination-training activities. It is expected that by the end of the project period the Center will be sufficiently developed, having adequate research and training facilities, competent and qualified core buffalo research staff as well as extension workers and farmer cooperators, a greater number of improved breeding stock of carabaos, and estimates of basic production parameters. The latter will provide a basis for developing further the efficiency of the carabao as a producer of human food and a source of farm power - an essential ingredient for improving the quality of life among the rural people.

IV. FUTURE PROSPECT

The national livestock research program in the Philippines is industry-problem oriented, and development targets for each commodity industry are well defined. Moreover, priority research areas for each animal commodity resource consistent with these development targets are well established and updated periodically. A built-in mechanism for the effective coordination, evaluation and monitoring of research and development activities in livestock and poultry, including close linkages among concerned government and private agencies, is strongly organized and managed through the Livestock Research Division of the Philippine Council for Agriculture and Resources Research. It is therefore anticipated that the production technology for each animal commodity resource resulting from the various on-going research projects/studies in poultry, pork, beef, carabeef, dairy and forage/pasture commodities will ultimately be field tested, verified and packaged for dissemination and utilization by the farmer/producers. With trained and closely supervised support services to assist livestock farmers (especially those on small scale) in the areas of feeding and management, animal health, credit and marketing, there is no doubt that development of the animal genetic resources in the Philippines appears to be promising and bright for an improved and efficient animal industry.

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Discussion

Rendel: With regard to crossbreeding of carabao and Murrah buffalo, I believe you have used some frozen semen from Karnal, India. As the use of frozen semen in buffalo breeding is rather recent, could you give some details of the results?

Eusebio: Only a limited amount of frozen semen from India was used, but the conception rate was only about 10%. We had some problem here because with local frozen semen, the conception rate was 58% (see Table 11).

Watanabe: Do you have data on the milking performance of the F_1 of Murrah x Carabao?

Eusebio: Data for the parent breeds under Philippine conditions are given in Table 9. The F_1 crossbred is more or less intermediate with a yield ranging from 700 to 1000 kg milk, and a lactation period of about 260 days.

Hardjosubroto: Where beef cattle are run in coconut plantations, is the production of coconuts affected?

Eusebio: No adverse effects on coconut production are found, provided proper cultural practices are observed in the management of the forage grown for grazing.

Barker: I would like to raise an issue that I believe is most important to our discussions, and one that relates not just to Dr. Eusebio's paper, but to most countries of the SABRAO region.

The emphasis on productivity - particularly in pigs and poultry - has been largely on that of the imported strains and breeds. However, Dr. Eusebio noted the high proportion of total human food requirements produced by native strains.

Because these native strains are adapted to village or small farmer conditions, surely they deserve much more attention, not only as a genetic resource, but also in terms of development and genetic improvement of their populations.

They provide an important source of livelihood or income to the small farmer and are likely to continue to do so for a long time.

ANIMAL GENETIC RESOURCES IN TAIWAN

Robert Chueng-Shyang Ma

I. INTRODUCTION

A. Imports

The first report on animal genetic resources in Chinese literature was written by Mr. Chen Te, a government official of the Ming Dynasty, in 1603. Mr. Chen Te wrote the report entitled Tung-Van-Ke ( ), meaning "A Narration On An Eastern Undeveloped Area", after he made the first official tour of inspection of Taiwan. He stated: there are cats, dogs, hogs and chickens, but no horses, asses, cattle, sheep, goats, geese or ducks in Taiwan. Accordingly, most of the present-day animals may have been introduced into Taiwan from mainland China and other places after 1603. The modern overseas breeds of cattle, swine, goats, sheep and poultry were introduced chiefly from U.S.A., Australia, New Zealand and Europe during the last 30 years, and they have been generally treated as follows after their introduction:

(i) They are first evaluated for their adaptability to the climate of Taiwan, with observations on heat tolerance, reproduction, growth, productivity, etc.

(ii) They are propagated by pure breeding when they are found to be adaptable to the local climate.

(iii) In order to take good advantage of heterosis, breed crosses may be carried out for commercial use.

B. Present species and breeds

Today's livestock species and breeds in Taiwan and their uses may be summarized as follows:

1. Cattle

(i) Beef production: Aberdeen-Angus, Charolais, Hereford, Santa Gertrudis and Simmental.

(ii) Milk production: Holstein, Australian Illawarra Shorthorn, Jersey and Red Sindhi.

(iii) Work: Chinese Yellow cattle and Kankrej.

Among them, Red Sindhi and Kankrej are *Bos indicus*. Chinese Yellow cattle and Santa Gertrudis contain the blood of both *Bos indicus* and *Bos taurus*, while all others are *Bos taurus*.

2. Water buffaloes (*Bubalus bubalis*)

Chinese water buffalo and Murrah.

3. Swine

(i) Native hogs: According to Chang (1952a), native hogs were classified into six breeds. Among them, Taoyuan, Meinung, Ting-Shuang-Hsi, Small long-snout, and Large Long-snout were introduced from mainland China, while the Aboriginal is considered an indigenous breed. The Taoyuan was the most popular and important breed, Taoyuan females being used as the base population to cross with Berkshire males for producing meat hogs. Since the large scale introduction of modern overseas breeds during the last two decades, it is very hard at the present time to find pure native hogs, except a very few Taoyuans in research institutes for conservation, and some Aboriginals in the off-shore islands.

(ii) Modern overseas breeds: From 1959 on, a number of modern overseas breeds, including Berkshire, Duroc, Landrace, Hampshire, Yorkshire, Minnesota No. 2, Pietrain and the Spotted have been imported from the U.S.A., West Europe and Japan. After detailed experiments, it has been found that Landrace, Yorkshire and Duroc are the most favorable breeds for producing three-way crosses for meat production. However, Hampshire and the Spotted are the most acceptable breeds to farmers because of their black hair.

Naturally, all breeds of hogs belong to Sus domesticus. The Aboriginal, however, is considered to be descended from a mixture of domestic pigs introduced by immigrants from the southern part of mainland China and indigenous pigs (the local wild Sus scrofa taivanus), domesticated by the Taiwanese aborigines.

4. Sheep (Ovis aries)

During the period from 1961 to 1975, Cheviot, Corriedale, Dorset, Lincoln, Romney and Southdown were sporadically imported to evaluate their adaptability to the hillside climate or the environment of the tidal land along the west coast of Taiwan. Consequently, the number of sheep is small, and all are kept in experimental stations, either provincial or belonging to the Taiwan Sugar Corporation (TSC).

A small flock of a meat breed, the Barbados Blackbelly (2 rams and 3 ewes) was donated by the President of Barbados and arrived in Taiwan on May 18, 1975. All are now kept at the Heng-Chun Branch Station, Taiwan Livestock Research Institute (TLRI), for evaluating their adaptability to the local climatic conditions.

5. Goats

The native goat (Capra hircus) is used for meat production. Introduced breeds (Saanen, Alpine and Nubian) are used for milk production, but their number is very limited.

6. Horses (Equus caballus)

They are used for recreation only. A few of them are Arabians, while all the others are descendants from the crossing of horses used in the Chinese and Japanese armies during World War II. Accordingly, they do not have any breed characteristics. Their number is very limited and the population is concentrated in a few areas such as in Taipei, Tainan, Taichung and Kaohsiung.

7. Deer

There are three indigenous species in Taiwan. Taiwan Shui-Lok (Cervus swinhoii) and Mei-Hua-Lok (Cervus taivanus) have been domesticated, harvesting velvet antler being the main purpose. Cervulus reevesi (Kiang) has not been domesticated and is nearly extinct, though its meat is very tasty. Recently Red deer have been imported from Oceania, but the number is very small.

8. Poultry

(i) Chicken (Gallus domesticus): Native chickens are still scattered all over the island. Modern strains of higher productivity have been introduced under different commercial names for either egg or broiler production and their population is almost three times as high as that of the native chickens. These modern strains are:

(a) Egg production: Arbor Acres, Colonial, Dekalb, Hubbard, Hyline and Iso Brown from the U.S.A., Babcock, H & N, Noline-101, Nishline, and Hyline from Japan; ISA from England; Harco from France; Hisex from Holland; Shaver from Canada; and Hyline from Australia. Among them, Shaver is the most popular, followed by Hisex and Babcock.

(b) Broiler production: Arbor Acres, Cobb, H & N, Harmen, Hubbard, Indian River, Jersey Giant, Mason, Parks, R.I.P., Red Cornish and Tatum from the U.S.A.; Anak and Kabir from Israel; Anderson, Convior Du Pin and S. P. from France; Neva, Hybro, and Hypeco from Holland; ENYA, H & N, Ishii, Led Breast, Pilch, and Studler from Japan; Tegel from Australia; Gambler from South Africa; Lohman from West Germany; Marshell and Ross-1 from England; and Shaver from Canada. Among them, Hubbard is the most popular, followed by Hybro and Shaver.

(ii) Common ducks (Anas platyrhynchos):

(a) Egg production: The domestic duck (Anas platyrhynchos var. domesticus) is the most important. The original domestic duck was brought in by immigrants from mainland China. The population of the Khaki Campbell and the Australia duck is nominal.

(b) Meat production: The Pekin duck was first introduced into Taiwan from U.S.A. in 1950. Since then, sporadic importation has occurred continually. Recently, ducks with the commercial name of either Cherry Valley or Hejgaard have been introduced from England and Denmark respectively.

(iii) Muscovy ducks (Cairina moschata): The males are of special importance in breeding. They are used to cross with the female domestic duck for producing mule ducks for meat production.

(iv) Mule ducks: The F_1 of the cross between male Muscovies and female domestic ducks is produced for meat production.

(v) Geese (Anser anser): The native goose, Emden from Holland and White Roman from Denmark are present.

(vi) Turkeys (Meleagris gallopavo): The native turkey and the Beltsville Small White Turkey from the U.S.A. are present.

(vii) Others: Pheasant (Phasianus colchicus), Guinea fowl (Numida melegaris), Quail (Coturnix coturnix), and pigeon (Columba livia) are all present, but their number is nominal.

C. Numbers and distribution

The population of livestock, including poultry, from 1969 to 1978, is shown in Tables 1 to 4. The distribution of the most important animals is shown in Maps 1 to 3.

II. DESCRIPTION

Sections II to VI deal with animals, while poultry are discussed in Section VII.

A. Species and breeds

Animals of the so-called native breeds and rarely known breeds are described in this chapter, as well as some imported modern breeds of special interest.

1. Yellow cattle

Yellow cattle in Chinese is a general term for all Bos taurus indigenous to China. The first introduction of Yellow cattle from the coastal provinces of mainland China (Fukien and Kwangtung) into Taiwan should be considered to have occurred in the period from 1603 to 1623. During the period from 1623 to 1661, the Dutch occupied Taiwan and imported cattle from Vietnam and Java, and probably also from India. Although the imported breeds or species are not named in the literature, Banteng (Bos sondaicus) is considered to be a possible introduction (Ma 1969).

Table 1. Dairy, beef cattle, water buffalo, and yellow cattle populations in Taiwan

Year	Total	Dairy		Beef cattle (including hybrids)	Yellow cattle	Water buffalo
		Female	Male			
1969	315,038	6,797	241	1,713	94,294	227,292
1970	284,677	7,228	368	2,074	86,137	188,870
1971	259,412	8,161	431	5,711	81,153	163,956
1972	247,872	10,604	786	9,405	77,341	149,736
1973	234,196	14,370	1,286	14,020	72,424	132,196
1974	241,977	19,829	1,625	25,617	71,892	123,014
1975	249,329	22,511	2,657	28,391	75,013	120,757
1976	253,297	23,200	5,370	35,979	73,719	115,029
1977	187,549	20,893	2,973	41,539	38,158	83,986
1978	159,240	21,063	2,792	29,333	34,648	71,304

Source: Provincial Department of Agriculture and Forestry 1979

Table 2. Swine population in Taiwan

Year	Number of farms	Total number of pigs	Breeders		Weaner pigs	Growing and Fattening Pigs		
			Boars	Sows		Weaner-30 kg	30 kg-60 kg	Over 60 kg
1969	631,685	3,048,462	4,406	206,057	654,257	796,665	777,818	609,259
1970	583,127	2,900,725	4,099	191,921	607,270	789,055	746,456	561,924
1971	540,583	3,078,548	4,983	245,341	607,022	773,153	820,349	627,700
1972	520,651	3,831,293	7,819	350,331	762,928	1,026,364	954,355	729,496
1973	444,020	3,637,925	7,096	277,577	548,517	988,379	1,009,592	806,764
1974	344,832	2,808,583	7,610	246,179	453,306	676,713	731,077	693,698
1975	345,199	3,314,823	9,724	296,642	544,672	842,610	842,202	778,973
1976	329,607	3,676,442	12,304	318,325	588,479	950,460	968,165	838,709
1977	293,121	3,760,475	12,246	323,878	575,684	967,845	994,735	886,087
1978	260,699	4,322,165	14,582	394,682	656,872	1,135,142	1,111,982	1,008,905

Source: Provincial Department of Agriculture and Forestry 1979

Table 3. Sheep, goat, horse and deer populations in Taiwan

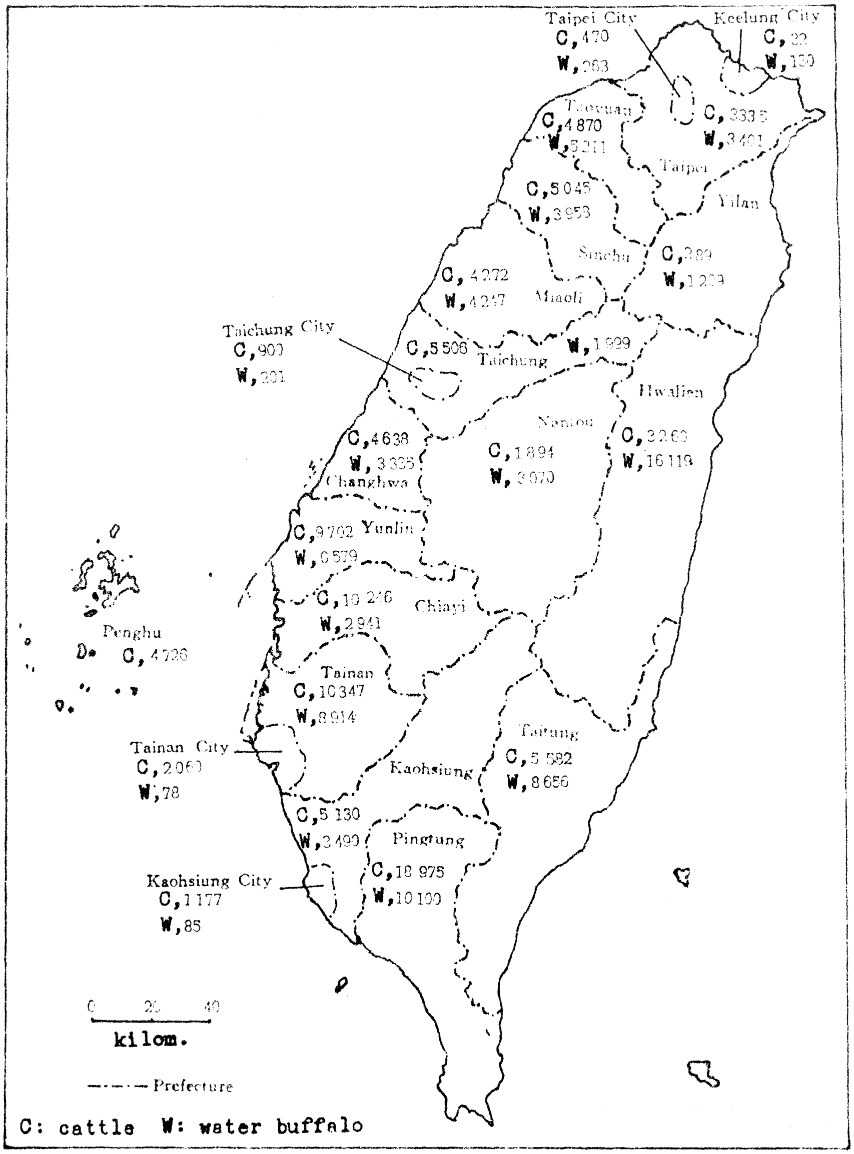
Year	Sheep	Goat	Horse	Deer
1969	1,563	169,382	64	1,436
1970	241	167,727	92	1,516
1971	239	174,252	86	1,601
1972	295	177,606	107	2,033
1973	329	180,538	92	2,624
1974	459	188,160	139	3,606
1975	531	191,434	127	4,465
1976	551	210,581	142	6,051
1977	306	200,536	148	7,174
1978	166	198,254	144	8,700

Source: Provincial Department of Agriculture and Forestry 1979

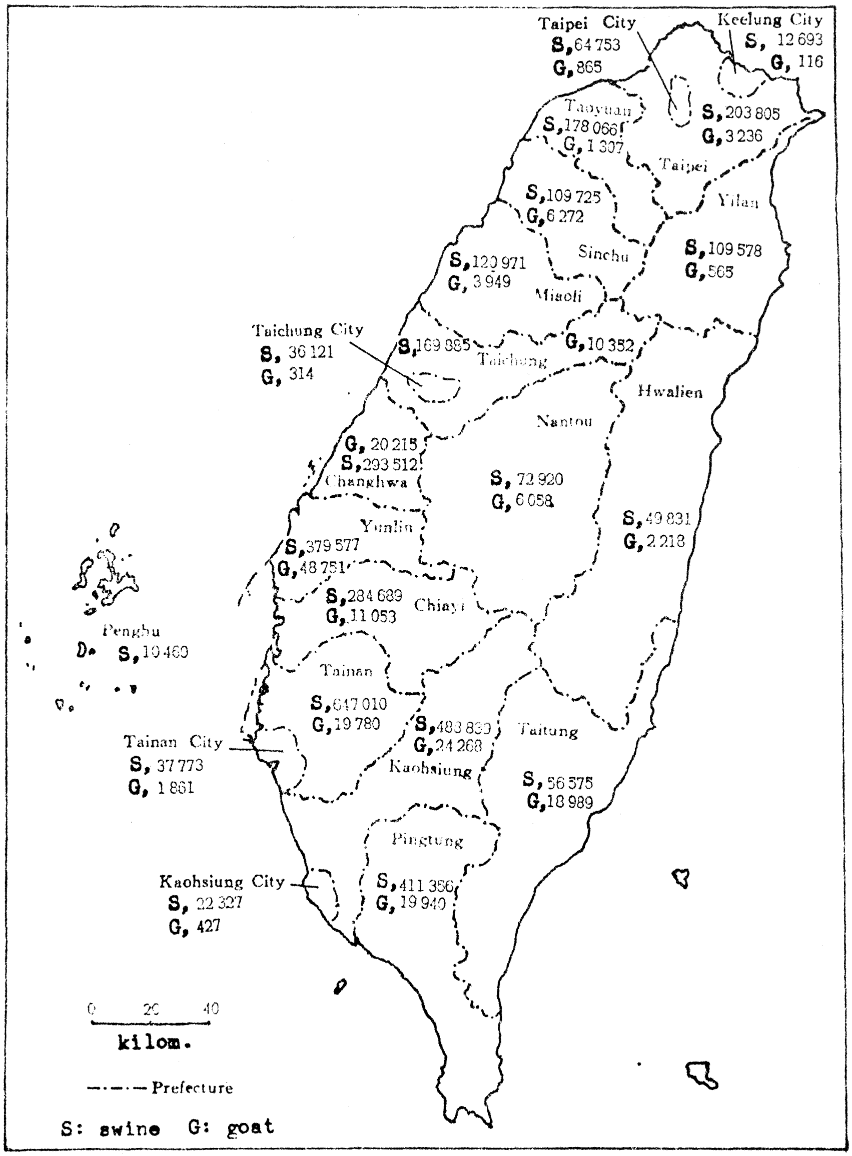
Table 4. Poultry populations in Taiwan

Year	Grand total	Chicken				Duck			Goose	Turkey
		Total	Layer	Broiler	Native chicken	Total	Domestic duck	Mule duck & Muscovy		
1969	23,045,392	14,435,235	2,974,332	2,794,868	8,666,035	6,588,523	....	....	1,499,545	522,089
1970	23,651,315	14,822,207	3,058,369	3,160,925	8,602,913	6,798,458	....	....	1,484,289	546,361
1971	25,972,330	16,702,364	3,585,594	4,397,819	8,718,951	7,308,239	....	....	1,417,772	548,955
1972	30,815,877	20,331,960	4,445,305	7,105,415	8,781,240	8,501,336	....	....	1,379,100	603,481
1973	28,198,153	19,325,552	3,788,222	6,835,961	8,701,369	6,909,398	2,412,962	4,496,436	1,357,279	605,924
1974	30,268,319	21,170,224	4,851,697	7,795,065	8,523,462	7,095,729	2,522,147	4,573,832	1,362,646	639,470
1975	34,481,398	24,756,191	6,272,022	9,871,134	8,613,035	7,715,670	2,645,859	5,069,821	1,334,564	674,973
1976	38,478,704	28,354,649	7,526,224	12,201,506	8,626,919	8,051,073	2,649,149	5,401,924	1,370,762	702,220
1977	47,192,151	35,488,598	9,279,031	17,004,481	9,205,086	9,585,461	2,795,492	6,789,969	1,422,681	695,411
1978	50,683,811	38,360,433	10,778,698	18,074,002	9,507,733	10,122,836	2,910,263	7,212,573	1,497,951	702,591

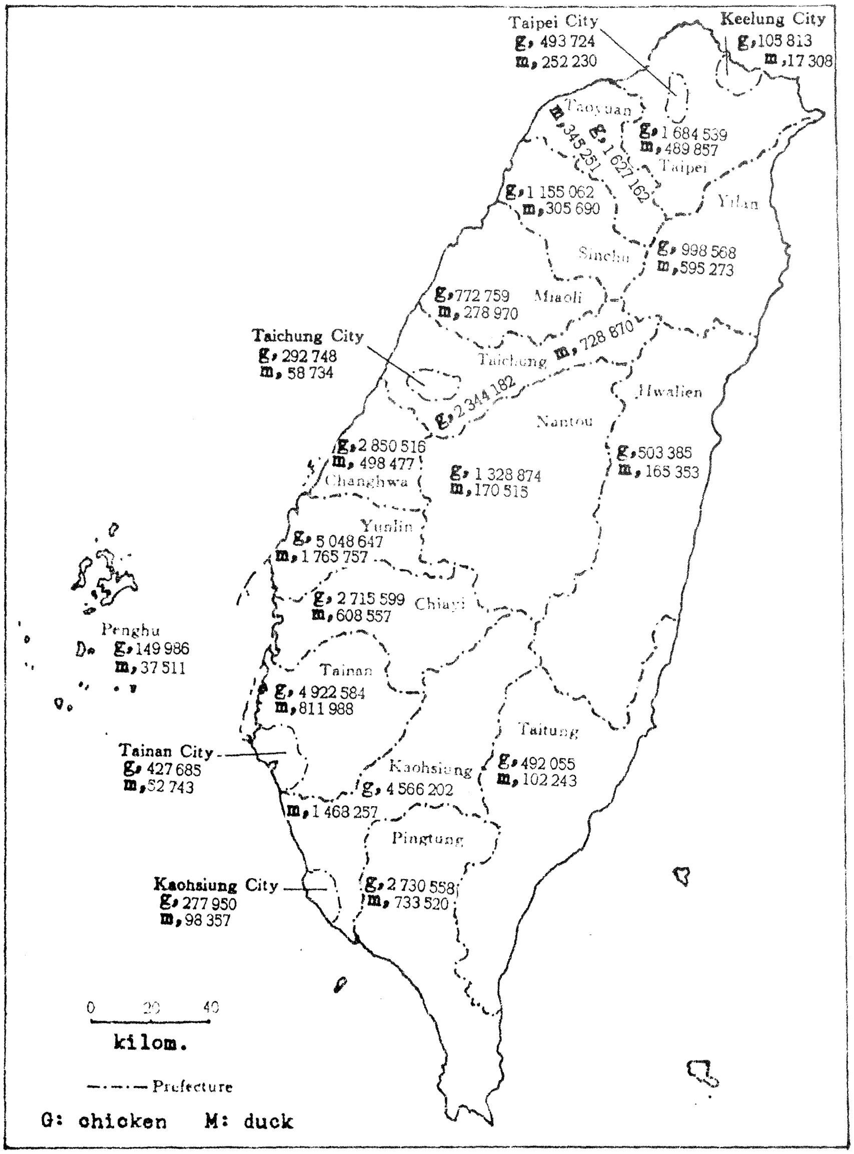
Source: Provincial Department of Agriculture and Forestry 1979



Map 1. The distribution of cattle (dairy cattle, beef cattle, Yellow cattle, and hybrids) and water buffaloes in 1977 (Provincial Department of Agriculture and Forestry 1978).



Map 2. The distribution of swine and goats in 1977 (Provincial Department of Agriculture and Forestry 1978).



Map 3. The distribution of chickens and ducks (Domestic ducks, Muscovies, and mule ducks) in 1977 (Provincial Department of Agriculture and Forestry 1978).

Despite the occupation of Taiwan by the Dutch, a great number of Chinese still kept moving to Taiwan with their cattle. In 1870, Mr. R. Swinhoe described these as being of a peculiar species, Bos chinenesis, combining the characters of Bos indicus and Bos taurus. It had the head and dewlap characteristic of the former, with a small hump, and the straight back and hind quarters of the latter. In the period from 1910 to 1929, the Japanese imported Kankrej (23 males and 41 females) and Red Sindhi (23 males and 62 females) from India for pure breeding and for grading-up Yellow cattle. Consequently, their humps and dewlaps became larger, the horns stouter, and the ears longer. Coat colour became white or pale cream, yellow, yellowish brown, brown, red-brown, dark brown, black or nearly black, with various shades of grey or dun. Occasionally, cattle show a brindle pattern. When the proportion of Kankrej blood is higher, long horns and a white or grey coat are more common. The adult body measurements for Yellow cattle are as follows (Kadono 1944):

Sex	Body weight (kg)	Body height (cm)	Body length (cm)	Heart girth (cm)
Male	340	127	137	171
Female	250	114	125	159

2. Kankrej and Red Sindhi

Originally, the Kankrej was imported for improving the draft ability of Yellow cattle, and the Red Sindhi for improving chiefly the heat tolerance of Holstein and possibly the milk production of Yellow cattle. Body measurements of adults are as follows (Kadono 1944):

Breed & sex	Body weight (kg)	Body height (cm)	Body length (cm)	Heart girth (cm)
Kankrej:				
Male	650-700	139	156	206
Female	400-500	139	148	187
Red Sindhi:				
Male	450-580	129	147	191
Female	300-350	120	132	154

3. Water buffaloes

Chinese water buffaloes were imported from the coastal provinces of mainland China at the end of the 17th and beginning of the 18th centuries. By that time, the need for buffaloes had increased through exploitation of the land for rice and sugar cane plantations. Today, Taiwan buffaloes do not differ noticeably from those on the mainland. They have a pair of backswept horns and are invariably dark grey, with white belly and white legs below the knees and hock joints. Calves have brownish hair which subsequently changes in colour. White buffalo may be found occasionally. People in some areas consider that the birth of a white buffalo calf will bring good luck to the owner, but those in other areas do not think so. This is based on the original religious belief of the community in mainland China from where the ancestors of the present inhabitants in Taiwan came. Adult males weigh 450 kg, females 400 kg. Body measurements for adults recorded by the TLRI after a survey on the whole island (Ma, 1969) are given in Table 5.

Table 5. Body measurements of adult water buffaloes in Taiwan

Area	Sex	Body height (cm)	Body length (cm)	Heart girth (cm)
Southern	Male	131.5±0.50	142.1±0.93	200.7±1.16
	Female	125.6±0.51	134.4±0.61	191.1±1.00
Middle	Male	130.9±0.59	144.1±0.79	200.8±0.94
	Female	125.8±0.55	137.2±0.66	193.6±0.84
Northern	Male	128.2±0.83	140.6±1.15	192.1±0.99
	Female	123.6±0.71	134.9±0.98	187.8±1.24
Eastern	Male	126.9±0.50	139.9±0.65	191.7±0.98
	Female	124.5±0.42	134.0±0.65	188.2±0.96
Over-all	Male	129.4±0.32	141.7±0.46	196.3±0.61
	Female	124.9±0.28	135.1±0.38	190.2±0.52

The importance of the Chinese water buffalo has gradually decreased since the mechanization of farming in the last 2-3 decades. Murrah buffaloes (3 bulls and 4 cows) were imported from the Philippines in 1957, with the hope of improving both milking ability and work power of the Chinese water buffalo. It seems that the effort has not been able to change the buffalo's destiny of decline.

4. Swine

A detailed description of native hogs in English literature has been presented by Epstein (1969). Readers who are interested in this subject may refer to Dr. Epstein's book.

The body measurements of the most important modern breeds - Duroc, Hampshire, Landrace, and Yorkshire - are shown in Table 6 (TLRI 1977).

Table 6. Body measurements of Landrace, Yorkshire, Duroc and Hampshire swine*

Breeds	Sex	Body height (cm)	Body length (cm)	Heart girth (cm)
Yorkshire	Male	65.7±2.90	112.4±3.38	98.5±2.32
	Female	65.9±4.23	112.2±4.71	100.9±3.97
Landrace	Male	65.7±5.76	112.4±4.29	99.4±4.21
	Female	64.8±4.09	114.2±3.08	101.6±3.88
Duroc	Male	66.9±2.53	111.2±3.51	100.5±2.85
	Female	67.3±3.21	112.1±4.31	101.6±3.92
Hampshire	Male	66.1±2.37	112.1±2.87	99.2±2.59
	Female	66.9±3.05	112.4±3.53	101.7±3.47

* Taken within 7 days after body weight reached 90 kg.

5. Barbados Blackbelly sheep

The Barbados Blackbelly is reddish brown to dark brown in colour with conspicuous black undersides. Black points are to be found in the face and feet. The tail is not fat, and looks like a slightly flat rod with a slightly larger tail root. The length of the whole tail is about 30 cm. Both sexes are hornless, but scur-like remnants can occur in males. Wool length is about 3 cm. Mature males have long wool (about 15-20 cm) in front of the breast. The mane is well-developed in males, being about 5-10 cm long. In the female, the udder is well-developed with two teats. The animals like to stay in groups and are easily managed. Adult body measurements recorded by Tsay (1979) at the Heng-Chun Branch Station, TLRI are as follows:

Sex	Body weight (kg)	Body height (cm)	Body length (cm)	Heart girth (cm)
Male	70	85	86	96
Female	55	72	73	90

6. Goats

The goats of Taiwan resemble those of the southern part of mainland China. They are of small size with a moderately long neck, long back, broad and muscular loin, muscular thighs, and short, strong and straight legs. The head has a concave profile, prominent forehead, and narrow erect ears approximately 8 cm long. Both sexes have a beard, which is particularly profuse in the buck, and strong conical horns, which project upwards, backwards and outwards to reach a length of about 15 cm. The wither is high. The tail is either turned up or is held horizontally. The udder is small with 2 teats. The coat is usually short, but sometimes of medium length. Adult bucks develop a mane that extends from the occiput to the withers and covers the neck down to the brisket; long hair also grows on the back, forelegs and thighs. Most goats are completely black, some are completely brown, and a few are brown with a mingling of black hair. Adult body measurements are as follows:

Sex	Body weight (kg)	Body height (cm)	Body length (cm)	Heart girth (cm)
Male	50	58	63	72
Female	42	49	57	69

7. Deer

There are two species of deer under domestication.

(i) Mei-Hua-Lok (*Cervus taivanus*): The most common coat colour for the summer is light bay, with deep red on the back of the neck. There is a narrow black stripe along the mid-line of the back, extending from the anterior end of the back to the tail root. Two rows of about 20 white spots each flank this narrow stripe on either side. Other spots are irregularly scattered on both sides of the body. The belly and the insides of the legs are white. The tail is bushy and black, with a white underpart. The winter coat is greyish brown, with the white spots moderately faded. Antlers are borne only by the males. The life span generally is about 17-18 years, but may exceed 30 years. Body measurements of the adults are as follows:

Sex	Body height (cm)	Body length - including head (cm)	Ear length (cm)	Tail length (cm)
Buck	90	137	12	13
Doe	77	118	11	12

(ii) Taiwan Shui-Lok (*Cervus swinhoii*): This species is easily distinguished from the Mei-Hua-Lok by its larger size, the lack of white spots, and the occurrence of a large sac between the eye and nose. This large sac has the power of opening and shutting. It appears to be expanded most frequently when the animal is irritated. Adults have coarse hair, which in summer is generally deep brown and in winter, greyish brown. Antlers are borne only by the males. Measurements of the adults are as follows:

Sex	Body height (cm)	Body length - including head (cm)	Ear length (cm)	Tail length (cm)
Buck	100	178	15	15
Doe	80	150	14	14

The main purpose for raising both Mei-Hua-Lok and Taiwan Shui-Lok is for harvesting velvet antler for Chinese medicine. Antlers are appendages of the skull composed of a solid bony core and supported on permanent skin-covered pedicels, which are shed annually. New antlers begin to grow by the end of May or the beginning of June, just a few weeks after the old ones have dropped away. During the growing period, the antlers are well supplied with blood. They are soft and tender, and are covered with a thin skin which bears short fine hair, with the appearance of velvet. By the end of August, the antlers have attained their maximum size. The blood then gradually recedes, and the skin with the velvety hair dries, loosens, and is rubbed off. Before the velvet is shed, all circulation of blood has ceased and, when shedding takes place, no bleeding is observed. After the velvet is rubbed off, the antlers serve as sexual ornaments and weapons. In any deer, both antlers are usually shed within several hours or days of each other.

Deer grow their first set of antlers at about two years of age, this first set being generally short, almost straight spikes. The antlers become larger and acquire an extra fork each succeeding year until the animal is 5 years old, when it has 3 extra forks (4 points). The antler of Mei-Hua-Lok attains its maximum size, an axis 50 cm long and weighing about 1.8 kg at the age of 6 or 7 years. The antlers of Taiwan Shui-Lok are much larger, the axis being already 70 cm long at the age of 3 years. At maximum size (6-7 years), a pair of velvet antlers weighs about 5.4 kg.

The velvet antlers are harvested by cutting them with an electric saw at the place just above the junction where they break off each year, 75-80 days after the "budding" of the antler. They are then good for Chinese medicinal use. The first set of velvet antlers, however, is not harvested, but allowed to grow up, become bony, and drop away the next year. After the harvesting of the velvet antler, the remnant on the head will go through the receding of blood, drying of the skin, and calcification of the bony core, and then drop away at the same time as the normal antlers usually do.

B. Heat Tolerance

1. Cattle

The Iberia Heat Tolerance Test was carried out for all newly imported dairy and beef breeds in TLRI. In all tested animals rectal temperature was measured twice daily at 10:00 a.m. and at 3:00 p.m. for three consecutive days. The Heat Tolerance Coefficient (H.T.C.) was calculated according to the formula, H.T.C. = 100-10 x (BT-101.0) where BT represents the average rectal temperature of six measurements, and 101.0 represents the normal temperature.

TLRI (1968) reported that the H.T.C. for the dairy breeds Jersey, Illawarra, and Holstein was 83, 77, and 72, respectively. Evidently, Jersey cattle are superior than the others in this respect.

The results of the experiment on heat tolerance of beef cattle at the Heng-Chun Branch Station, are shown in Table 7 (TLRI 1976). Santa Gertrudis is superior to all the others. During the experimental period, all beef cattle of

Table 7. Some physiological characteristics of beef cattle (at 25-30°C with a relative humidity of 68-78%)

Breed	Body temperature °C	Pulse No./min.	Respiration No./min.	H.T.C.*
Hereford	39.8 (38.8-40.7)	69.6 (57-84)	15 (14-16)	73.2±11.91
Angus	40 (38.9-41.3)	74.4 (60-84)	16 (13-18)	69.5±14.94
Santa Gertrudis	39.5 (38.9-40.6)	73.5 (54-90)	13 (12-14)	78.5± 8.15
F_1 (Hereford x Shorthorn)	40.0 (38.7-41.0)	81.8 (66-90)	16 (15-17)	69.9±13.78

* Heat Tolerance Coefficient is expressed as Mean ± S.E.M.

Numerals in parentheses represent the range

European origin would stay under the shade of the trees and stop eating when the environmental temperature was over 30°C in summer. Angus began to pant, open the mouth, extend the tongue, and salivate. Sometimes, they liked to stand beside the pond and extend their feet into the water. Eating usually occurred only before 9:00 a.m. and after 4:00 p.m.

2. Water buffaloes

In an early experiment (Kadono and Terada 1941), it was found that Chinese water buffaloes required 9-18 daily wallowings during the summer, the total time taken up each day being just under 5 hours. During the winter, these animals seldom needed more than two daily wallowings and some days no wallowing at all. Each wallowing usually took less than two minutes. Evidently, during the hot summer months, buffaloes must be given ample opportunity to wallow if they are to perform satisfactorily.

In the Hualien Livestock Propagation Station, other experiments concerning the reactions of buffaloes to heat stress were carried out (Liu 1968). Buffaloes were not allowed to wallow. Their body temperature, pulse, and respiration were measured individually at 8:00 a.m. (environmental temperature was 31.2°C) and at 2:30 p.m. just after grazing under 35.9°C for 30 minutes. Results showed that the Murrah and the F_1 (Murrah x Chinese water buffalo) were superior in heat tolerance to the Chinese water buffalo (Table 8).

Table 8. Reactions of water buffaloes to heat stress

Breed	Before Heat Stress			Grazing Under Heat Stress		
	Body temperature °C	Pulse No./min.	Respiration No./min.	Body temperature °C	Pulse No./min.	Respiration No./min.
Murrah	38.2	52	25	38.6 (0.5)	59 (7)	42 (17)
Chinese water buffalo	37.6	40	28	39.9 (2.3)	53 (13)	95 (68)
F_1 (Murrah x Chinese buffalo)	37.7	44	24	39.4 (1.7)	52 (8)	71 (47)

* Numerals in parentheses represent the amount of increase

C. Diseases

Anthrax, foot and mouth disease, pleuropneumonia, and rinderpest of cattle have not been recorded in this island for decades. Brucellosis and tuberculosis are found in dairy cattle only, and some necessary measures for eradicating these two infectious diseases have been set up by the government. Mastitis is still a serious problem for the dairy industry. Piloplasmosis, anaplasmosis, and trypanosomiasis sporadically attack Yellow cattle and dairy cattle. Trypanosomiasis also may attack the water buffalo. Reproductive disorders, such as summer sterility, nutritional (the imbalance between calcium and phosphorus in the feed) and metabolic disorders (ketosis and milk fever), are generally found in dairy cattle. Photosensitization is a serious problem for the newly imported Hereford breed. Symptoms usually occur in the grazing animal after several consecutive rainy days.

In swine, the morbidity from hog cholera has been decreased to the low level of 0.02% in the whole population of the island, by using the lapinized hog cholera vaccine. Pseudorabies is an infectious disease recently invading the island. Prevention, through vaccination, of major diseases such as TGE (transmissible gastroenteritis), pseudorabies, atrophic rhinitis, colibacillosis, swine influenza, Japanese encephalomyelitis, etc., remains a distant goal. Progress has been made in controlling a number of bacterial and viral diseases, such as Japanese encephalomyelitis, swine erysipelas, pasteurellosis, swine dysentry and internal parasites (Ascaris and lung worms) by timely medication. Some miscellaneous diseases, such as gastric ulcers, reproductive failure, parakeratosis, and mastitis, may occur occasionally.

Diseases in sheep reported at the Heng-Chun Branch Station, TLRI (Chang and Liu 1970) are infectious pneumonia, gastroenteritis, listeriosis, blowfly strike, internal parasites (Haemonchus contortus), and photosensitization. Of these diseases, photosensitization is the most serious and its morbidity may reach 9.52%.

Nematodiasis is the only problem for the native goat.

III. ENVIRONMENT, MANAGEMENT AND FEEDING

A. Environment

Taiwan is a mountainous island in the South China Sea, about 150 kilometers off the southeastern coast of mainland China. Including Penghu (Pescadores Islands), it covers 35,961 square kilometers. Thickly forested mountains run lengthwise from the northeastern part to the southern tip of the island and cover about two-thirds of the land area. The highest peak rises 3,997 meters above sea level. In the east, the mountains descend precipitously to the Pacific. Only a few valleys are suitable for farming. In the west, the mountains slope to a broad shelf of gently rolling hills and level land.

Latosols and alluvial soils are the main agricultural soils in Taiwan. The reddish brown latosols are the main soil group developing on the rolling hills and terrace tableland. Most of them have been cultivated for tea, citrus fruits, pineapple, citronella, etc.

The yellowish brown latosols are developed on the lower parts of rolling hills whose elevation is below 1,000 m. Most of the vegetation consisted of deciduous trees and shrubs, but has been changed to upland crops and paddy rice since the soil became cultivated.

The young alluvial soils are the most important soils for agriculture in this island, and occupy the largest area of the cultivated land, especially on the southeastern coastal plain. Most of the alluvial soils are irrigated for planting two crops of rice a year, but a different type of rotational farming, including rice, sugar cane and sweet potato has been practised wherever irrigation is not sufficient.

Taiwan has a subtropical climate with hot and humid summers (May to October) and mild winters (January and February). The annual average temperature is 70.9^{o}F in the north and 75.7^{o}F in the south. The annual average relative humidity is 81% for the whole island. Rainfall is heavy, averaging 2,500 mm annually, and the sunshine averages more than 2,000 hours per year. Snow occurs in the higher mountains during the winter. Accordingly, the climatic conditions of Taiwan are quite favorable for plant growth. The growing season is virtually continuous for most field crops. Furthermore, the excellent and efficient facilities for irrigation make agriculture on this island a prosperous and diversified enterprise, and have alleviated the damage caused by a few drawbacks, such as (a) prolonged drought in the winter on the southwestern coastal plain, (b) heaviest rainfall in the northeast in the winter and in the south in the summer, (c) violent summer thunderstorms, which with the intense rainfall result in severe hillside erosion, overloaded streams and occasional damaging floods in the lowlands, and (d) typhoons, which bring damaging rains and winds that sometimes exceed 165 kilometers per hour, in the period of July-September of each year. Taiwan's chief products are rice, sugar, bananas, vegetables, pineapples, citrus fruits, tea, mushrooms, and timber.

On account of the high temperature and humidity, the animals of higher productivity imported from the temperate zone generally cannot produce as well as in the temperate zone itself. Besides, with the limited land area and the ever-increasing population pressure, almost all the utilizable land has already been opened up to grow crops. Grassland that can be used for raising livestock is very scarce, and in general livestock raising is a rural sideline. The geographical distribution of the animals is almost entirely coincident with the distribution of cultivated land and rural population.

B. Feeding and management

Under the small intensive farming system, which consists mostly of small holdings with a mixed subsistence and cash economy, farmers have integrated their livestock and crop production, and conventional pasture-grazing systems are not applicable. Generally speaking, dairy cattle, beef cattle, deer and swine are fed in confinement and provided with a small exercise yard, while water buffaloes, Yellow cattle, and goats are grazed on the road sides or open fields during day time, being housed at night and on rainy days. Pasture-grazing for dairy cattle, beef cattle, and sheep is carried out only in the government-owned experimental stations.

Water buffaloes and Yellow cattle not only meet the work need of farming but also represent the savings of farmers. However, since the beginning of the rapid mechanization of farming in 1970, the numbers of these animals have decreased (Table 1). In 1968, there was one buffalo per 4 family farms and one Yellow cattle beast per 22.4 family farms. By 1977, these numbers were one per 10.4 and one per 39.6 farms respectively. Water buffaloes and Yellow cattle are efficient converters of crop residues, such as rice straw, peanut stover, and sweet potato vines, as well as of agricultural by-products, such as rice bran, wheat bran, soybean meal, and sweet potatoes and their chips.

The daily water consumption for water buffaloes averages 19.8 kg (Kadono and Terada 1941) and for cattle of Indian origin (*Bos indicus*) 25-30 kg with a maximum of 61 kg on hot summer days (Kadono 1939).

Although water buffalo calves are weaned at the age of 13 months on the average, over 40% are weaned at the age of 7 to 12 months (Lin 1975). It seems that most farmers do not have a definite weaning pattern and calves will usually run with their mothers as long as the latter will allow them to suckle. Yellow cattle calves generally are weaned at the age of 6 months.

Both water buffalo and Yellow cattle males are castrated at the age of 2-3 years. Surplus buffalo breeding bulls are usually castrated at an age of about 5-6 years, or one year later than that of Yellow cattle and crossbred cattle breeding bulls (Lin 1975).

Goats chiefly depend on grazing, with a supplement of salt given by using a salt-filled short bamboo tube with many small holes in the wall. Sometimes, goats are fed on crop residues and agricultural by-products. Goat kids usually are allowed to run with their mothers and suckle until the next breeding season begins. Male kids generally are not castrated, but if they are, it is at about 6 months of age.

The proportions of entire males, castrates and females for all recorded breeds are shown in Table 9.

C. Improved feeding and management systems

Formulated feeds with well balanced nutrients for different production stages of dairy cattle, beef cattle, swine, and poultry have been produced on a large scale by a number of feed mills since a decade ago. Although the most important feed ingredients, corn and soybean meal, are chiefly imported from other countries, the feed supply never runs short. The exemplary feeding and management systems for some animals of higher economic value are now described briefly.

1. Dairy cattle

Dairy calves generally are allowed to suckle their mothers' milk for one

Table 9. The proportion of entire males, females and castrates of the animal populations in Taiwan for the year 1977

Animal	Percentage				
		Male			
	Female	sub-total	Intact	Castrated	Total
Sheep	49.35	50.65	38.89	11.76	100.00
Goat	43.66	56.34	25.97	30.37	100.00
Deer	54.06	45.94	45.94	0.01	100.00
Horse	50.34	49.66	12.84	36.82	100.00
Water buffalo	64.02	35.89	18.08	17.90	100.00
Beef cattle	58.32	41.68	33.29	8.39	100.00
Work cattle	57.75	42.25	16.21	26.04	100.00
Swine					
1. Breeders					
A. Native breeds	1.14	---	0.004	---	1.14
B. Modern breeds	4.87	---	0.32	---	5.19
C. Hybrids	2.60	---	0.006	---	2.61
Sub-total	8.61	---	0.33	---	8.94
2. Weaners					
A. Native breeds	---	---	---	---	0.13
B. Modern breeds	---	---	---	---	6.37
C. Hybrids	---	---	---	---	8.81
Sub-total					15.31
3. Growing and fattening pigs					
A. Native breeds	---	---	---	---	0.76
B. Modern breeds	---	---	---	---	31.24
C. Hybrids	---	---	---	---	43.75
Sub-total					75.75
Total for the swine					100.00

Source: Provincial Department of Agriculture and Forestry 1978

week after birth. From the 2nd to the 4th week, the weaning age, they are fed with milk replacer plus creep feeding. After weaning, they are fed with the feed for calves of 3-6 months. Heifers, when they become 6 months old, are able to digest roughages and begin to feed on plenty of roughages, such as Napier, Pangola, weeds, pineapple waste, corn fodder, asparagus peel, sugar cane tops, soybean pods and stems, etc. plus 2 kg of heifers' feed per head per day. If a heifer or a cow is pregnant, she is supplemented with extra feed, i.e., 1 kg more per day for the 7th month, 2 kg more per day for the 8th month, and 2-3 kg more per day for the 9th month. The amount of feed, however, should be slightly decreased in the last week of pregnancy.

A milking cow is fed with as much grass as she can eat, plus 1 kg of balanced milking ration per day for maintenance and daily production of 5 kg of milk. An additional balanced milking ration on the basis of 1 kg feed per 3 kg of milk increase per day is given to the cows which produce more than 5 kg of milk per day. Water is supplied ad libitum. It is said that the daily water consumption is 52-74 kg for Holstein cattle, the amount varying greatly with sex and environmental temperature. Bulls consume more water than cows, and more water is consumed under higher environmental temperatures. In the hot summer, the daily water consumption may be up to 153 kg (Kadono 1939). With the exception of rainy days or when a typhoon occurs, cows are permitted to stay in the yard over night in the hot season, and in the cool season to walk around in the yard during day time for a few hours between milkings. Milking cows generally are milked twice daily.

In order to improve human nutrition and to make good use of the marginal slope land, 16 specialized dairy farming villages have been established so far. Each dairy farmer owns about 25 dairy cattle. Of the 25 dairy cattle, about 10-15 are milking cows. Milk production averages nearly 4,600 kg per head per lactation period (321 days), produced by stall-feeding. Dairy barns are usually re-modeled or simply-constructed houses. Each dairy house is provided with an exercise yard. The area of the yard should allow a walking exercise space of 2 square meters per cow.

Dairy herds vary in size from one to over 41 cows. Forty-two point three % of the adults are distributed to farms with between 1 and 20 head, 19.6% to farms between 21 and 40, and 38.1% to farms with more than 41 cows (Taiwan Agricultural Year Book 1978). The geographical distribution of dairy farms and milking cows is given in Map 4.

2. Beef Cattle

With a few exceptions, raising of beef cattle is similar to that of dairy cattle. Beef calves are allowed to run with their mothers up to 6 months old, the weaning age. There are only two kinds of formulated feed for beef cattle, one for calves before weaning and the other for cattle after weaning. Beef cattle are also fed plenty of roughages, the same as those with which dairy cattle are fed. It is said that 1 kg of body gain needs 3.85 kg of formulated feeds and 28.0 kg of roughages.

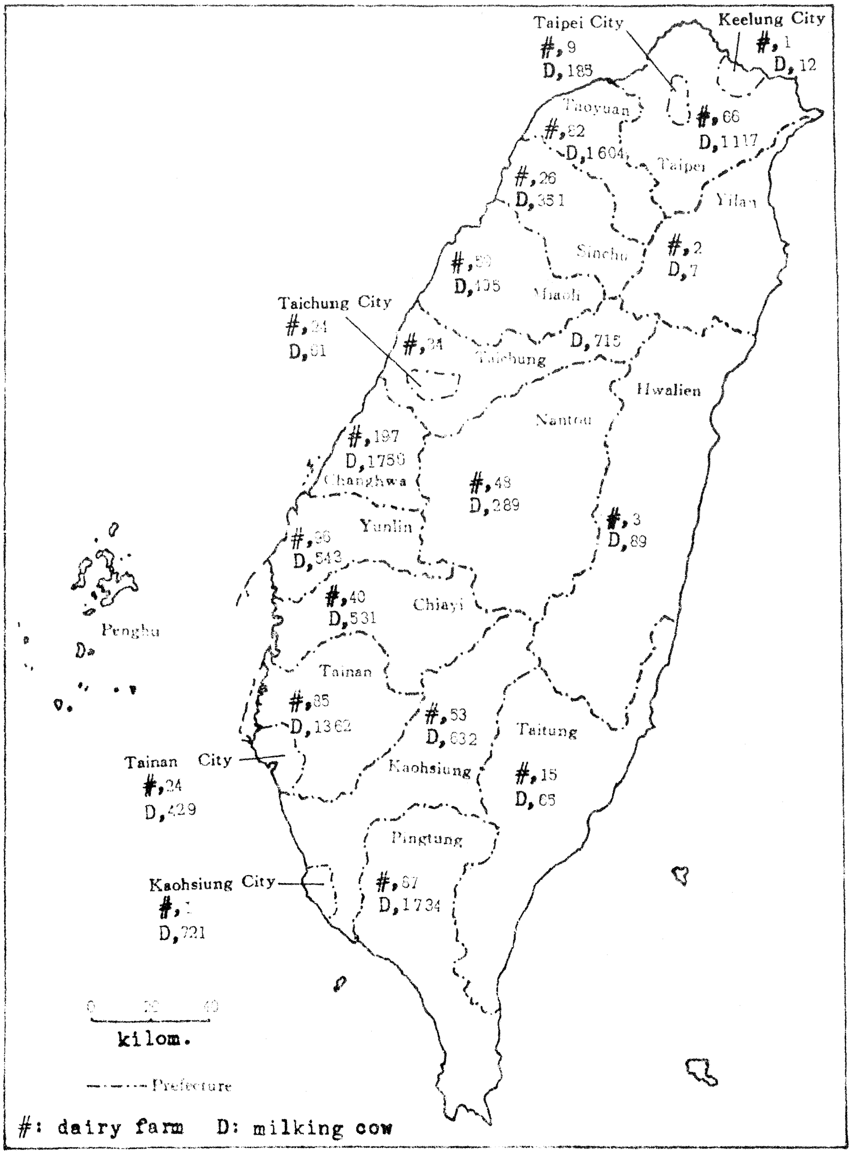
The grazing system of beef cattle at the Heng-Chun Branch Station may be described briefly as follows:

(i) Breeding cows are kept rotationally on the range. They are bred all year round by the bull. The ratio of bulls to cows is 1:18-19. In order to avoid inbreeding depression, bulls are used only for 2.5-3 years in the same herd.

(ii) Calves are raised on the range. After birth, they are allowed to follow their mothers for suckling, no creep feed being given to them. After weaning, they are on the feed lot for 3-6 months until the weather and pasture conditions become favorable.

(iii) Once the weaned calves are released to the pasture, they will be on pasture, regardless of weather, until the age for marketing or for other uses. They are weighed and dipped once every two weeks. Because of the shortage of grasses in the dry season (October to May) cattle are supplied with formulated feeds at the rate of 1-1.5 kg per head per day.

Hepatogenous photosensitization is a seasonal disease of grazing cattle, and usually occurs in the period from June through September (the rainy season) at the Heng-Chun Branch Station. According to Chang (1974), during 1965 to 1973 there were 330 affected cases. The mortality was 34.5%, and 86% of the affected cases occurred in the rainy season. The occurrence of photosensitization not only varies with the season, but also with the breed and age of the animals, as well as with the grass species. Holstein and Hereford are the most seriously affected breeds, followed by Santa Gertrudis and the F_1 of Santa Gertrudis x Yellow cattle, Red Sindhi, Yellow cattle, F_1 of Red Sindhi x Yellow cattle, and F_1 of Red Sindhi x Holstein. Morbidity at the ages of 7-12 months, 13-18 months, 19-24 months, and over 25 months was 43.9, 21.8, 15.8 and 4.4% respectively. Animals on Pangola pasture were more easily affected by photosensitization. To prevent this disease, it has been suggested that the grazing herd should be removed from suspected paddocks and kept away from sunshine.



Map 4. Geographical distribution of dairy farms and milking cows in 1977 (Provincial Department of Agriculture and Forestry 1978).

3. Sheep at the Heng-Chun Branch Station

Sheep are kept on pasture all the time despite bad weather. Consequently, pastures are divided into fenced sections, each provided with water. All sections are grazed in rotation by the sheep when the grasses reach the height of 10 cm, by which time the digestible crude protein is about 11.4%. If they are 40 cm tall, the digestible crude protein is only 5.8%. Shearing is done twice a year, in November and April-May.

The grass land is planted with 80% Pangola, 15% weeds, and 5% *Desmodium*. No concentrate is supplied to the sheep under normal conditions. In the most prosperous stage of the grasses (from June to August), one hectare of Pangola grass can carry 33-44 non-pregnant ewes, if 100 kg of calcium nitrate (23% N) is spread as fertilizer. If 400 kg of calcium nitrate is spread, the carrying capacity becomes 44-66 non-pregnant ewes with 5-6 kg of body gain per ewe.

4. Deer

Both Mei-Hua-Lok and Taiwan Shui-Lok are fed in confinement. The bedded area needs to provide 2.5 x 5 m for a male and 2.5 x 2.5 m for a female within the deer house. The deer house may be provided with an exercise yard. The size of the yard varies with that of available land. During the breeding season, 2 or more males should not be kept together, to prevent fighting. Napier and Pangola grasses are best for deer. Banana stem and leaves, sweet potato vines, sugar cane tops, corn leaves, pineapple waste, leaves of certain trees, such as mulberry, common paper mulberry and banyan-tree, wheat bran, rice bran, and sweet potatoes and their chips, are all good feed for deer. Deer usually are fed three times a day, in the morning, noon, and evening. The daily feed consumption of Mei-Hua-Lok (1 adult male, 2 adult females, and two young), recorded by the Dairy Farm of National Taiwan University, is 2 kg of milking cows' feeds plus 10 kg of green grasses. Water should be supplied *ad libitum*.

5. Swine

Modern feeding and management systems are strictly applied in the large swine farms. Houses are specially constructed, and there are breeding houses (gestation houses) for the breeders. Pregnant sows are moved to the farrowing houses 3 or 4 days before their farrowing date. Every piglet is ear-notched one day after farrowing, and the sow with her litter is moved to the nursing pen ten days after farrowing. Creep feed is provided to the baby pigs till they are 4 to 8 weeks old, the weaning age. Male piglets are usually castrated at the age of about 3 weeks, but the operation may be done simultaneously with tooth-clipping at 5 days of age. After weaning, the weaners are moved progressively from one building to another for growing and for finishing. On the smaller confinement establishments, the growing house and the finishing house may be combined as the growing-finishing house. All types of houses may have either slotted floors paved with red bricks, or slatted floors, and are equipped with the necessary facilities. Hogs may attain 90 kg of body weight at the age of about 170 days. Large swine farms usually prepare formulated feeds for their own use. Feed efficiency is in the order of 3.1 kg feed consumed for 1 kg of body gain. During the hot season, when the environmental temperature is over 27°C, the growing-finishing hogs are sprinkled with fresh water for 15 minutes, two or three times a day (Wung 1974). Water consumption, including drinking, sprinkling, and washing at the stages of gestation, farrowing, early weaning, growing and finishing, as recorded by the Animal Industry Research Institute (AIRI) of TSC, averages 79, 291, 32, 27, and 32 kg per pig per day, respectively (Wung 1974). Manpower needed for the stages of gestation, farrowing and nursing, early weaning, growing, and finishing is also recorded by the AIRI, TSC. One worker can take care of 96 gestating sows, 21.3 farrowing and nursing sows, 480 early-weaning pigs, 480 growing pigs, or 426.7 finishing pigs (Wung 1974).

For the feeding and management of pigs in small-scale swine farms, non-specific

Table 10. An analysis of the swine population in 1977

	Number of farms	Total number of pigs	Breeders		Weaners	Growing & Fattening		
			Boars	Sows		Weaner -30kg	30kg -60 kg	Over 60 kg
Total	293,121	3,760,475	12,246	323,878	575,684	967,845	994,735	886,087
Farmers, sub-total	293,064	3,429,750	10,613	286,193	490,546	920,684	912,862	808,852
Farmers carrying from 1-49 heads	283,041	1,637,682	4,210	145,988	260,979	408,786	436,450	381,269
Farmers with over 50 heads	10,023	1,792,068	6,403	140,205	229,567	511,898	476,412	427,583
Taiwan Sugar Corporation (TSC)	21	317,290	1,616	36,174	83,490	44,019	78,678	73,313
Veteran Advisory Commission (V.A.C.)	36	13,435	17	1,511	1,643	3,142	3,195	3,922
Average No./Farm								
(sum total)	---	12.83	0.04	1.10	1.97	3.30	3.40	3.02
Farmers, sub-total	---	11.70	0.04	0.98	1.67	3.14	3.11	2.76
Farmers (1-49 heads)	---	5.79	0.01	0.52	0.92	1.45	1.54	1.35
Farmers (over 50 heads)	---	178.80	0.64	13.99	22.91	51.07	47.53	42.66
TSC	---	15,109.05	76.95	1,722.57	3,975.72	2,096.14	3,746.57	3,491.10
V.A.C.	---	373.19	0.47	41.97	45.78	87.28	88.75	108.94
Comparison with 1976:								
Totals, increase or decrease	-36,486	+84,003	-58	+5,553	-12,745	+17,385	+26,570	+47,378
%, increase or decrease	-11.07	+2.29	-0.47	+1.74	-2.17	+1.83	+2.74	+5.65

Source: Provincial Department of Agriculture and Forestry 1978

cropping-pig production, and the integration of pig-raising with fish and duck production, refer to Moises R. de Guzman "Hog Raising on Small Farms In Taiwan" (1977).

The composition of the pig population in the whole island is presented in Table 10.

IV. REPRODUCTION

A. Cattle and buffaloes

The reproductive age for male Yellow cattle is 1.5-7.0 years, and for the female, 1.8 or 2.0 to 20 years (Chang 1952b). Age at first parturition and the gestation period for Yellow cattle are 42.0 months and 282.5 days (Chang 1952b). Age at puberty for both male and female cattle of European origin is generally considered to be 1.5 years. Age at first mating was recorded to be 2.6-3.6 years for the Chinese water buffalo and 27 months for the Murrah (Lin 1975) and 24.8 months for Santa Gertrudis (TLRI 1976). The reproductive period for male Chinese water buffalo is 3-13 years, and for the female 3-12 years (Chang 1952b).

Hand mating is practised for all cattle, and artificial insemination is well-performed for both dairy cattle and beef cattle. The conception rate of the Santa Gertrudis is 77.9% by hand mating (TLRI 1976), and 49-69% by artificial insemination (TLRI 1978). The conception rate of the Holstein ranges from 44.7% to 64.8% by artificial insemination, using either frozen or fresh semen, and each pregnancy needs 1.9 inseminations (Chyr 1979). The twinning rate for the Santa Gertrudis is 0.01% (TLRI 1976). Some other reproductive performances of cattle in Taiwan, as obtained from the literature, are summarized in Table 11. The most

Table 11. Some reproductive performances of cattle of European blood in Taiwan

Breed	Gestation period (day)	Age at 1st parturition (month)	Sex ratio (% of males)	Calving interval (month)	Mortality to weaning (180 days, %)
Santa Gertrudis	285.9±4.4 [a]	34.4 [d]	51.0 [d]	15.8 [d]	6.1 [d]; 14-21 [e]
Holstein	M: 281.5±6.7 [b] F: 280.0±6.5	30.1-36.0 [b,c]	54.5 [b,c]	14.9-17.2 [b,c]	
Jersey	M: 280.5 [a] F: 282.0	30.9-31.7 [b,c]	52.6 [b,c]	12.7-16.8 [b,c]	
Illawarra	M: 280.0 [a] F: 281.0	31.8-35.8 [c]	60.0 [c]	13.9-15.2 [c]	
Angus			55.6 [e]		3.7 [e]
Hereford			34.7 [e]		10.2 [e]

Sources: (a) TLRI 1975, (b) Ma and Chyr 1976, (c) TLRI 1970, 1971, 1972, 1973a, 1974, (d) TLRI 1976, (e) TLRI 1978

interesting feature for cattle reproduction in Taiwan is that both indigenous and some of the imported cattle show striking peculiarities under the subtropical climate.

Chang (1952b) has reported the seasonal distributions of conception in cattle. In Yellow cattle, 31% of conceptions occur in summer and 29.2% in spring. The number of the cows which shows oestrus is least in January and February, begins to increase in March, and reaches a maximum in May and June. After June, the number of cows which show oestrus begins to decrease gradually until January of the next year. The conception rate for the Kankrej is least in January, begins to increase in February, reaches a maximum in June and July, and then gradually decreases until December. The conception rate for the Red Sindhi is least in the period from December to February, gradually increases to the highest point in July and August, and then gradually decreases until December. It seems that all of these three breeds show similar vicissitudes which coincide with the fluctuations of day-length period.

However, the case of the dairy cows of European origin is quite different from that of these three breeds (Ma and Chyr 1976). Holstein and Jersey cows in Taiwan can be mated all year round, but the Holstein cows have two seasonal depressions in fertility in July-August and December-January and the Jersey cows in July and February (Fig. 1). Santa Gertrudis have a slightly higher proportion of total annual conceptions (10.6-11.0%) in the period from September to November than that (6.0-8.7%) in the other months.

The Heng-Chun Branch Station (TLRI 1978) reported that Hereford cows produced 44 live calves (17 males and 27 females), but 17 (5 males and 12 females) were miniature calves. Angus cows produced 26 live calves (15 males and 11 females), but 5 (3 males and 2 females) were miniature calves. These miniature calves were very small, and when adult were still below average size, while the males did not have male characteristics. The average body weight for the Hereford miniature males was 184 kg at 770 days of age, and 230 kg for the females at 1,010 days of age. The average body weight for the Angus miniature males was 172 kg at 596 days of age and 218 kg for the females at 680 days of age. This might be another problem for beef cattle of European origin, which are less heat tolerant in the subtropical climate.

B. Swine

It seems that the pig is the only farm animal in which no striking effect of climatic factors on reproduction is observed. Puberty in both males and females is generally considered to be at the age of 8 months. In an early report from AIRI appear these findings: the age of the 1st farrowing for Landrace, Duroc, and Yorkshire is 417, 423 and 389 days respectively, and the farrowing interval averages 160.6, 163.5 and 172.2 days (Lin and Tsou 1974). Postpartrum oestrus is exhibited in less than 1% of the females at less than 4 days after farrowing, in 87% of the females at 5-10 days, and in a little more than 12% of the females at over 10 days. Postpartrum oestrus is manifested on the average 6.5 days after farrowing (Yen 1975).

Recently, in order to accelerate the quality improvement of pigs, it has been recommended that a mature boar (after 10 months of age) may mate 3-5 oestrous females per week by natural mating, or be used for semen collection once every 4-5 days for artificial insemination. The reproductive period for a boar in the nucleus stock is from the age of 1 to 2 or 3 years. Gilts may be artificially inseminated after they reach about 110 kg in body weight, when exhibiting their third oestrus after puberty between 8-10 months of age. They may be used for three years, producing 4-6 litters.

Artificial insemination is quite common in the island. A report from the Taiwan Provincial Department of Agriculture and Forestry in 1976 indicates that of the 317,885 breeding sows and gilts, 136,885 female breeders were artificially inseminated, each once in a year. Because a female breeder can produce 1.5 litters per year on average, the actual insemination rate is 28.6%. Of the 136,545 female breeders, 119,814 conceived and thus the conception rate was 87.8%. Each pregnancy needed 1.3 inseminations. In a report by TLRI (1975), it was indicated that the conception rate by artificial insemination for Landrace, Duroc, Yorkshire and Hampshire, considered as a whole, was 83.4%; the litter size was 9.4-9.8; and sex

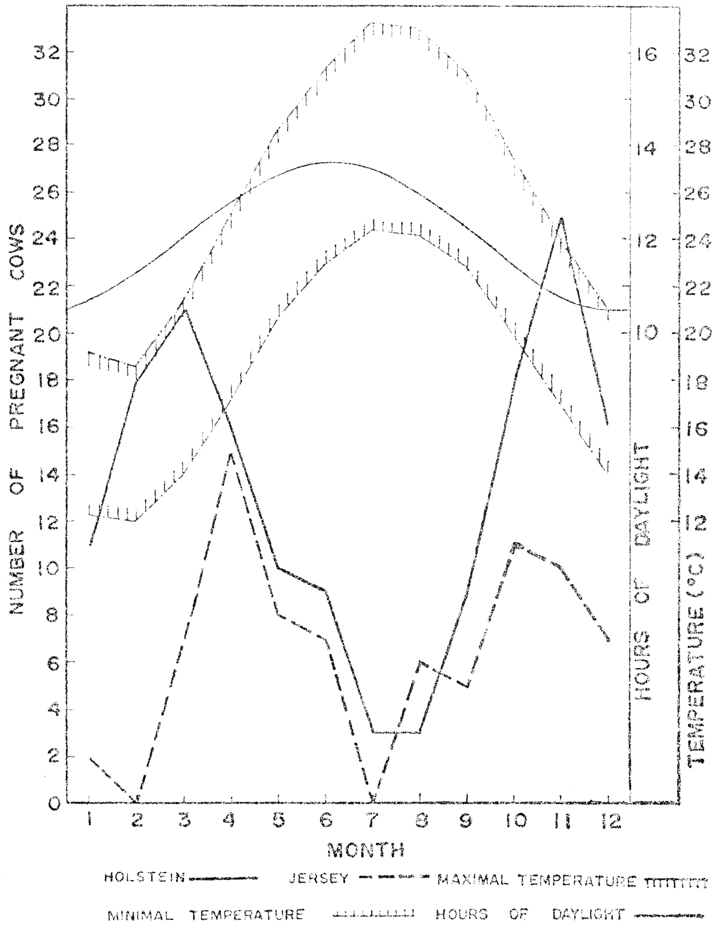


Fig. 1. Monthly variations in fertility (from Ma and Chyr, 1976).

ratio was 50.4%. Conception rate by natural mating is generally considered to be in the order of 85-90%.

According to TLRI (1978), the reproductive performance of the daughter generation of the Yorkshire, Landrace, Duroc and Hampshire imported from the U.S.A. in 1974, may be summarized as in Table 12. Shen (1978) gave the reproductive performances for first litters of Landrace, Yorkshire and Duroc as follows:

	Landrace	Yorkshire	Duroc
Litter size at birth	7.9	7.9	7.2
Litter size at 56 days	6.7	6.9	5.6
Litter weight at 56 days (kg)	81.9	89.8	66.0
Mortality at 56 days (%)	15.7	12.5	22.7

Recently, a native breed, Small-ear pig, from Lan-Yu is being investigated at National Taiwan University. Preliminary results indicate that the age of puberty for both males and females is 17-18 weeks, the body weight at weaning age of 8 weeks averages 7.56 kg for males and 8.67 for females. The litter size averages 7 piglets and the sex ratio is 43%. Body weight at the age of 52 weeks is 44.6 and 49.8 kg for the restricted-feed females and males and 67.9 and 84.0 kg for the full-feed females and males respectively (Lee et al 1977). The gestation period is considered to be 114 days.

C. Other species

Deer, goats, and sheep are short-day breeders and generally reach puberty in the breeding season of their second year. The breeding season for Mei-Hua-Lok and Taiwan Shui-Lok deer is in the period from September to January of the next year. The gestation period is 246 days for the Mei-Hua-Lok and 270 days for the Taiwan Shui-Lok. They usually produce one young, occasionally two, per pregnancy and give birth to their young in the period from May to August.

Although the native goats are considered as seasonal breeders, some does are able to kid twice a year. In order to keep the doe nourishing the young, farmers prefer to have the doe give birth three times in two years. Records at the Heng-Chun Branch Station (TLRI 1964), indicated that the native doe tended to kid throughout the year, with a peak in the period from February to April, when 53% of the kiddings in the year occurred. It seems very likely that the native goat tends to have a relatively restricted breeding season from September to November. The does usually have 1, 2, or occasionally 3 kids per birth. Pregnancy is shorter for twins or triplets than for singles, and also for the first as compared with later parities. The following gives estimates of the gestation period for the native goat.

	Gestation period (days)
First Parity:	
Singles	138-150
Twins	138-143
Second parity:	
Singles	143-154
Twins	141-156
Triplets	139-151

The Corriedale and the Romney showed good reproductive performance in the first year after their introduction in 1969 (Table 13). After that, the lambing crop of the original imported ewes and their progeny never exceeded 86.4%. In 1975, the lambing crop dropped to 60% for the Corriedale and to 71.4% for the Romney (TLRI 1975). Since then, the ewes of these two breeds have been crossed with Barbados Blackbelly bucks in the hope of producing hybrids for meat production.

Table 12. The reproductive performance of the daughter generation of 4 different breeds imported from the U.S.A. in 1974

Breed	Parity	Conception rate (%)	Gestation period (day)	Litter size At birth	Litter size At weaning (8 weeks)	Litter weight (kg) At birth	Litter weight (kg) At weaning (8 weeks)	Mortality at weaning (%)
Yorkshire	1st	89.3	115.7	8.7	7.2	10.8	99.4	17.3
	2nd	88.3	114.9	9.6	7.9	10.7	107.0	18.5
	3rd	84.6	114.6	9.3	7.7	12.1	103.4	16.8
Landrace	1st	88.9	113.5	8.4	6.8	11.3	98.2	19.1
	2nd	90.7	113.7	8.6	7.0	12.4	101.3	17.7
	3rd	86.1	113.6	7.7	6.0	10.5	78.6	22.0
Duroc	1st	84.3	114.9	8.1	6.7	11.5	90.3	17.8
	2nd	87.9	114.9	8.0	6.5	11.8	85.5	19.4
	3rd	81.5	114.9	7.1	6.4	10.9	83.1	9.9
Hampshire	1st	82.4	114.6	7.8	6.3	10.9	79.9	19.2
	2nd	80.5	114.6	7.5	6.1	11.3	79.9	18.5
	3rd	78.3	114.4	9.9	6.9	13.6	78.0	30.2

Table 13. Reproduction of Corriedale and Romney ewes after introduction into Taiwan

Breed	Breeding season	Flock mating	Lambing season	Sex ratio (%)	Conception rate* (%)	Lambing crop** (%)	Twinning rate (%)
Corriedale	From the middle of November to the middle of January	From November 15 to December 28 (43 ewes mated)	April	53	86.0	93.0	6.97
Romney	From late November to early February	From November 15 to December 28 (33 ewes mated)	April	58	69.7	87.9	18.10

* Ewes conceived/ewes mated
** Lambs born/ewes mated

Source: Chang & Liu 1970

The Barbados Blackbelly reach puberty at the age of about 11 months. After puberty, the ewes tend to have a relatively restricted breeding season in the period from September to February, (TLRI 1977), but some may exhibit oestrus throughout the year (Tsay 1979). According to TLRI (1978) 2 out of 8 ewes lambed twice in 1977. Both these two had a single lamb in February and twins at the second lambing, one in July and the other in August (Tsay 1979). The lambing crop is 150% with a twinning rate of 50%, and a triplet rate of 4% (TLRI 1977). The birth weight of the lambs, irrespective of sex, averages 3.6 kg for the singles and 2.2 kg for multiple births (TLRI 1977). The gestation period is 150-152 days (Tsay 1979).

V. BREEDING

A. Cattle

Attempts have been made to test the crossing of Red Sindhi and Holstein or Yellow cattle to produce progeny of higher milk productivity and better heat tolerance for subtropical Taiwan. After detailed experiments, this work was discontinued in 1972 in view of the higher productivity of Holstein cows newly imported by private dairy farms. From an economic viewpoint, the value of introducing Murrah for crossing with Chinese water buffaloes to improve milk production is doubtful, especially after the importation of 622 Holstein cows from the U.S.A., 337 from Australia, and 5,371 from New Zealand during the period from 1972 to 1974, together with Holstein frozen semen from more than 5 bull studs in U.S.A. with a Predicted Difference of 400 or more for each sire for the insemination of those imported Holstein cows. The more recent hitherto unpublished data shows that milk production (305 day, twice daily milking, mature equivalent) for the top ten Holstein milking cows in the year 1977 was 6,614-7,812 kg and for the top ten in the year 1978, 7,956-9,395 kg (Chyr 1979). These yields of selected cows may be compared with the average yield for all Holstein cows (Table 19). From these facts, it may be seen that the breeding plan for the genetic improvement of dairy cattle emphasizes the use of pure Holsteins only. A program somewhat like the herdmate comparisons, which is being used by the D.H.I.A. in the U.S.A., is being planned.

The raising of beef cattle is still in the stage of evaluation of their adaptability to local climate by the introduction of a number of Santa Gertrudis, Hereford, Angus and Simmental, and the grading of Yellow cattle by crossing with Santa Gertrudis bulls or by using frozen semen of Charolais, Simmental, Angus, Hereford and Santa Gertrudis from the U.S.A. Some preliminary results, which have been mentioned in Sections III and IV, indicate that the raising of beef cattle of European origin and their grades is not too promising.

B. Swine

Of all the domestic animals in Taiwan, swine have received most attention. Every effort has been made to improve the quality of pigs. After World War II, people still kept using Berkshire boars to cross with the Taoyuan sows for producing F_1 for meat production. Later on, it was found that the female F_1 of either Yorkshire x Landrace or Landrace x Yorkshire crossed with the Duroc boar produced much better progeny for meat production. Consequently, after the beginning of the 1960's, the so-called three-breed crosses became more popular for meat production. The TLRI maintains nucleus stocks of purebred Hampshire, Yorkshire, Duroc and Landrace, which are being constantly improved through rigorous selection. Selection for breeding boars starts at the age of 8 weeks, with those having a body weight of 12 kg or more, and emphasizes daily gain, feed efficiency, age at 90 kg body weight, and backfat thickness. Reports from TLRI (1977) for the performance of selected animals of 4 different breeds are summarized in Table 14. From 1978 on, the performance of each boar has been scored on a selection index from the formula:

Index = 250 + 110 x daily gain (kg) - 50 x feed efficiency (kg of feed consumed per kg of body gain) - 19.685 x backfat thickness (cm)

Table 14. Performance of selected boars from 4 different breeds, and the average performance of all tested boars

	Duroc	Hampshire	Yorkshire	Landrace
No. of animals in the original population	95	42	71	72
No. of selected animals	13	8	10	7
Performance of the selected animals:				
Daily gain, kg	0.77±0.08	0.75±0.07	0.79±0.06	0.73±0.07
Feed efficiency*	2.48±0.21	2.54±0.33	2.44±0.32	2.76±0.34
Thickness of back fat, cm	1.89±0.55	1.66±0.57	2.07±0.48	2.39±0.39
Age at 90 kg, day	164.9± 8.69	168.2± 9.34	159.0± 8.77	170.0±11.06
Performance of all tested animals:				
Daily gain, kg	0.71±0.11	0.70±0.09	0.68±0.12	0.65±0.08
Feed efficiency*	2.71±0.43	2.78±0.31	2.86±0.48	3.16±0.55
Thickness of back fat, cm	2.07±0.55	1.83±0.41	2.05±0.44	2.68±0.50
Age at 90 kg, day	175.2±16.08	180.5±16.17	172.6±17.76	173.8±15.60

* Expressed as kg of feed consumed per kg gain

Source: TLRI 1977

Only 30% of the animals with the highest scores from the tested population are saved for breeding purposes. The selection criteria for breeding gilts are based on the number of littermates (more than 6 for Hampshire and 8 for the other three breeds), breed characteristics without any abnormalities and hereditary deformities, normal development of mammary glands with the teats arranged in two rows of 6 or more each, weight of 12 kg or more at the age of 8 weeks, normal reproductive organs, and better performance, including daily gain (30 kg to 90 kg body weight), age at 90 kg body weight and backfat thickness at 90 kg (TLRI 1978). The TLRI operates seven substations engaged in producing Landrace x Yorkshire or Yorkshire x Landrace hybrid gilts, which are sold to farmers for mating with Duroc boars. Performances of these boars are tested and they are distributed to artificial insemination stations.

The AIRI of TSC also maintains nucleus stocks of purebred Yorkshire, Duroc and Landrace for TSC's own use. The selection program is the same as that used in the TLRI. Shen (1978) indicated the performances of the selected boars for the foundation stocks as follows:

	Landrace	Yorkshire	Duroc
Age at 90 kg body weight (days)	167.4	169.2	174.0
Daily gain (kg)	0.723	0.735	0.700
Feed efficiency (kg feed per kg body gain)	2.80	2.72	2.83
Body length (cm)	114.3	113.1	112.2
Backfat thickness (live probe) (cm)	2.33	2.29	2.22

Recently, a central swine performance testing station, with 600 individual testing pens, has been established at the Pig Research Institute in Chunan, Miaoli. Government institutes as well as private swine farms can send their young boars weighing 24-26 kg to this station for testing. Testing begins when the young boar weighs 30 kg and ends when it weighs 90 kg. At the end of testing, the selection index for each boar is calculated according to the same formula as that used by the TLRI. Generally, about 50% of the tested boars are saved and sold by auction for breeding. The remaining boars are culled for slaughter. The performance of the tested boars with the highest index in January, 1979, may be a good sample for the testing result as shown in Table 15.

Table 15. The performance of the tested boars with the highest index in January, 1979, and the average performance of all tested boars that passed the test*

Breed	No. of boars	No. of litter mates	Daily gain (kg)	Feed efficiency (kg feed/kg gain)	Backfat thickness (cm)	Age at 90 kg body weight (days)	Index
Highest index boars							
Duroc	1	7	1.07	2.24	2.4	141	208
Hampshire**	1	9	1.06	2.35	2.1	134	208
Yorkshire	1	8	1.10	2.34	2.5	149	205
Landrace	1	9	0.91	2.52	2.4	150	177
All boars passing the test							
Duroc	22	8.2±1.37	0.92±0.08	2.49±0.16	2.3±0.20	161±14.6	181.9±13.06
Yorkshire	9	9.6±2.24	0.97±0.11	2.54±0.15	2.4±0.22	149± 8.6	183.8±13.54
Landrace	2	9	0.90	2.55	2.45	151	173.5

* 56 boars were tested and 34 passed the test. The lowest index among these 34 was 165 of a Yorkshire boar.

** Only one Hampshire boar was tested.

Source: Central Swine Performance Testing Station 1979

In order to keep the breed pure and enlarge its use, as well as to improve its performance, the Provincial Department of Agriculture and Forestry initiated a program of Berkshire Registry in 1952. Because the development of the three-breed crosses excluded the use of Berkshire, this program lasted only for a short time. Recently, a program of registry for Landrace, Yorkshire, Duroc, and Hampshire has been established at the Pig Research Institute. It includes

Breeders' Registration, Reproductivity Registration, Piglet Registration, and Meat Productivity Registration.

C. Other Species

The breeding of other animals, such as goat, deer, water buffalo, and Yellow cattle, is done mainly on the basis of the owner's will without any well-planned or scientific selection and mating systems.

VI. PERFORMANCE

A. Draught

Water buffaloes and Yellow cattle have long been the main working power on farms (Chang 1952b). Their importance, however, has been greatly decreasing since the mechanization of farming. Generally, they are put to work at the age of 2½ to 3 years. The animal can work for quite a long time if the load which he or she draughts weighs only about 1/10 to 1/8 of his or her body weight. When draughting is only for a short time, the load weight should still not be over 1/6 of his or her body weight.

Water buffaloes can be used for 10-15 years while Yellow cattle can be used for 6-12 years only. Water buffaloes and Yellow cattle, which are used for transportation, usually work 227 days per year. If they are used for farming, they work only 136 days per year. Each water buffalo can plough 11.06 ha of paddy field or 19.29 ha of dry land in four hours, while a Yellow cattle beast can plough 6.3 ha of paddy field and 19.58 ha of dry land. Accordingly, water buffalo are good for paddy fields, while Yellow cattle are best for dry land.

However, with increasing mechanization, farm draught animals work much less than their capacity. For example, it is reported that water buffaloes work for only about 53 days per year. An average buffalo ploughs about 0.25 ha in a working day of from 7 to 8 hours and, during the busy season, one animal is able to cope with the cultivation of 3 ha of paddy field (Lin 1975).

The burden capacity and draught power of the animals of different breeds in Taiwan are summarized in Table 16.

Table 16. Working ability of various animals

Breed	Maximum burden capacity (kg)	Draught power		
		Maximum (kg)	Average (kg)	A cart-load and speed (kg; m/min)
Yellow cattle	691	370	210	155; 60
Kankrej				
Male	1,123	432	294	432; 86
Female	994	402	280	402; 87
Water buffalo				
Female	869	370	287.5	155; 57 Empty; 50
Red Sindhi				
Steer	---	---	330	-------

Source: Chang 1952b

B. Meat Production

Swine are the chief meat animals in Taiwan. The slaughtered water buffaloes and Yellow cattle are only those that are old and unfit for work. Goats also contribute some table meats, but their importance cannot compete with other kinds of meat animals in Taiwan.

TLRI (1964) surveyed the dressing percentage of water buffalo and Yellow cattle in the whole island, and the results are summarized in Table 17. More recently, the average figures of the dressing percentage are given by Taiwan Grain and Feed Development Foundation (1979) as 80% for swine and 52% for all kinds of cattle. The number of animals slaughtered and their meat yields in the period from 1969 to 1978 are shown in Table 18.

C. Milk Production

On account of the thousands of imported Australian, New Zealand and American dairy cattle, the establishment of specialized dairy villages, the use of shelter, and the feeding of well-balanced rations, there is a steady increase of milk production. Almost all imported dairy cattle are Holstein. Only very few are of other breeds, such as Jersey and Illawarra for experimental use. According to Chyr (1979), the most recent milk yield for a milking cow in the specialized dairy villages averages 4,600 kg in a lactation period of 321 days. Table 19 shows milk yields for the period 1969 to 1978.

Table 17. Dressing percentages for water buffalo and Yellow cattle

Age (year)	Dressing percentage	
	Water buffalo	Yellow cattle
8, or under	---	44.5
9	---	46.5
10	---	45.6
11	---	46.0
12	44.8	46.8
13	43.9	46.2
14	43.0	44.9
15	44.9	---*
16	44.2	---
17, or over	47.9	---
(The above data are irrespective of sex)		
Sex, irrespective of age:		
Male, castrated	43.64	46.85
Female	45.19	46.20
Over all results, irrespective of age and sex	44.24	46.67

* For Yellow cattle with an age of 15 years or more, the dressing percentage is considered to be 44.9%.

Table 18. Number of slaughtered animals and meat yields

Year	Total meat yield (mt)	Yellow cattle		Water buffalo		Other cattle*	
		Number slaughtered	Meat yield (mt)	Number slaughtered	Meat yield (mt)	Number slaughtered	Meat yield (mt)
1969	358,520	19,336	3,040	33,293	5,706	1,807	282
1970	403,060	18,124	2,886	35,160	6,056	809	120
1971	408,931	14,374	2,271	29,718	5,194	598	99
1972	433,689	8,282	1,300	16,812	2,936	1,183	189
1973	529,587	10,600	1,675	20,994	3,672	1,558	245
1974	468,426	5,811	916	13,155	2,296	9,607	1,542
1975	400,954	4,090	798	11,692	1,520	9,149	1,976
1976	534,150	31,610	5,123	20,472	3,904	9,295	1,523
1977	591,913	48,245	8,175	23,030	4,469	16,304	3,154
1978	590,287	35,471	5,666	15,421	2,789	7,531	1,528

* Other cattle include beef cattle, culled dairy cattle, hybrids, etc.

Year	Swine			Goat	
	Number slaughtered	Average meat yield/hog (kg)	Total meat yield (mt)	Number slaughtered	Meat yield (mt)
1969	3,634,206	96	348,322	43,225	1,170
1970	4,319,801	91	392,755	45,570	1,243
1971	4,374,787	91	400,062	44,749	1,305
1972	4,537,263	94	428,068	39,525	1,196
1973	5,803,702	90	522,661	41,967	1,334
1974	5,079,403	91	462,484	42,876	1,188
1975	4,224,657	94	395,320	49,083	1,340
1976	5,582,657	93	521,968	59,679	1,630
1977	6,197,405	93	574,656	54,343	1,459
1978	6,204,549	93	579,327	33,249	977

Source: Provincial Department of Agriculture and Forestry 1979

Table 19. Number of milking cows and milk yield

Year	No. of dairy farms	No. of milking cows	Total milk yield (mt)	Milk yield per cow (kg)
1969	394	4,168	14,966	3,591
1970	389	4,430	16,123	3,640
1971	408	4,844	17,906	3,697
1972	546	6,240	22,932	3,675
1973	838	10,127	37,640	3,717
1974	1,290	13,233	41,879	3,165
1975	1,321	14,035	46,189	3,291
1976	1,326	12,793	45,111	3,526
1977	1,002	12,608	45,727	3,627
1978	804	11,834	44,615	3,770

Source: Provincial Department of Agriculture and Forestry 1979

D. Wool Production

Wool production in Taiwan is practically insignificant. However, the data recorded at the Heng-Chun Branch Station may be of some value for reference. Sheep are shorn twice a year in November and April-May. Irrespective of their ages and breeds (Corriedale and Romney), the yearly wool production for Taiwan-born sheep was 3.30-3.83 kg for rams and 3.08-3.18 for ewes. The wool length of the shoulder, rib, and rump of the Corriedale at 3-4 years was 9.4, 9.3 and 9.8 cm in April and 6.8, 8.8 and 8.8 cm in November; that of the Romney was 11.5, 11.8 and 12.7 cm in April and 8.1, 8.8 and 10.1 cm in November, respectively (Chang and Liu 1970).

The wool quality examined by the Reward Wool Industry Co. in 1970 is reported as : fineness 38/56's; length, $2\frac{1}{2}$-$3\frac{1}{4}$"; colour and lustre, good/fair; soundness, +; burr and seed, N.F.; style and condition, good; and estimated yield, 65% (Chang and Liu 1970).

VII. POULTRY

A. Description

1. Chickens

Chickens have been present in Taiwan since unknown times, though the native chicken has lost its original characteristics for a long time because of mingling with the imported breeds, such as Rhode Island Red, New Hampshire, Australorp, Barred Plymouth Rock, Leghorn, etc. However, the native chicken still keeps its broody nature, and its heat tolerance and disease resistance are much better than those of any imported pure breed. Body size and feather colour are not only dependent on the places where the chickens are being raised but also on the individual. Most native chickens weigh about 2 kg for mature males and 1.5 kg for mature females.

Recently, on account of the introduction of modern strains of black chickens, the Fung-Tsai-Chi, meaning mimic native chicken, with black feathers has been produced by using females of the modern black strains, such as Harco, to cross with Dark Cornish males. In addition, franchise hatcheries sell baby chicks of black strains to the farmers through the feed shops in the villages. The farmers raise these chicks under the backyard feeding system and let the birds run about. Naturally, it takes more time for the birds to grow, but they become well fleshed and their meat becomes more tasty. People also call such chicken Tu-Chi, meaning native chicken. Accordingly, the meaning of "native chicken" is under considerable change.

2. Ducks

(i) Muscovy ducks: Probably, original Muscovies were introduced from Europe by the Spanish or Portuguese. When and how they were introduced in Taiwan is unknown. However, the presence of Muscovies was mentioned in Taiwanfoo Gazetter (1693). They are vigorous and aggressive birds. The body is long and broad and the carriage is nearly horizontal. There are three varieties in Taiwan based on the colour of the feathers: Pure White, Pure Black, and White and Black. The most popular one is the White and Black, which has black plumage covering the whole body except the white plumage in the wing bow and bar. Pure Black is the next most popular one. Pure White is very scarce, but is steadily increasing because of its use in producing white mule ducks. The bill is black tinted with red. The toes and shank are black. The feathers on the forehead are straight. When the birds get angry, those feathers become stiffened. An adult male weighs 4 kg and a female 2-2.5 kg.

(ii) Domestic ducks (Tsai-ya): Originally Domestic ducks were brought into Taiwan by immigrants from the southern part of mainland China. The time of the first introduction is unknown. Females are used not only for egg production but also for crossing with male Muscovies for producing mule ducks. Adult males weigh 1.0-1.2 kg; females, 1.2-1.5 kg. The most striking difference between males and females is in the feathers. Adult females are whitish brown or dark laced brown, while the adult males have 2 pairs of hard and well curled sexual feathers in the tail, arranged in two rows, and the head and upper part of the neck in the males are glossy dark green. Some males may have a white ring surrounding the middle of the neck.

Originally, there were three varieties: Yi-Lan, Ta-Chia, and Ping-Tung, named after their districts. However, after the introduction of white ducks from Japan in 1901, no pure variety could be found any longer and sometimes pure white Tsai-ya could be found in flocks. Recently, on account of the crossing between pure white Tsai-ya and Pekin drakes, a new variety, called by the farmers Kai-ya, meaning "improved duck", is being developed. Accordingly, this breed of ducks is changing extraordinarily fast. An adult male Kai-ya weighs 1.8 kg, while a female weighs 1.6 kg. The typical Kai-ya should be pure white with orange-yellow bill, shank, and toes.

(iii) Mule ducks: This is a cross between Muscovy drakes and female Domestic ducks, and is used for meat production. Being an intergeneric cross, the mule duck lacks reproductive ability. Originally, the colour of the mule duck is brownish black; the back and wing become lustrous in the adult. The bill and shank are dark brown. Occasionally, there are black-white or greyish silver individuals in the flock. However, white mule ducks are being produced since the development of white Kai-Ya.

(iv) Modern breeds from overseas: In 1934, the Japanese introduced the Khaki-Campbell into Taiwan, but no good result was recorded on account of World War II. In 1953, the government introduced the Pekin duck. Owing to its larger size, it was very difficult for the farmers to accept it, but the F_1 or F_2 with colored Tsai-ya have been easily accepted. In 1963, the Indian Runner, Rouen, and White Muscovy were introduced.

3. Geese

The goose is not indigenous to Taiwan. The first record of goose-raising was in the Huang-Shan-Hsien Gazetter (1720). The Taiwan goose is very similar to the goose in the southern part of mainland China, whence the original goose was evidently introduced by immigrants. Taiwan's geese may be divided into two varieties, White and Greyish. The White variety has a yellow beak, shank, and toes. The feathers are all white. The Greyish variety has a grey beak and sometimes, black shank and toes. Almost all the feathers in the back and the wing are grey, while the feathers in the other parts of the body are all white.

4. Turkeys

The turkey also is not indigenous to Taiwan. The first introduction into Taiwan is not exactly known, but according to the Taiwanfoo Gazetter, published in 1693, turkeys were then being raised. The native turkeys, as now called, are the descendents of those original imported turkeys. During the period 1895-1945, the Japanese introduced a better variety of turkey for improving the performance of native turkeys, but no good results were obtained.

In 1953, the government introduced the Broadbreasted Bronze turkey from the U.S.A. in an attempt to improve the native turkey; again no good results were obtained. In 1963 and 1964, Beltsville Small White Turkeys were introduced and raised at the Kaohsiung Animal Propagation Station.

Native turkeys are scattered all over the island. They may be roughly divided into three varieties:

(i) The White: Feathers are white. Shank and toes are slate. Snood and caruncle are red. At the age of one year, a male weighs about 6 kg and a female weighs about 3 kg. Most of them are raised in the southern part of Taiwan.

(ii) The Black: Feathers are lustrous black. Shank and toes are slate. Snood and caruncle are red. At the age of one year, a male weighs about 5.5 kg, while a female weighs about 3.5 kg. The Black is the most popular variety in Taiwan.

(iii) The Greyish White: Feathers are white with black bars. About two-thirds of the feathers of the whole body are white, while the remaining one-third is black. Shank and toes are greyish slate. Snood and caruncle are red. At the age of one year, a male weighs about 5 kg, while a female weighs about 3 kg. Most of the Greyish White turkeys are raised in the northern part of Taiwan.

Pure varieties are becoming more and more difficult to find because of unrestricted intercrossing between the varieties.

B. Environment, management and feeding

1. Environment

Generally speaking, the natural environment as described in Section III, is not favorable to the imported modern strains of chickens for either egg production or meat production, because of high temperatures and high relative humidity. Accordingly, the construction of chicken houses to allow cooling in hot summers is of special importance. The conventional open-sided house is the most common one in Taiwan. It seems that turkeys, geese, and ducks are less affected by hot and humid weather. However, laying hens and laying ducks do decrease their egg production when they are subject to the attack of the typhoon in the summer and the cold wind from the north in the winter. Some protective measures, such as the administration of antibiotics (*e.g.* Aureomycin) for alleviating the stress caused by the typhoon (Ma *et al.* 1964), and keeping the birds warm in the winter, are considered to be necessary for maintaining normal egg production.

2. Management and feeding

Almost all farmers like to raise some native chickens in their backyard, under the so-called backyard feeding system. Farmers also occasionally raise a few ducks, turkeys or geese under the backyard feeding system for meat, and to collect the down of the ducks and geese for cash. With the ample supply of all kinds of well-balanced poultry feeds, farmers may use them as the basic ration, plus crop by-products.

Ducks are also raised in flocks, usually 300-600 or even up to 1000 or more in one flock, by the specialized duck farmers. Duck farms are usually located in such places as the bank of the river or a pond, or even a ditch, with access to water. The farm is usually surrounded by bamboo fences, and is chiefly made up of two sections, i.e., the exercise yard provided with a swimming pool and the duck house for staying during the night and for laying. The whole house is simply constructed with bamboo and rice straw, or other cheap materials; expensive materials, such as wood and/or bricks, are seldom used. Duck houses in southern Taiwan are about 2.9 m high, while those in northern Taiwan are about 1.9 m high. Inside the duck house, the floor may be of concrete or dirt, and littered with rice straw, rice hull, weed hay, or fine sand. Some duck farmers construct a slatted floor with small and intact bamboos for easy cleaning of the droppings. In egg-producing farms, the corner of the house is always littered with clean and dry rice staw to serve as a nest for laying ducks. The floor space for 100 ducks (either Domestic or Mule) ranges for 9 to 28 m^2. Ducks are fed in troughs. Feeding is carried out in the exercise yard, with the formulated feeds as the basic ration, blended with crop by-products, such as sweet potato chips, crumbled rice, rice bran, wheat bran, vegetables or even rice hull, etc.

Geese are fond of eating grasses, so they are set free in the open ground for grazing. In recent years, some flocks of 200-300 geese, or even up to 8,000, have been established. One of the typical flocks is owned by a farmer Chang near Peitou, Changhua. His flock consists of more than 200 native "lion-head" geese, and is raised in his orchard next to his home. Beside the orchard is a pond for swimming. No house is provided. The geese are fed with formulated feeds as the basic ration, plus crop by-products.

Farmers who raise native chickens only may use the broody hen to incubate the eggs and take care of the baby chicks after hatching. Farmers who like to raise a few ducks, geese, or turkeys, may purchase the young from a hatchery and brood the young in a small box or some such convenience for keeping the young warm for a few weeks until they are able to stand the environmental temperature and take care of themselves. In the duck or goose farm, the young are kept inside the house. When the weather is cold, the young may be kept in a bamboo basket or wood box for keeping warm by their own dissipated heat; there is no special brooding equipment for the young. It is reported that viability under such a brooding system is less than 80% for ducklings. Recently, the brooding method imitated from that used in taking care of baby chicks is being practised in certain research institutes, experimental stations, and large farms, and the mortality is reduced to less than 5%.

After the introduction of modern broiler and laying strains of chickens, a number of private chicken farms on a large scale have been established, and are now scattered all over the island. According to Kao (1979), the former president of the Poultry Association, the size of the flock is getting bigger and bigger. For laying chickens, there are 7-8 farms which each own 500,000 or more layers, about 10 farms which each own 400,000-500,000 layers, 10 or more farms which each own 300,000-400,000 layers, 50 or more farms which each own 200,000-300,000 layers. Only a few farms own less than 200,000. Almost all layers are caged with 1 or 2 layers in each cage. Houses for caged layers are of a completely open type without any surrounding walls. The house is 3 m wide with one row of 2 or 3 decks of cages constructed against each lateral side of the house. Between the cage rows is the central corridor, which is 1 m wide, extending from the front to the back end of the house. The length of the house will depend on the available land and the owner's plan. The height of the house i.e., from the foundation to the roof line, is 4.3 m and the height from the foundation to the overhang is 3.3 m. Generally, breeders are raised on the floor with males and females together. If the breeders are caged, artificial insemination is practised every seven days. The house for the breeders if feeding on the floor, is 12 m wide, 40 m or more long, and 4.3 m high. Inside the house, one-third of the whole floor on either side of the house is constructed as slatted floor against the inner side of each lateral wall, for better ventilation and easy disposal of droppings from the outside. The remaining one-third in the central part of the house is littered. One row of nests is arranged against the lateral wall on either slatted floor.

From the economic point of view, the least number of broilers produced at each time for a broiler farm is 30,000 birds. At the present time, the largest broiler farm in Taiwan has facilities to raise 500,000 birds at the same time. The broilers are sold at the age of 8-9 weeks, weighing 1.8-2.4 kg. The broiler house is 12 m wide and 160 m long, and divided into 40 pens 12 x 4 m each. Each house is able to keep 14,000 broilers with one man to take care of them. Broilers are raised on the floor.

The Hover brooder is the most popular one, with gas or electricity as the heat source. In some farms, slab heating is used in the brooder house. In this method a slab of concrete floor is heated by running pipes through the concrete and forcing warm water through the pipes.

The feeding and management systems for these large farms strictly follow the directions or instructions of the foreign farms which supply the chicks through their franchise hatcheries in Taiwan. Water is supplied ad libitum for all kinds of poultry at all times. The feed efficiencies (kg of feed consumed per kg body gain) for the chicken broiler, chicken layer, meat duck, and duck layer are 2.4, 2.5, 3.4 and 5.0, respectively.

The most serious diseases, such as Marek's disease, Newcastle disease, chicken pox, chronic respiratory disease, and duck virus hepatitis, have been controlled through vaccination. Some diseases, such as bronchitis, fowl cholera, and coccidiosis also have been controlled through timely application of antibiotics and (or) sulfa drugs. Other diseases, such as avian encephalomyelitis, pullorum disease, and infectious laryngotracheitis, have become less serious through elimination of the infected birds, and more progress is being made. Aflatoxiosis was a problem. However, it is not a trouble any longer, since careful examination of the aflatoxin level in the feed is being performed.

C. Reproduction

1. Mating and incubation

Males are always with the females for the native chicken, Domestic duck, Muscovy duck, goose, and turkey under the backyard feeding system and for the Domestic duck in specialized duck breeding farms. Artificial insemination has been practised in crossing Muscovy males with Domestic duck females for producing mule ducks, and with chickens for both egg-producing breeders and meat-producing breeders. Natural incubation occurs in native chickens, geese, Muscovies, and turkeys. A broody female bird can brood her own eggs and eggs of other breeds as well. The number of eggs which can be brooded by a broody female depends on egg size and the body size of the broody female herself. For example, a broody native hen may brood 10-15 chicken eggs, but she can brood only 2-4 goose or turkey eggs. Artificial incubation with modern automatic incubators is practised for the production of ducklings or baby chicks on a large scale. Formerly, the artificial incubation of duck eggs for producing either Domestic ducks or Mule ducks was carried out by the so-called traditional egg-incubator-egg method. The principle for this method is based on the fact that the duck eggs were warmed up by preheated rice hull (later, it was improved by preheating eggs in the incubator) at the beginning of the incubation. Then the incubation temperature was maintained by the heat dissipated from the developing embryo within the egg. The incubation period for chickens, Domestic ducks, Muscovies, Mule ducks, geese, and turkeys is 21, 28, 35, 31, 28 and 28 days, respectively.

2. Chickens

Native chickens reach sexual maturity at the age of about 7 months. The hens lay 60-80 eggs per year and each weighs about 45 gm. Most males may be slaughtered for meat from the age of 6 months to one year. The remaining males may be kept for one more year for breeding. Females may be kept as long as they continue to lay eggs.

Among chickens of modern strains, egg-producing layers generally lay their first eggs at the age of about 5 months and their laying period lasts for one year. The eggs laid in the first 2 weeks of the laying period are too small to be used for hatching. Meat-producing layers lay their first eggs at the age of 5.5 months and their laying period lasts for 8-10 months only. The hen-day egg production is 95% for the egg-producing breeder in the whole laying period, and 80% at the beginning of the laying period for the meat-producing breeder. The hen-day egg production of the meat-producing breeders usually drops to 40-50% by the 8th-10th month of the laying period. By that time these breeders are culled for economic reasons, except when the price of the baby chicks is very high.

When the egg-producing breeders and the meat-producing breeders are kept on the floor, the proportions of males to females is 100 to 1,000 for the former and 150 to 1,000 for the latter. Fertility, hatchability of fertile eggs, and mortality to sexual maturity are 95%, 90% and 5%, respectively, for both egg-producing and meat-producing breeders. However, the mortality for the adult layers by the end of the laying period is almost 40% (Kao 1979).

3. Ducks

The hatching season for the Domestic duck is from March to October in northern Taiwan, and from February to November in southern Taiwan. Domestic duck females lay their first eggs at the age of 4-5 months. The males are usually mated with the females at the age of six months, the ratio of males to females in the breeding flock being 1 to 7-8. The fertility may be over 80%. Natural mating may occur between Muscovy males and Domestic duck females in a pond after handling the Muscovy male to mount the Domestic female several times. This kind of "training" may last for 10-14 weeks. In such cases the ratio of Muscovy males to Domestic duck females averages 1 to 9 with a range of 1 to 7-13. The fertility is only 40-50%, but may sometimes reach 80%. However, fertility can be increased by 10-15% with artificial insemination.

Laying Domestic ducks usually stop laying and begin to moult in autumn. It may take a few months to complete this process. An adult female generally lays 180-200 eggs per year, but one report indicates that one adult female can lay 250 eggs per year. Oviposition generally occurs between 0:00 a.m. to 8:00 a.m., with 95% of the eggs laid between 0:00 a.m. to 6:00 a.m. (Ma 1968). The weight of an egg is about 60 g. Adult Domestic duck males are used for breeding purposes for half a year only, while adult females may be used for laying for 3 years, with a slight decrease of egg production in the last 2 years.

Muscovies reach their sexual maturity at the age of 8-9 months. Females have four laying periods per year and lay about 10 eggs per period. The weight of the egg ranges from 54.8 g to 104.3 g. There is a broody period between each two egg-laying periods. The broodiness can be interrupted by the injection of testosterone (Chyr and Ma 1977). The sex ratio of males to females in a flock is 1 to 4. Mortality to rearing stage is 22.7%.

4. Geese

A flock of native geese in Changhua area shows that the native goose reaches sexual maturity at the age of about 5 months. At that time, the male weighs about 9 kg and the female weighs about 6 kg. The female lays about 40 eggs per year. The laying period (season) is all year round, except the month of June, and most eggs are laid in the winter. Fertility is high if the sex ratio in the flock is 1 male to 4 females. The female can be used for five years, while the male can be used for 7-8 years.

Another experiment at the Kaohsiung Animal Propagation Station (TLRI 1976) indicates that the native goose lays the first egg at the age of 180 days, when its body weight is 4.1 kg. Each egg weighs 110 g on average. The broody instinct is very strong in the females. Females usually regain laying in 20 days after "waking up" from the broodiness if they are not permitted to brood. The laying period (season) lasts from August to April of the next year, most eggs being laid from November to January. Under natural mating, fertility may reach 81%. Hatchability for fertile eggs is 56.4%. Mortality is 5% at the end of brooding.

Figures for the White Roman at the Changhua Animal Propagation Station (TLRI 1975) indicate that it weighs 6.2 kg at the age of 16 weeks, while the native goose weighs only 3.5 kg. The White Roman lays its first egg at the age of 150 days.

5. Turkeys

The native turkey reaches sexual maturity at the age of about 9 months. The hen turkey lays 20-30 eggs per laying period (season). Results of raising Beltsville Small White Turkeys at the Kaohsiung Animal Propagation Station (TLRI 1973b) indicate that the hen turkeys lay their first eggs at the age of 237 to 249 days, when the body weight is 5.4-6.2 kg. The laying period (season) is restricted to the period from December to June of the next year. The number of eggs laid is 74-82, during a 33 weeks' laying period. Fertility is 78.6-90.5%. Hatchability for fertilized eggs is 56.4-66.9%.

Another experiment (TLRI 1974) indicates that the age at first egg is 257.3 days, each egg weighing 71 g on average. The mortality is 28% to 8 weeks of age, and 5% after 8 weeks. Jan (1965) indicated that the mortality is 17.2% at the age of 24 weeks.

D. Breeding

There has not been any well-planned breeding system for native poultry. Selection of males and females is determined by the owner. However, a research program, using reciprocal recurrent selection for selecting white Kai-ya and white Muscovies for the production of white Mule ducks is being done at the Yilan Animal Propagation Station.

Breeders of parent stocks of modern chicken strains are imported on a large scale from other countries, the numbers imported being shown in Table 20.

E. Performance

Egg production for different species and breeds has been mentioned in Section C (Reproduction).

Mule ducks are used for meat production only. They reach their marketable weight, 2.5 kg, at the age of 12 weeks.

Table 20. Number of day-old chicks of the parent stocks from foreign countries (1968-1978)

Year	Broiler	Layer	Total	Reference
1969	651,880	220,874	872,754	Kao 1975
1970	479,999	157,359	637,358	Kao 1975
1971	450,269	301,191	751,460	Kao 1975
1972	713,357	119,301	832,658	Kao 1975
1973	659,559	110,133	769,692	Chen 1974
1974	550,997	134,240	685,237	Chen 1975
1975	703,498	177,648	881,146	Chen 1976
1976	815,366	256,459	1,071,825	Chen 1977
1977	778,042	333,272	1,111,314	Chen 1978
1978	832,798	314,629	1,147,427	Chen 1979

According to a survey by TLRI (1964), the dressing percentage for the native chicken, mule duck, and culled Domestic duck is as follows:

Breed	Sex	Dressing percentage
Native chicken	Male & female	68
Mule duck	Male & female	73-76
Domestic duck	Male	73
	Female	67

The dressing percentage of the imported modern broiler is in the order of 80% (Taiwan Grain and Feed Development Foundation 1979).

Total egg production and numbers of poultry slaughtered per year in the last 10 years are shown in Table 21.

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Table 21. Number of slaughtered poultry and egg production

Year	Number of slaughtered poultry								Hen eggs (Unit:1,000)	Duck eggs
	Total	Old hen	Broiler	Native chicken	Old duck	Mule duck & Muscovy	Goose	Turkey		
1969	46,090,784	...	...	...	...	...	2,999,090	1,044,178	529,071	423,562
1970	47,302,630	...	...	...	...	...	2,968,578	1,092,722	574,961	463,518
1971	51,944,660	...	...	...	...	...	2,835,544	1,097,910	600,559	455,099
1972	65,634,843	2,676,966	20,130,659	21,875,236	...	...	2,796,872	1,152,436	715,307	494,833
1973	66,739,758	2,744,509	24,397,408	21,853,261	...	...	2,736,379	1,209,405	762,875	515,494
1974	71,498,630	2,879,973	25,604,295	21,531,038	1,645,036	15,872,969	2,719,925	1,245,394	797,162	437,014
1975	78,655,087	3,707,906	30,915,848	21,420,622	1,722,665	16,876,393	2,697,210	1,314,443	980,332	478,756
1976	88,949,551	4,599,415	38,627,121	21,549,943	1,764,999	18,325,554	2,705,326	1,377,193	1,209,968	478,849
1977	106,453,402	5,711,094	51,110,494	22,290,022	1,814,882	21,335,836	2,793,443	1,397,631	1,377,426	469,254
1978	122,188,019	6,685,910	61,387,438	23,389,937	1,901,917	24,504,452	2,920,363	1,398,002	1,743,175	517,664

Source: Provincial Department of Agriculture and Forestry 1979

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Discussion

Barker: I would like to draw attention to the apparent lack of adaptation in the imported pig and sheep breeds, which showed decreased reproductive performance over only a few years.

In evaluating imported, so-called improved breeds, it is important to evaluate not just productive traits (e.g. growth rate) but also reproductive and adaptive traits, and to consider the total value (i.e. economic return to the farmer) as the final criterion.

Ma: I agree that this is most important.

Mukherjee: True comparisons of exotic breeds with native breeds can be made only when management levels are the same for both groups of animals.

Turner: Dr. Mukherjee's comment is most important. Often when breeds are introduced, data for these exotic breeds are obtained in an experiment station, but are compared with data for local breeds under village conditions. Such comparisons are meaningless.

There is a further point that even if comparisons are made under the same conditions, immediate distribution of an exotic breed throughout the population usually is not possible. Crossbreeding with the local population generally will be involved, and therefore the initial evaluation should include the exotic, the local breed and the cross between them, and this evaluation should be made in the environment where the animals will be used commercially.

Wilkins: The question whether the introduction of exotic breeds is good or bad depends on the management environment to which they are introduced. Where they are to be kept under entirely artificial conditions, then the introduction may be desirable for social or economic reasons. Where partial environmental management is possible, introduced exotics may well perform better than native breeds, since the latter may not be adapted to these improved environments. Finally of course, the introduced exotics may be useful in producing hybrids exhibiting heterosis.

Bhat: When talking about introductions, we must be careful to define just what is meant by an adapted breed. Obviously, both genotype and environment are important.

Ma: I would say that those introduced breeds that perform as well, or almost as well as they do in the places from which they come, may be considered adapted.

Clearly the performance of an animal is the product of the interaction of its genotype with its environment, and it is important to distinguish the effects of these two factors. For example, the Hereford and Holstein breeds are more likely to be affected by photosensitization than are other cattle breeds. That is a genetic factor. But animals on Pangola pasture are more likely to be affected than animals on other pastures. That is an environmental factor.

Tanabe: I note that you found very low fertility in Holstein cattle in the summer months. Perhaps in a hot country such as Taiwan, the Murrah dairy buffalo would be more useful. Do you have any data on the Murrah?

Ma: The raising of Murrah for milk production is of no economic value in Taiwan. I believe their milk production is only about 8 kg per day.

Barker: While the average lactation yield of the Holstein in Taiwan is very satisfactory, I would emphasise again that their value relative to improved Murrah buffalo must be determined taking into account other traits such as calving interval, fertility and lifetime production.

ANIMAL GENETIC RESOURCES IN THAILAND

Suntraporn Ratonadilok Na Phuket

I. INTRODUCTION

Approximately 85 percent of the 44 million people of Thailand live in rural areas where agriculture provides the major source of income. Crop, livestock, fisheries and forestry are four major components of agriculture which constitute about 30% of Thailand's G.D.P., 71% of export earnings, and 75% of employment (5).

Although livestock account for only about 13% of agricultural production, they are nevertheless an integral part of the rural economy, constituting a significant source of cash income for small farmers and a capital reserve in the event of crop failure. Livestock bring about 22% of average cash income from the agricultural sector per agricultural household (4). In the North-east, the largest and poorest region, the income from livestock accounts for 30% of average cash income from the agricultural sector. Cattle and buffalo also account for most rural draught power. The livestock and poultry numbers, breeds and uses are shown in Tables 1 and 2.

A. Cattle and buffaloes

Almost all cattle and buffaloes are raised for draught purposes and all those sent to slaughter are over 8 years old, having retired from work on farms. Cattle are predominantly of the indigenous breed. About 50,000 head of crossbred American Brahman are owned by small farmers in the North-east and about two thousand American Brahman cattle are raised on Government farms. About 550 American Brahman bulls are serving in the "Loan Bull" programme, and about 300 American Brahman cattle are on private farms. Dairy cattle numbers are estimated at 10,000 head consisting mainly of Holstein-Friesian cross-breds (6). Jersey, Brown Swiss, Australian Illawarra Shorthorn and German Brown were introduced and produced some crosses, but most were eventually crossed with Holstein-Friesian. There are about 1,200 head of Red Danish-Red Sindhi crosses maintained at the Dairy Promotion Organization's farm. However, the Holstein-Friesian crosses are also expected to replace this herd.

At present the total milk production of the country is about 50 tonnes a day which is only 6-7% of the total requirement, so the government has launched a dairy heifer production programme based on using Holstein-Friesian semen on American Brahman cross-breds to increase the number of milking cows (6).

Buffaloes are essentially all of the indigenous swamp type breed (*Bubalus bubalis*). A few Murrah buffaloes, a riverine breed, are used for milk production by Indian people near the Bangkok suburbs. Small numbers of Murrah-Thai cross bred buffaloes called "Kwai Negro" can also be found.

Buffaloes are used mainly for draught purposes and are essential to the livelihood of Thai farmers. The major portion of beef consumed in the country is from old retired animals. They also comprise the major part of livestock-based exports from Thailand.

Table 1. Livestock Populations of Thailand

Livestock species	Breed type	Uses	Population	Year
Cattle	Native, Zebu, Brahman, Holstein crosses and other crosses exotic breeds	Draught, meat milk, skin	4,705,580	1978
Buffaloes	Native swamp buffalo, Murrah and crosses (very few)	Draught, meat, milk, skin	6,561,575	1978
Pigs	Large White, Landrace, Duroc Jersey, Native and crosses	Meat	4,942,695	1978
Sheep	Native	Meat, wool	10,000	1963
Goats	Native	Meat		
Horses	Native Thoroughbred Arabian cross breeds	Racing, packing, draught	48,002	1977
Asses		Packing	7,998	1977
Mules		Packing	414	1977
Elephant	Native	Work	6,629	1977

Table 2. Poultry Populations of Thailand

Livestock species	Breed type	Uses	Population	Year
Chickens	Rhode Island Red, White Leghorn Commercial meat and egg breeds, Native and many other egg laying breeds and their crosses	Eggs, meat	65,324,000	1978
Ducks	Native, Pekin, Khaki Campbell, Indian Runner and their crosses Muscovy	Eggs, meat	9,013,000	1978
Geese	Native	Meat	214,000	1976
Muscovy Ducks	Muscovy	Meat, pets	na*	
Quails	Native, Japanese	Eggs, meat	na	

* not available

The future demand of buffaloes for work, export and meat cannot be met under the present system of buffalo production, since the rate of increase in buffalo numbers is less than one-half that of human population growth. The basic problem facing Thailand at the present time is how to increase buffalo production to meet this demand.

B. Swine

It has been estimated (12) that about 95-98% of the pigs slaughtered are derived from backyard raising where inputs, especially feed costs, are minimal. The production of weaner pigs has been a significant feature of village pig production, while pig fattening is generally related to rice-mill operations where by-products such as rice bran and broken rice are used as energy feeds. Semi-commercial and commercial scale production of market pigs have come into the picture during recent years and are growing fast towards monopolizing the Bangkok metropolitan market, where about 1,200 pigs are slaughtered each day (3). At present practically all pigs sent to market are cross-breds resulting from a grading-up program with exotic breeds. The predominant breeds in Thailand at present are Large White, Landrace and Duroc Jersey. Many other exotic breeds such as Berkshire, Hampshire, Poland China also have been introduced, but are disappearing. Native pigs also still exist in the remote areas, especially in Southern Thailand, where the livestock industry is not of major interest. Hill-tribe people also are still keeping pigs as scavengers around houses and farms. The distinct breeds of native pigs are Hailum, Raad, Puang and Kwai. Wild boars also exist, and it is often found that native pigs raised in the villages close to the jungle where wild boars still exist, bear the offspring of wild boars.

C. Sheep and goats

Sheep and goats have played only a limited role in livestock production in Thailand but their potential as a good source of meat and milk has been fully recognized by farmers and scientists, especially in the case of goats.

Sheep are raised mainly by Pakistanis for meat purposes. Some sheep are also raised by hill-tribes, especially Karen, to produce wool for making blankets. The number of sheep in Thailand is very limited, and the only census available is from the 1963 Census of Agriculture, where they numbered about 10,000.

The sheep are mainly of indigenous breeds, which are of Indian and/or Arabian origin. Six or seven Dorset rams were imported from U.S.A. by the Baptist Mission and introduced to two Karen villages about 10 years ago, along with the indigenous sheep. In 1975, six Polwarth rams from Australia were also introduced to improve wool quality and body size in these two flocks. Through His Majesty's project, German Merino sheep were imported and donated to 17 hill-tribe villages in December 1970. They have produced a few hundred offspring since then (16, 18, 20, 24, 25, 34).

Almost all goats in Thailand are believed to be raised by Moslems and according to Nozawa (28), Thai native goats are divided into three catagories: (1) ordinary goats being raised by Pakistani people for meat and milk production, (2) small-sized meat goats called "Kambing Katjang" (Malayan language) raised by Moslem people in the southern-most area of Thailand, (3) so-called "hill goats" being kept for meat purposes by several hill-tribes in mountainous areas of Northern Thailand (15).

Exotic breeds such as Saanen, introduced by Kasetsart University for milk production and teaching purposes, have now been distributed among the Pakistani people and have produced many cross-breds.

D. Horses, asses, mules

The latest census of horses in 1977 was 48,002 head, the number having been greatly reduced from the period before 1969, when it was over 170,000 head. A similar situation is also found in mules, where the number has declined from over 1,000 head during the period before 1973 to 43 head in 1977. However, the number of asses has increased rapidly from one or two hundred head before 1976 to 2,021 in 1976 and 7,995 head in 1977. King Rama V first introduced thoroughbred horses from Australia in the early 19th century, for up-grading the Thai pony, and Arabian horses were introduced by military organizations around 1949. Since then, introductions of these two breeds for racing and breeding purposes have been common. The horses found on the race tracks are cross-breds of the two breeds, predominantly thoroughbred. The majority of these race horses are produced in 5 provinces in central areas of the North-east region: Khon Kaen, Roi-et, Mahasarakam, Kalasin and Buriram where there are estimated to be over 3,000 head.

Besides the ponies raised by the hill-tribes in mountainous areas, Thai ponies can be found throughout the country, but are concentrated in two major areas where horse carts are still being used: in Ubolrajthani province in the North-east and in Lampang province in Northern Thailand. According to Hayashida and Otsuka (17) the Thai pony belongs to a group of small-sized horses in Eastern Asia and has originated from the Yunnan and Szechwan ponies in China proper.

Asses and mules are raised mainly by hill-tribe people, and in military units for carriage purposes. Two breeds of asses were introduced to Thailand for producing mules for military uses, the American Jack from the United States and the Manjukok from Manchuria (54). The American Jack produces taller mules which are easier to train than those produced from Manjukok asses. However, the Manjukok asses sire very strong and tolerant mules.

E. Elephants

In the past the Thai elephant played important roles in wars and in timber work. Nowadays the forest area is greatly reduced and more mechanization has been developed. The need for elephants for log-hauling is reduced somewhat, resulting in a decline in the number of elephants to 6,629 head in 1977, which was just over a half of what they had been in the period before 1969. The new roles of elephants now are as tourist attractions and for participating in local fairs and ceremonies. The most popular elephant show in Thailand is the "Elephant Roundup" show during mid-November every year at Surin province in the North-east. Elephants in Thailand belong to the Elephas maximus species, the Asiatic elephant.

F. Poultry

1. Chickens

According to official statistics, the number of chickens was estimated at around 65 million in 1978 (4). These are generally produced on commercial farms. However, backyard chicken raising, though generally not counted in a census, must not be overlooked, since practically all farm families raise 5-50 chickens each for home consumption and petty cash, and there are about 4.3 million farm families in Thailand. These farmers are usually not considered as poultry-producers, and the chickens raised are of the indigenous breed, so their contribution is usually overlooked. In a case study (51) in four villages of Kampaengsaen District, Nakornpathom Province, in the central region of the country, it was reported that the average number of chickens per household is 22.34±16.76 and nearly every household (98.1%) raises some chickens. From a survey study in the North-east (32), it was found that about 58% of rural families raise 6 to 20 chickens, about 22% raise less than 6 birds and 20% raise more than 20 chickens with an overall average of about 11.6 chickens per family. This means that in the North-east alone about 35 million chickens, or more than one-half of the census of chickens in the country, were not recorded. Practically all of these chickens are of the indigenous breed.

According to Suwan Vajok Kasikij (45), there are three kinds of indigenous fowls, namely Kai Oo, Kai Jae, and Kai Tapao. At present, the native fowls could still be differentiated into the three catagories, but the differentiations were not clear cut since they constituted typical hybrid populations under random mating systems. Nishida *et al.* (26), throughout their survey investigations on Thai native fowls in 1971 and 1972, classified about half of the native fowls as the game type by body shape.

The commercial chickens raised in Thailand are for egg and meat consumption. The common egg-laying breeds are Rhode Island Red, Leghorn and Barred Plymouth Rock. Other breeds such as Australorp, New Hampshire, White Plymouth Rock and Cornish are also available in small numbers. Some breeds such as Wyandotte, Worthington, Brahma, Kochin, Langshan have been introduced but are not now kept for commercial production. Commercial hybrid chickens are now popular with commercial farmers, both for eggs and meat purposes. Egg producers are Arbor Acres, Hy-line, Goto, etc., and the broilers are Arbor Acre, Cobb, Hubbard, etc.

Jungle fowl are raised as decoy birds for catching other jungle fowl. The real jungle fowl is difficult to domesticate and cross-breds are usually used for this purpose. There are two kinds of jungle fowl found in Thailand, namely the Burmese red jungle fowl (*Gallus gallus spadiceus*) and Tonkinese red jungle fowl (*Gallus gallus gallus*).

2. Ducks

The number of ducks was in the range of 11-12 million birds during 1973-1976, but was reduced to 9 million in 1978 due to the high cost of duck feed resulting from large imports of animal feeds. Ducks are mainly raised on large-scale farms or in large flocks on rice fields after harvest. The ducks raised for commercial purposes are derived mainly from Indian Runner, Khaki Campbell and Pekin breeds. The native breeds are known, according to their major production areas, as Nakornpathom, Paknam or Cholburi type. Most of them are cross-breds or related to one of the exotic breeds mentioned above. Nakornpathom ducks are raised principally for meat and are related to Pekin ducks while Paknam and Cholburi types are raised mainly for egg production and are related to Indian Runner and Khaki Campbell.

3. Muscovy ducks

Muscovy ducks are more common to the rural family than geese but unfortunately there are no data available on their number. They are raised as pets and for non-specific purposes in most villages, especially in Central and Southern Thailand. There is some misconception about the consumption of Muscovy duck meat, more women than men refusing to eat it. It was found (33) that about one-third of the villagers surveyed in the North-east who refuse to take Muscovy duck meat gave as the reason that they are afraid of developing leprosy. However, among those who consume this duck meat, 90% of them like it. This misconception needs to be corrected because the potential of Muscovy ducks as a source of protein in the village seems to be great.

4. Geese

Geese have become more and more popular as common dishes, and young geese are also prepared as "Pekin Duck" in the expensive restaurants. Surprisingly, the number of geese reported (4) was reduced from over 500,000 birds during 1963-1975 to about 214,000 birds in 1976, and there is no figure available for the last 2 years.

Geese raised in Thailand are Chinese geese (Cygnopsis cygnoides) which have a small body size but are a high egg producing type.

5. Japanese quail

Quail eggs are very popular among Thais in different ways of cooking, including making desserts. Quail also provide a good source of meat and are very popular. There are 12 species of quail available in Thailand but the commercial breed is Japanese quail, introduced from Japan during 1947-1955. Even though quail eggs are always available and consumed everywhere in Thailand, there are no data on their number and production.

II. DESCRIPTION, HUSBANDRY AND PERFORMANCE

The characteristics and performance of different breeds of all species described in this paper will be limited to those of indigenous breeds and their crosses. The characters of exotic breeds available in the country are the same as those described elsewhere and will not be repeated. Information on native livestock in Thailand is rather limited, but what is available will be presented. The management and performance of various species are also described in this section.

A. Cattle and buffaloes

1. Description

(i) Size: Thai native cattle are the smallest of the native cattle in eastern Asian countries (31), males weighing about 300 to 400 kg and females 150 to 280 kg, while the native buffalo is the largest swamp buffalo in the same region, males weighing 400-600 kg and females 360-440 kg (30). Mature sizes of cattle and buffaloes from various studies are presented in Table 3. The data also indicate that cattle and buffalo males are still gaining in size up to 7 and 10 years respectively.

(ii) Colour: Cattle have no specific coat colour, but show an assortment ranging from white, grey, brown, dark brown, and black to a mixture of white with other colours. The predominant colour is brown in various shades. The shade of each colour varies from animal to animal. Table 4 shows frequencies of different colours of Thai cattle. From this table it can be observed that the white and grey coat colour of cattle is influenced by the American Brahman in the North-east, where that breed is promoted, and by American Brahman, Burmese cattle and probably some Holstein-Friesian in the North. In the central plains, more spotted cattle are found than in other regions due to the influence of Holstein-Friesian. The grey colour in this area, especially in the Singhburi province, is also influenced by the American Brahman, while in Ayuthya it is influenced by the Zebu cattle of the Indian dairymen. The cattle in the south are practically all native, so brown and black colours are predominant. The Amercian Brahman x native crossbreds manifest greyish or white coat colours, or show a lighter shade of their dam's colour. Animals graded towards the American Brahman show its colour. The Holstein-Friesian cross-breds show some white spots, and sometimes are nearly solid black in colour.

Buffalo have much less hair than cattle, and their coat colour is predominantly black or grey. White buffaloes are present in small proportion, mainly in the North-eastern parts of the country (40). Nozawa and NaPhuket (29) enumerated black or grey and white buffaloes in country areas, mainly by counting from a car travelling

Table 3. Body measurements of mature cattle and buffaloes in Thailand

Species	Sex	Age	Body weight (kg)	Wither height (cm)	Chest girth (cm)	No. animals measured	Studied Site*	Author***
Cattle	Male	Mature**	323.3	-	-	20,399	S	2
		"	370.7±53.6	136.3± 7.3	181.8±10.4	496	S	44
		"	307.7±35.8	127.0± 6.2	162.2± 7.7	230	S	36
		"	-	114.1± 1.2	156.8± 1.9	30	V	31
		"	300 - 400	-	-	-	-	41
		"	327.0±36.7	-	165.3± 6.9	695	-	27
		(5-6 yrs)	279.1±27.2	114.9± 5.3	155.1± 9.4	7	V1	35
		"	264.7±40.4	114.9± 6.3	151.2± 7.7	35	V2	"
		(7 yrs)	321.6±42.0	117.6± 4.5	161.9± 6.1	11	V1	"
		"	321.5±43.7	118.6± 4.6	164.0± 8.0	23	V2	"
	Female	Mature	226.7±24.7	110.0± 5.1	147.8± 9.4	35	V	14
		"	-	119.0± 1.3	158.6± 2.3	20	V	31
		"	195.2±17.3	103.6± 8.9	136.3± 6.9	14	V1	35
		"	182.2±23.1	102.8± 4.7	133.2± 5.6	15	V2	"
		"	235.5	-	-	-	V	41
		"	205.0±18.6	-	136.9± 3.4	435	V	27
Buffalo	Male	Mature	409.6	126.5	185.6	1,018	S	19
		"	534.1	-	-	15,400	S	2
		"	538.9±63.1	137.3±14.6	208.9±11.7	486	S	44
		"	498.7±57.5	131.8± 5.0	196.5± 8.9	287	S	36
		"	529.9	-	-	-	V	41
		"	595.0±78.1	-	208.7±10.5	38	V	27
		(7-9 yrs)	-	136.5± 1.7	194.1± 2.3	9	V	30
		(10 yrs)	-	138.6± 3.6	205.9± 2.6	4	V	"
		(Castrated)	-	136.2± 2.4	208.8± 4.6	12	V	"
	Female	Mature	431.0	-	-	-	V	41
		"	476.0±52.6	-	194.5± 5.6	71	V	27
		(3-4 yrs)	-	120.7± 1.5	180.5± 2.2	12	V	30
		(5-6 yrs)	-	119.3± 1.0	176.7± 2.3	9	V	"
		(7-9 yrs)	-	120.5± 0.8	178.5± 1.5	27	V	"
		(10 yrs)	-	124.5± 0.9	186.3± 1.6	14	V	"

* Symbol for site of studies: S = Slaughter houses, V = Villages, V1, V2 = Specific village case study
** Mature age - usually unstated, assumed to be 4 or more years
*** Numbers refer to bibliography, which covers all species

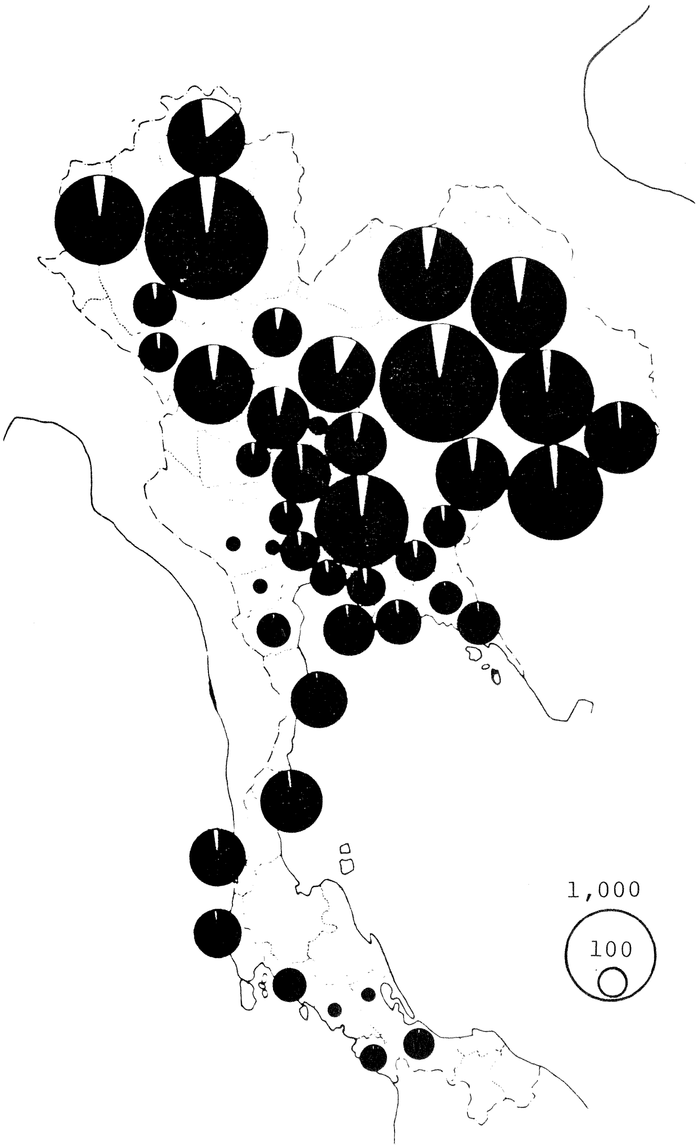

Fig. 1 - Frequency distribution of white gene of water buffaloes in Thailand (1971). Total number of individual's examined: 19,083 (Reference 29).

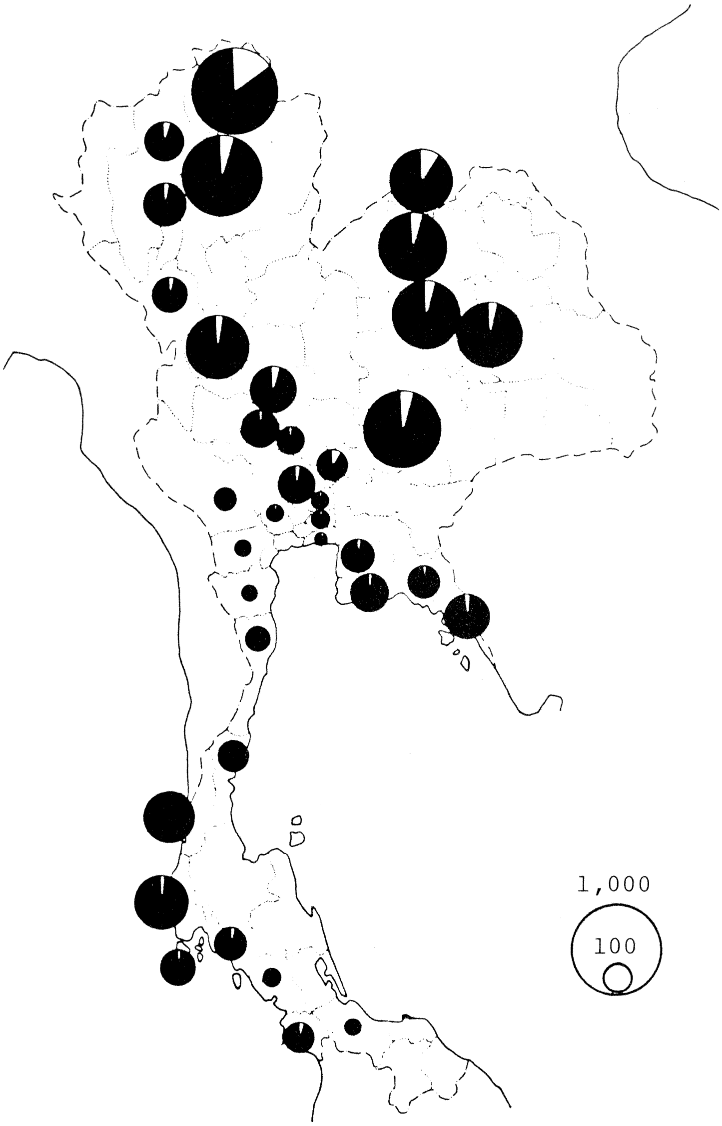

Fig. 2 - Frequency distribution of white gene of water buffaloes in Thailand (1972). Total number of individual's examined: 7,926 (Reference 29).

Table 4. Coat colour of Thai native cattle

Region	Numbers of cattle	Percent which were: White/Grey	Brown	Dark Brown	Black	Spotted	Authors
North and Upper Central	1,541	35.63	53.68	5.94	4.75	(7.66)*	23
Northeast	1,747	29.82	54.15	4.98	11.05	(7.40)	"
Central	1,535	16.81	56.74	10.75	15.70	(15.54)	"
South	2,264	2.83	61.31	10.29	25.57	(19.38)	"
Bangkok	103	23.30	62.13	10.68	3.88	**	44
Nakorn Pathom	404	15.98	40.87	16.55	11.95	14.65	35

* Percentage of spotted cattle calculated separately
** Spotted animals included in major colour classes

on highways. The total number of animals counted was 19,083 during one trip in 1971 and 7,926 for a second trip (1972). The results of the estimation of the frequency of the gene for white coat colour in different provinces are shown here in Figures 1 and 2. A north-south geographical cline of white gene frequencies was clearly observed. The frequency in the North-western province, Chiengrai, was about 15%.

(iii) Ears and horns: Native cattle have small-sized ears and medium-sized horns. The ears are about 16 cm long and 11 cm wide, while the horns are about 15-25 cm long in males and 12-20 cm in females.

Buffaloes possess much bigger and longer horns than cattle. Two types are commonly found in Thailand. The regular-type horns point out and upward, the two horns being very close together. It is also common for horns not to bend inward but to point outward with great length before bending upward, making the tips of the two horns more than one metre apart. The other type of horn commonly found is called "Khao Too"; it is big, thick and short. Some irregular types can also be found, such as loose horns which are not attached firmly to the buffaloes skull. Some buffaloes, usually females, have drooping horns which look like those of some riverine buffalo breeds.

The ears of buffaloes are about 20-24 cm in length; they are situated immediately beneath the horns.

Table 5 shows various measurements of cattle and buffalo horns, ears and tails. The data provided are "averages" from a sample of animals surveyed in Khon Kaen province in August 1979.

(iv) Hump, udder, teats: The humps of Thai native cattle are much smaller than those of Indian cattle, but larger than those of Taiwan yellow cattle (31). Thai buffalo have no hump.

The udder and teats of indigenous cattle and buffalo are relatively small, but the four teats are evenly spaced.

(v) Temperament: Both cattle and buffaloes are docile animals. Buffaloes also have a phlegmatic temperament but may become restless when kept for too long without a refreshing water bath. By submerging in a muddy pool to cover its body with a layer of mud, the buffalo protects itself from insects and solar radiation.

2. Management and feeding

(i) Draught animals: Under existing farming systems in Thailand, which consist

Table 5. Body characteristics of Thai cattle and buffaloes

(a) Horns

Type of animal	Number of animals	Circumference (cm)	Length (cm)	Width between tips of horns (cm)	Width between base of horns (cm)
Native Cattle	31	11.9	10.2	NA	9.7
Cross-bred Brahman Cattle	8	13.3	15.1	24.9	16.5
Male Buffaloes	7	31.8	62.8	74.2	17.3
Female Buffaloes	18	26.1	55.9	63.1	18.5

(b) Ears

		Width at base (cm)	Max. width (cm)	Length (cm)
Native Cattle	31	12.8	NA	16.4
Cross-bred Brahman Cattle	8	15.9	11.9	23.8
Male Buffaloes	7	18.7	16.9	21.2
Female Buffaloes	18	18.9	16.3	20.3

(c) Tail

		Length of tail (cm)	Length of switch (cm)	Circumference (cm)
Native Cattle	31	71.5	37.6	16.1
Cross-bred Brahman Cattle	8	75.0	40.6	23.5
Male Buffaloes	7	65.5	31.6	21.7
Female Buffaloes	18	69.1	36.9	20.5

(d) Hump

		Height (cm)	Length (cm)
Cross-bred Brahman Cattle	8	11.3	22.9

Source: Survey by officers of North-east Livestock Development Project, Khon Kaen, August 1979.

mostly of small holdings with a mixed subsistence and cash economy, farmers have integrated their livestock and crop production. Buffaloes, with cattle, are the main source of draught power, and sometimes also represent the savings of farmers. They are managed according to seasonal conditions.

During the dry season, after the rice and other crops have been harvested, buffaloes and cattle are herded on the croplands, where they graze on indigenous weeds and harvest wastes. Later in the dry season, farmers supplement their animals' dwindling diet with rice straw, which is conserved after each harvest. In the Central Plain and other extensive rice producing areas, animals are also supplied with fresh indigenous grasses growing along irrigation and drainage canals.

During the rainy season, when paddy fields and upland crop areas are being cultivated, the area available for grazing is gradually reduced. Draught animals graze on the paddy fields and on the diminishing area of uncultivated land, while the rest are herded on to upland communal grazing areas and/or forest land, where the working animals join them after the crops have been planted. Areas along roadsides, school playing fields, borders between croplands and around ponds and waterways are also grazed.

It is thus obvious that the area available for grazing is greater in the dry season than it is in the wet season. On the average, the communal grazing areas are stocked at a rate of 3.2 hectares (20 rai) per grazing animal. In the North-east, the major species of grasses contributing to forage resources are lalang (*Imperata cylindrica*) and sour grass (*Paspalum conjugatum*). Mauritius grass (*Brachiaria mutica*), an exotic species, also appears to be naturalizing and spreading in damp areas, especially in Central and Southern Thailand. The time when feed is in shortest supply is not in the dry season, but during the period just prior to crop harvesting (approximately November and December). After the crops have been harvested and stock are allowed to graze on croplands and paddy fields, buffaloes immediately improve in condition at a much faster rate than cattle.

Under this semi-subsistence farming system, the major cost of livestock production to the individual farmer is the capital required to purchase a new animal. Management and husbandry cost farmers very little. At night time, animals are kept underneath the house or in nearby corrals which have no specially constructed shading.

Most of the labour used in cattle and buffalo care is for herding, except during the period from June to August, when forage gathering is a major task, especially in the major rice production areas. Labour inputs for castration, branding, parasite and disease control and repair of facilities are negligible. Buffalo herding does not provide full time employment for each individual in the small holder sector, the task of watching the family herd being allotted to the youngsters of the farming household; this is labour with little or no cost.

(ii) Dairy cattle: Most dairy cattle are managed in a stall feeding system. The milking cows are kept in the milking barn almost continuously. Dry cows and heifers are tied under trees or other available shade. Calves are confined together in small cages next to or in the milking barns for the convenience of taking them to the cows at milking time to stimulate milk let-down. Usually cows with Red Sindhi or Zebu blood need stimulants. Most roughages fed to dairy cows are hand harvested from waste areas. Some groups of farmers travel as far as 100 km to collect pasture and need to share the cost of the trucks for this operation. Para and native grasses are the major roughage sources for dairy cattle. Except for the dairy settlement colonies, there are very few farmers who grow grasses for forage and the amount produced is merely a supplement to the grass harvested elsewhere. All farm byproducts and wastes are used for cattle feed whenever available. In the dairy settlement colonies where land is provided to develop pasture the milking cows are allowed to graze on private pasture but dry cows and heifers are usually driven to communal pasture. Additional grass is also necessary for this group of farmers because they continue to increase their dairy cattle numbers. Pasture is cut and carried to farms from road sides or wherever else it is available. It is common practice for all dairy farmers to feed concentrates to milking cows while they are milking.

Since most farmers have few cows, bulls are not normally kept for breeding purposes. Almost all dairy farmers have their cows bred by artificial insemination provided by the government.

3. Breeding practices

(i) Breeding season: The herding pattern of buffaloes and cattle follows a seasonal trend. When crops are planted, animals are herded in small groups, to avoid trampling and crop damage. It is only after one of the major crops has been harvested that animals are run together as a large herd, non-castrated and incompletely castrated males then being able to circulate and mate. In most cases, this is in the cool period, beginning at the time of the rice harvest in December and January. As a large percentage of conceptions occur in January-March, the bulk of cattle calving takes place during the October-December period. Under similar circumstances, buffaloes, with their longer gestation period of 322 days (about 40 days more than cattle), have their calving peak falling later, from November-February. It appears, however, that the breeding season is continuous.

Village case studies at Mab Kae and Nong Jek Lee, which are corn-producing villages, reveal increased cattle births in June and July; De Boer (13) suggests that, after the corn harvest in September and October, corn stover is grazed by larger herds of cattle, and mating occurs during this period, resulting in June and July calving. The same thing can also happen with buffaloes, as was indicated in the result of a controlled mating experiment conducted at the Northeast Agricultural Center, Khon Kaen in 1971 (37). Twenty buffalo heifers varying in age from 17 to 29 months were bred in the offseason, during July through October (5 each month); in July 9 heifers were in heat and 7 instead of 5 were bred because the bull got to them. Mating was reduced to four in August, to leave enough animals for later months. Results showed that buffaloes are not seasonal breeders, and that offseason mating is effective as ten out of eleven heifers conceived at the first service.

The seasonal breeding of cattle and buffaloes living under village conditions is fortunate, especially for the calf, for many reasons which have been described previously (38). The suitability of these phenomena has been described elsewhere (33).

(ii) Castration of bulls: Except in Southern Thailand and in areas along the Mekong River, it is common practice in most villages to castrate cattle and buffalo bulls at about three years of age; thus insufficient mature bulls are available for service. The cow is served either by an immature bull or one which has been incompletely castrated. This results in a lower conception rate, which in turn reduces reproductive efficiency. There is a long calving interval, and cows are frequently quite old at first calving.

Under the present system of breeding management, there is negative selection for growth efficiency. A young, fast-growing male is likely to be castrated at a younger age than slower growing animals, since he reaches working size and shows sexual characters at an earlier age. This efficient young male has a lesser chance of mating during the period from puberty to castration time than slower growing animals.

If efficient young bulls could be selected for mating with the village cows and heifers, and if heifers could be raised with this type of bull on separate community pastures, the reproductive efficiency and production potential of the village buffalo population could be greatly improved. Experimental evidence suggests that the average mating age could be reduced to about 2 years, with the first calving at about 3 years; the calving interval could be reduced to 1-1½ years if the management of the breeding herd were improved and good quality males used as herd sires (35).

4. Disease and parasite control program

Disease control programs for village cattle and buffaloes are provided by the Department of Livestock Development free of charge. Throughout the country, animals are vaccinated for haemorrhagic septicemia twice a year, while vaccinations for foot-and-mouth disease and anthrax are provided whenever outbreaks occur and in the buffer zone areas south of Bangkok. Rinderpest vaccination is carried out once a year in the border areas adjacent to Laos and Kampuchea.

Sarcoptes and Haematopinus spp. are serious skin parasites of buffaloes in North-east Thailand, being particularly serious in the dry season (28), or if the animals are confined in a compound without access to a water or mud hole. Under the existing management system it is difficult to control disease and parasitic infestations, while economic conditions give farmers no incentive to invest in a prophylactic program. Some type of production-oriented scheme based on co-operative farming should be developed, so that disease and parasite control programmes and improved herd management practices could be effectively adopted.

5. Performance

(i) Weights and gains: Available data on birth weight, weaning weight, yearling weight and pre- and post-weaning gain of native cattle and their cross-breds from exotic beef and dairy bulls are presented in Table 6. The birth weights of native cattle and the cross-bred animals are within the range of 15-24 kg. The higher graded animals and exotic breeds have higher birth weights under the same feeding and management.

Cross-bred animals from native cows, sired by exotic beef breeds, have out-gained the pure-bred native cattle by 30% to 65% under normal management and feeding on stations, and have higher weaning weights. But under poorer feeding and management (9) the cross-bred animals grow at the same rate as do native cattle in their normal environment (10). However, in this experiment (9) it was demonstrated that crossbred animals from different sire breeds showed no difference in pre-weaning weight gain if dams were from the same breed, since this trait reflected mothering ability. It can also be observed that the crossbreds from the native dams grew faster than the native calves after weaning, and the cross-bred animals sired by Brahman (Bos indicus) outgained the cross-breds sired by Charolais (Bos taurus) under the Thai environment and feeding system.

Native cattle have shown a response to the feeding of concentrated feed supplement. Under a fattening scheme of supplementing with pineapple bran and urea (49), yearling native cattle (6 male and 6 female) gained 585 grams per day, whereas without supplemental feeding they (3 male and 3 female) gained only 324 grams per day.

The size and growth of buffaloes are generally superior to those of native cattle and cross-breds. At birth, buffalo calves average 27.5 kg for males and 25.4 kg for females (11), compared with 15-24 kg for native and cross-bred calves (9, 10, 56). The average daily gain of buffaloes from birth to one year has been found by Rufener (41) to be slightly higher than that of local cattle; the average daily gains were 0.41 and 0.38 kg, respectively. An experiment carried out at the North-east Agricultural Centre compared the growth rate of 20 Brahman

Table 6. Growth performance (kg) of Thai native cattle and crosses

Breed	Birth wt	Weaning wt	Yearling wt	Gain per day: Pre-weaning	Gain per day: Post-weaning	Author
Native (N)	15.3(213)†	85.3(95)	120.5(11)	0.340(95)	0.269(11)	10
	16.4(28)	119.2(28;250d)††	-	-	-	56
	-	-	127.9(24)†††	-	0.26(8;196d)	39
					0.35(8;196d)	"
					0.32(8;196d)	"
Brahman (B)	29.7(22)	192.4(22;250d)	-	-	-	56
BN	19.8(234)	116.3(58)	179.7(53)	0.462(85)	0.451(53)	10
	21.1(16)	139.2(16;250d)	-	-	-	56
BBN	23.3(9)	-	-	-	-	10
Zebu (Z)	21.9(23)	148.3(23;250d)	-	-	-	56
ZN	18.4(18)	123.0(18;250d)	-	-	-	56
CN*	20.2(56)	137.2(13)	145.7(12)	0.562(13)	0.345(12)	10
	18.5(4)	98.2(4)	-	0.34 (4)	-	9
CCN	18.9(18)	-	-	-	-	10
HN**	17.3(13)	102.3(12)	-	0.35 (12)	-	9
RN***	16.3(35)	102.5(27)	-	0.36 (26)	-	9
	-	-	-	-	0.3(10;163d)	8
	-	-	-	-	0.2(9;163d)	"

*Charolais x Native ** Hereford x Native *** Red Sindhi x Native
†Number of animals †† Number of animals and days of age ††† Data for females, all other data pertain to males

grade heifers and 20 selected buffalo heifers of about 15 months old grazing native and para grass pasture, supplemented with rice straw and rice straw plus concentrate. Buffaloes consumed very little concentrated supplement, but at the end of one year their average daily gain was 0.34 kg, while that of cattle was 0.29 kg. When pasture growth was abundant in the wet season, the buffaloes gained 0.65 kg a day and the cattle 0.44 kg. These results indicate the potential of the buffalo as a meat producer.

The dressing percentage of buffalo carcases has been examined in many studies; although accurate data on the age of these beasts was lacking, most of them were old work animals. The percentages in some studies were 41.8, 43.0 and 46.9 (55, 43, 7). In other studies (44, 36), the dressing percentages of buffaloes were 48.9 and 46.0 respectively, compared with mature cattle figures of 58.8 and 53.9. In other words, the dressing percentage of buffaloes is generally slightly lower than that of cattle, probably owing to their larger internal organs, bones and horns, and their heavier hides.

(ii) Milk production: From a recent visit to one of the major dairy areas in Rajburi province, about 100 km southeast of Bangkok, where about 8,000 dairy cows are raised, it was found that average milk production of about 3,800 cows is about 6-7 litres a day. This production was in the same range as that in the Kasetsart University herd (1). Some of the top performers produced about 15 to 20 litres a day and some herds produced an average of 10 litres per cow per day.

B. Swine

1. Description

On morphological observations, Thai native pigs are classified into three types:

(i) The Hainan breed, also called "Hailum", raised in the southern region. Its colour is black and white, and it has a short, straight snout, hollowed back, large belly and small, erect ears.

(ii) A breed raised throughout the country, called Raad in the north, where it is most numerous, Puang in the north-east and Ka Done or Keopra in the south. It is black in colour, with a long, straight snout, straight or slightly hollowed back and small, erect ears.

(iii) The Kwai breed (which means "buffalo"), raised mainly in the north. It is large, black in colour, with white legs; this colour pattern is the main way of differentiating it from the Hailum breed.

The weight range for Hailum pigs has been reported as 110-120 kg, and for male and female Kwai as 125-150 kg and 110-125 kg respectively (51). It is estimated that the weights of Raad or Keopra pigs are in the range of 60-80 kg.

Comparison of body size among the three types of adult native pigs was made by means of body height and length and chest girth measurements (46) as shown in Table 7. In the same study it was reported that the average number of teats of the Hainan breed is significantly more than for the other two types, and that the teat numbers for all three types of Thai native pigs are less than those of Berkshire pigs in Japan. The number of teats in different breeds are shown in Table 8. The number of teats of native pigs is generally less than those of European breeds, even though the litter size of native pigs is usually greater.

Table 7. Average body measurements of various breeds or types of Native pigs in Thailand (46)

Breed or type	Sex	No	Height (cm)	Length (cm)	Chest Girth (cm)
Hailum	Male	6	58.1±2.30	101.4±3.78	97.6±4.54
	Female	20	57.2±2.30	102.1±3.86	98.6±3.81
Raad	Male	8	52.7±1.43	86.6±2.43	85.3±2.12
	Female	14	51.9±2.97	84.0±2.77	85.7±2.99
Kwai	Male	10	70.3±2.51	127.4±3.40	130.1±2.62
	Female	8	71.2±1.88	127.5±6.88	131.8±3.66

Table 8. Number of teats of Thai Native pigs and Berkshire (46)

Breed or type	No of sows	Range	Means
Hailum	53	10-14	11.94±0.18
Raad	43	9-12	10.26±0.11
Kwai	18	10-12	10.44±0.20
Berkshire*	3,636	9-17	13.11±0.02

* Cited from Makita (1965) by Tanaka (46)

2. Management and feeding

There are two classes of swine production, backyard and commercial; the management, feeding and breeding systems being completely different.

(i) Backyard production by small farmers: Feeder pig production is common among small farmers. In one case study (51), 96 percent of pig producers in the villages were producing piglets for sale. Sows are fed with only minimum amounts of rice bran and broken rice. The major sources of feed include weeds or crop wastes available locally, such as water hyacinth, morning glory, banana stems, grasses, sweet potato vines etc, as well as garbage. About 39 percent of farmers give supplements of mixed concentrated feed to piglets (51), while the other 61 percent give no supplements but let the piglets eat poor quality feed with the dam scavenging round the houses.

Housing for sows and piglets is generally of minimum standard. Sows are usually tied round the neck, across the forelegs or around the leg, or otherwise kept confined under the house in a pen built of cheap materials. A few have separate barns with concrete floors and iron roofs, while a small proportion are let run loose with only feeding troughs available to them.

The proportion of pigs managed under these systems varies from village to village. In Kampangsaen villages about 75 percent of sows are kept confined or tied under the houses or trees, and only 2 percent are allowed to run free around the houses (51).

Labour for pig-raising is provided mainly by women; in the case study mentioned above the women's contribution was 79 percent.

Piglets are generally weaned at 8 weeks of age, and males are usually castrated before entering the fattening period.

(ii) Commercial production: Large scale pig production is generally associated with rice mills or factories from which waste products can be used as pig feeds. The main sources of energy in pig feeds are commonly rice bran, broken rice and various kinds of waste such as garbage, Chinese noodle factory waste, etc.

During 1975, approximately 428,000 tonnes of mixed feed were produced (21), but only about one-fourth of this amount went to pig feeding, mostly in the form of premixes. Most commercial pig producers buy premixes to formulate their own rations, using in addition cheaper feed ingredients.

More specialized producers may provide houses with concrete floors for their pigs, while commercial producers build more sophisticated and expensive pig barns. Some commercial producers also produce breeding stock, and most of those in this group also produce feeder pigs depending on the demand of the market. Most feeder pigs from such farms are cross-bred or three way crosses of the main exotic breeds, Large White, Landrace and Duroc Jersey. The management, feeding and breeding systems in these farms are of a high standard. These farms are mostly developed from Government Sponsored Pig Breeding Farms.

Commercial producers may wean piglets at 5-6 weeks, to produce more pigs per sow per year.

3. Breeding

Since small farmers generally raise only about 1 to 5 sows, matings are obtained through contract service provided by other farmers operating a boar service. Usually the sow in heat is taken to the boar. Service can also be obtained by taking sows to the Government Livestock Stations or Breeding Centres. Artificial insemination is also provided by the government A.I. stations, but these stations and centres are limited in number and farmers prefer to deal with boar service operators. From case studies in four villages in the Central Region (51), the services of 3 operators were recorded at 1.52±0.80, 0.91±0.76 and 0.68±0.70 per boar per day. The service charge per conception for Landrace and Large White boars is 2.5 U.S. dollars, while 2 U.S. dollars are charged for Duroc Jersey boars. At present the charge for contract mating ranges from 2 to 3 U.S. dollars throughout the country.

4. Performance

In small village farms and large scale pig fattening farms, cross-bred pigs require 6 to 8 months on a medium plane of nutrition before they reach a weight of 100 kg, and very often farmers will let the pigs grow to a weight of 135-140 kg. Commercial producers finish their pigs at about 100 kg within 6 months.

Production for native and cross-bred pigs under commercial and village conditions has not been recorded. Only production data under different feeding trials are available and then mainly of the three way cross-breds of Landrace, Large White and Duroc Jersey. The average daily gains range from about 500 to 836 g with feed conversion efficiencies ranging from 0.22 to 0.34 (gain/feed), depending mainly on ingredients used for feed (42, 50, 52, 53).

Data from breeding stock owned by private breeding farms, called "Government Sponsored Breeding Centres" are collected every year for selection purposes by the Small Animal Section, Division of Animal Husbandry, Department of Livestock Development (3). The average litter size and weights at birth, 3 months and 8 months are presented in Table 9 for Large White (39 farms) and Duroc Jersey (14 farms).

Table 9. Piglet production of Large White and Duroc Jersey sows in Thailand

	Large White	Duroc Jersey
No of farms	39	14
No of litters	453	85
At birth		
Ave litter size	9.50	10.61
Ave litter weight	11.95	8.34
At 3 months		
Ave litter size	9.37	34.77
Ave litter weight	36.82	8.34
At 8 months		
Ave litter size	9.12	110.62
Ave litter weight	134.57	16.34
No of days per litter	196.0 (270 litters)	191.2 (51 litters)

C. Goats

All available data for Thai native goats are summarized in Table 10.

Table 10. Body measurements and distributions of coat colour and other morpho-genetic characters of Thai goats*

Characters	Ordinary Goat		Kambing Katjang		Hill Goat	
	Male	Female	Male	Female	Male	Female
Body measurements	(1)**	(70)	(6)	(18)	(4)	(5)
Wither height	69.3	66.87±0.51	56.65±1.59	51.52±0.60	58.35±2.92	59.40±1.44
Chest girth	80.1	76.22±0.69	65.83±1.66	60.60±0.96	67.50±3.47	71.90±2.14
Body length	70.6	66.88±0.56	58.08±1.96	52.81±0.62	56.67±1.56	63.26±1.54
Colour			(652)	(115)	(96)	
White or cream			238	13	0	
Chinchilla			9	0	2	
Himalayan			33	0	0	
Brown, black stripe			139	81	22	
Brown, black stripe, spot			45	10	0	
Black			85	4	66	
Black, spot			50	3	6	
Brown			39	2	0	
Brown, spot			14	2	0	
Chocolate			0	0	0	
Horns			(529)	(92)	(91)	
Horned (pp)			449	92	90	
Polled (P-)			80	0	1	
Wattles			(474)	(97)	(92)	
Wattled (W-)			40	0	0	
No wattles (ww)			434	97	92	
Supernumerary Teats			(182)	(44)	(22)	
Present			33	3	4	
Not present			149	41	18	
Pendant Ears			(145)	(44)	(82)	
Present			111	0	1	
Not present			34	44	81	

* summarized from Nozawa (28)

** () total number observed

Table 11. Body measurements of Thai native horses (17)

Measurement	Male (77)*		Female (14)		Castrated male (22)	
	Mean (Height ratio)**	Standard deviation	Mean (Height ratio)	Standard deviation	Mean (Height ratio)	Standard deviation
Wither height	117.01 (100.0)	5.56	114.69 (100.0)	5.68	120.59 (100.0)	4.43
Hip height	114.92 (98.2)	6.29	113.66 (99.1)	5.74	119.07 (98.7)	4.99
Body length	114.41 (97.7)	6.31	115.88 (101.0)	5.43	118.50 (98.2)	6.01
Chest width	27.66 (23.6)	2.76	26.21 (22.8)	4.07	29.87 (24.7)	3.79
Chest depth	52.35 (44.7)	2.85	52.19 (45.5)	2.27	55.00 (45.6)	2.59
Hip width	35.67† (30.4)	2.99	36.54 (31.8)	2.53	37.73†† (31.2)	3.31
Thurl width	32.52 (27.7)	2.11	33.46 (29.1)	1.93	34.36 (28.4)	2.57
Rump length	36.88 (31.5)	2.16	36.69 (31.9)	2.97	37.98 (31.4)	2.33
Chest girth	131.01 (111.9)	7.72	129.19 (112.6)	8.68	134.73 (111.7)	6.79
Cannon circum.	15.00 (12.8)	0.73	14.11 (12.3)	0.65	15.31 (12.6)	0.67

* Number of animals ** Ratio of measurement to height

† 75 animals †† 21 animals

D. Horses

Thai native ponies belong to a group of small-sized horses in Eastern Asia (17) standing less than 12 hands. Most of Thai native horses at present, however, have Burmese (Chieng Tung) influence of historically long association. Their measurements are given in Table 11, from survey studies by Hayashida and Otsaka (17). Improvement of horse-breeding comes mainly through the influence of the military, who introduced thoroughbred and Arabian horses for up-grading the military horse and the Thai pony (54).

On the race track, the average times for cross-bred horses to cover 1 km and 1.2 km are 1 min 16 secs, and 1 min 32 secs, respectively.

E. Elephants

Although elephants reach sexual maturity towards the end of the first decade of life, they are not fully grown until they are about 25 years old. A fully grown elephant in Thailand has an average height of about 2.65 meters for a male and 2.35 for a female, and weighs about 3.2 or 2.9 tonnes for male and female respectively (48). The weights and other measurements of mature elephant are shown in Table 12; body weight not only had a high correlation (r = 0.84) with heart girth, but also other measurements, especially front foot circumference (r = 0.85).

Elephants are fed with leaves and grasses. The most favoured foods are banana and sugar cane. While they are working in forests, the main feeds are bamboo leaves and grasses. Salts are usually supplied once a week.

According to Kowenitch (22) elephants can pull a mass not greater than 2 tons and can move timber at a rate of about 450 cubic metres for one kilometre distance in a year. They can lift a mass with their tusks not more than 700 kg and can carry only 100 kg mass by packing. They can walk about 4 km per hour and only 20 km per day. After three days of travelling, elephants need to rest for one or two days.

Table 12. Body weights and measurements and correlations of these with body weight for Thai elephants (48)

Measurements	Male	Female	Correlations
Body weight	3,218.0±492.0	2,898.6±458.0	
Shoulder height	2.65±0.67	2.35±0.19	0.79
Heart girth	3.46±1.24	3.35±0.14	0.84
Body length	2.39±0.54	2.23±0.18	0.84
Foot circumference	1.30±0.10	1.16±0.60	0.85

Note 1) Weights in kg from 10 males and 29 females.
Measurements in metres from 21 males and 44 females.

2) Age 30-80 years for males and 25-65 years for females.

F. Poultry

1. Description

(i) Chickens: Native fowls vary in size and type. Nishida *et al*. (26), from two survey studies in Thailand, classified them into two types, game and non-game. The frequencies for the types are in Table 13.

Table 13. Body type and earlobe colour of Thai native chickens (Nishida *et al*. (26)).

Characters	Number of Indivduals (%)	
	First survey (1971)	Second survey (1972)
Type of Body Formation:		
Game	2,174 (47.6)	1,543 (44.5)
Non-game	2,388 (52.4)	1,921 (55.5)
Earlobe Colour:		
Red	3,351 (99.5)	3,031 (96.9)
White	16 (0.5)	97 (3.1)

From studies in some North-east villages (47), the mature weight of the smaller type is about 0.4-0.5 kg in males and 0.3-0.4 kg in females. The larger, gametype, males weigh about 2-5 kg and the females 2-3 kg. The overall average weight is 1.5 kg, while the average weight of fighting cocks is 2.6 kg.

Nishida *et al*. (26) gave heights and body measurements for native female birds, the weight range being 0.62 to 2.02 kg. The long bone measurements are: femur, 71.2-112.4 mm; tibia, 103.5-131.2 mm; tarsus and metatarsus, 76.2-93.5 mm.

From the same study (26), it was shown that nearly all native fowl possess red earlobes, very few having white (Table 13).

Plumage colour patterns of native fowls are inconsistent (47). They vary from white to dark blue and from barred to non-barred. In general, fowls with dark blue plumage comprise the largest part (about 90%) of the total population. Small chicks have dark body colour, with black and white head feathers. Some individuals are dark tan. These colours change when they advance in age. The growth of feathers is very slow and it takes about 4 weeks for full body cover. Female fowls usually have a single colour such as dark-blue, buff or grey. There are thin black pin feathers on the face, which make them appear to have black faces. When they are mature the face becomes red, with a small part coloured black. Mature males usually possess mixed coloured plumage patterns. On one individual, there may be 2-3 colour patterns, such as a stripe of dark-brown on the neck and back. A stripe of dark-blue is also present on the abdominal part. The tail varies from dark-blue to buff, with a mixed colour of white and dark-blue also on the same plumage.

Rose-and-pea combs are more common among native fowls than rose combs. Individuals possessing rose-and-pea combs usually belong to the large body type, since these are crosses with the fighting-cock type.

Shank colours are black, yellow, or yellow and black. The black-shanked fowls comprise the majority of the population, while long shanks with yellow and black usually belong to the faster growing, large body, fighting type.

(ii) Ducks: The native duck can be divided into two types, Nakornpathom (large body) and Paknam (small-size). The Nakornpathom type has light brown plumage like the sheath of sugar cane (47). Body feathers and beak are grey. The male has a green head with a white ring on the anterior part of the neck. The leg shanks of both sexes are orange. The Paknam type has black feathers with a white breast.

(iii) Muscovy ducks, geese and quail: There are two varieties of Muscovy duck commonly raised in Thailand, one being white, and the other black. The geese raised in the country are Chinese, and the quail raised for commercial production are Japanese. The characteristics of these birds are the same as those raised elsewhere.

2. Management, reproduction and performance

Poultry production in Thailand can be classified in two types, namely backyard and commercial.

(i) Backyard production:

(a) Management

Chickens comprise by far the greatest proportion of poultry raised by keepers of backyard poultry. Generally, it can be said that native chickens are raised in every village all over Thailand. It may be estimated that about half the total production is contributed by backyard native chickens throughout the country, the other half being contributed by modern commercial intensive farms.

Ducks: As in the case of chickens, backyard ducks are raised in almost every village, but are all of an egg-type. The total number of ducks estimated in 1976 was 11.7 million, and among these there are many on intensive egg producing farms in the coastal provinces.

Geese: By a very rough estimate, about 60,000 geese are raised intensively in the outskirts of Bangkok to produce fertile eggs for sale to hatcheries in Bangkok. In addition, some central provinces produce not less than 80,000 broiler geese each year. However, geese are also raised sporadically throughout the country, though they are much less popular than chickens.

Muscovy ducks: This variety of duck is raised in small numbers compared with chickens, but it still can be said that they are found sporadically through the country as a backyard fowl. No intensive farms are operated.

Guinea fowl: Guinea fowl are found in backyard raising in numbers very similar to those of Muscovy ducks.

A survey in 1979 by staff of the North-east Livestock Development Project (NELDP) of six North-east Thai villages indicated that more than 75% of households own chickens, whereas not more than 20% have ducks, less than 5% have muscovies and very few families keep geese or turkeys. All forms of poultry are kept for home consumption of eggs and meat and for petty cash.

Native chickens and other poultry normally have a very low status in regard to the time they receive from village farmers for care and husbandry. They are seldom confined and roam village areas obtaining food by scavenging. Some supplementation may be given in the form of whole and broken rice (32). Because of this non-intensive system of keeping chickens, these birds are more exposed to the forces of natural selection than are large animals in the same villages. Sufficient attention is paid to chickens, however, in the form of feeding, provision of semi-protected nesting sites and water, for the birds to identify their owner's house, and they are consistent in returning to roost beneath the house or in trees at night.

Chickens, geese and muscovy ducks are completely natural brooders, but ducks are not. Their eggs and ducklings can be taken care of by the hens. However, most ducklings are bought from the market and no artificial brooding is done, due to lack of knowledge and facilities. This causes rather high mortality.

The average flock sizes per family for backyard poultry are:

Native chickens:	6-10 birds
Ducks:	20-40 birds
Geese:	1-4 birds
Muscovy ducks:	1-7 birds

Age at sale or slaughter varies; 72.6 percent of chickens are kept to 4 months of age, while approximately 9 percent are sold or slaughtered at each of the ages 5, 6 or more than 6 months.

Replacement chickens are bred by 81 percent of families, and 19 percent buy from other people.

All forms of backyard poultry in Thailand show excellent tolerance to heat at temperatures below 104°F with normal Asian relative humidity. The critical temperature for survival is around 108°F - 110°F, dependent on humidity. The tolerance to direct solar radiation is fair.

With regard to resistance to parasites and disease, all forms of backyard poultry including geese, native ducks, muscovy ducks, guinea fowl and native chickens have fair resistance to internal parasites (tape worm and round worm), although in some cases, especially among native chickens, health has been seriously affected.

External parasites such as chicken lice (especially fluff louse and wing louse) are found in every village, and even on some intensive farms. These lice have a minimal effect on backyard poultry, causing only mild annoyance, and reducing egg production only in highly productive birds. Chicken flea is another important external parasite for both adult and baby chicks; it destroys about 5-10 percent of chicks each year. The stickfast flea, which commonly infests the face, comb and wattles, is found all over the North-east region, and destroys many chicks each year.

Raising of fighting cocks is associated with better-than-normal disease control. Outbreaks of disease among other chickens are common; in 10 provinces studied, 96.2 percent of all flocks were affected, and in 64.1 percent of these flocks all affected birds died. Most outbreaks (65.8 percent) occur in the hot season, and in most areas only one outbreak occurs per year. No preventive vaccination is practised, due to lack of knowledge, and extension work reaches only a few villages.

Species of fowl other than chickens have few epizootic diseases.

(b) Reproduction: There is no specific mating system in backyard production, where males are always with females; mating is indiscriminate except for fighting chickens. There is no artifical insemination.

The ratio of males:females is not constant, but averages 1:10 for chickens and Muscovy ducks, and 1:4 for geese. Males are normally home-bred.

The age at first use for males is 6-8 months for chickens and ducks, and 12 months for geese. Females produce their first eggs at 7 months for all three types; the age at which they are first used for reproduction is 7 months for chickens and ducks, 16 months for geese.

The fertility of eggs set for chickens is 70-75 percent, and for geese, 61 percent.

Hatchability of eggs set is 80 percent for Muscovy ducks and 60-65 percent for chickens (both figures from brooding). For geese, using a modern-type incubator, with extra high humidity, the figure for hatchability was given as 66 percent of fertile eggs.

(c) Perfomance: There is no special feeding or management apart from filling troughs with paddy rice, broken rice or rice bran or throwing it on the ground or yard. For backyard and small scale poultry production chickens produce 24-30 eggs per bird per year, whereas for geese the number is 20-30. The average weight of eggs is 40-50 g for chickens and 161±14 g for geese. Normally chickens are kept as egg layers for 1 year, although there is some variation. Ducks are kept for about 10 months as layers, Muscovy ducks 2 years, and geese 3-4 years.

(ii) Commercial production

(a) Chickens: Meat production from commercial broilers is mostly from stock imported from U.S.A. and Canada, including Arbor Acre, Hubbard, Peel, Hyline and Cobb breeds (57).

Body weight at 8 weeks is 1.7±0.2 kg, and feed conversion (gain/feed) values have been measured at:

1-4 weeks : 0.53-0.56
1-8 weeks : 0.43-0.48
4-8 weeks : 0.38-0.40

The average weight at 4 weeks is 490-500 g, 1100 g is gained between 4 and 8 weeks, and total gain from 1 to 8 weeks is 1600-1750 g. Average carcase grade is 4; average dressing percentage is 84 percent.

Commercial egg production is from stock of the brown-shell type, including the cross between Rhode Island Red and Barred Plymouth Rock, which is a medium strain (Super Harco), and the Hubbard Golden, a light-medium strain (58). Within feed limitations, body weight at first egg for the medium strain is 1.7 kg and 1.5 kg for the light-medium strain.

Gain/feed figures are:

2-7 weeks : 0.29-0.31
7-16 weeks : 0.20-0.22
16-19 weeks : 0.10-0.33
2-19 weeks : 0.22-0.25

At 70% production level, values for feed per dozen eggs are given at between 1.8 and 2.2. 4.0-4.5 kg of feed is required per kg of eggs.

Hen-day production (300 days) is 50-55%, and age at 50% production is 175-177 days.

Egg weight is 56-58 g/egg, the Haugh units 68-71, shell thickness 30-32 (0.01 mm) and the persistency of lay, 10-12 months.

(b) Geese: The breed used is Chinese (both grey and white varieties) and local stock are kept on the outskirts of Bangkok.

Body weight for females at 14 weeks of age is 4.0-4.2 kg, and at first egg, 4.5-4.6 kg. At 20 weeks of age males are 4.5±0.4 kg, within feed limitations. Gain/feed has been measured between 4 and 14 weeks of age as 0.20-0.25.

Age at first egg is 165±17 days and 26.4±8.0 eggs are laid per year. Hen-day production is 9.28% (for 42 weeks). Egg weight is 157-161 g/egg, and persistency of lay is 10 months/year, 3-4 years per bird. Fertility is 80±10% dependent on age, and with modern incubation, hatchability is 73% of fertile eggs.

(c) Japanese quail: Although the stock is originally from Japan, quail are now produced in large intensive farms located near the outskirts of Bangkok. 200±10 eggs are laid per bird per year, and persistency of lay is 10-12 months.

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Discussion

Barker: Dr. Suntraporn has referred to work done on the native livestock of Asian countries by the "Society for Researches on Native Livestock" in Japan. It would seem that these studies are very relevant to our efforts at this Workshop, and as Dr. Nozawa has been involved in this work, I wonder if he would provide more information on the Society and the research that it has supported.

Nozawa: The Society was established in 1960, and so far it has published eight reports on morphological and genetic studies of native livestock in Japan, the Ryukyu Islands, Taiwan, Korea, Thailand, Malaysia and the Philippines. Copies of these reports are obtainable from the Society office, Department of Animal Breeding, Tokyo University of Agriculture. The reports are written in Japanese, but a summary of each paper is given in English, and the explanations of each Table and Figure are given in English, as well as Japanese.

Eusebio: The mortality of chickens in Thailand was given as 40%. This seems very high, and I would like Dr. Suntraporn to indicate the production/management system involved.

Suntraporn: This figure is for chickens in villages where no vaccination or disease control is practised, and where the birds are scavengers.

Turner: Dr. Suntraporn has made many useful points, but I think three are of particular importance to us -

(i) A large proportion of national production (e.g. of chicken meat and eggs) comes from the native breeds, and they are therefore of special importance in producing in the existing environment.

(ii) Unless that environment can be rapidly improved, selection should be for animals or birds which produce best in it. Dr. Suntraporn mentioned looking for chickens which produce best on waste material, and Dr. Bhat previously made the same point about production in low-input systems.

(iii) Dr. Suntraporn referred to the value of sheep and goats for small farmers. Until recently, goats in particular have been largely neglected, but these small ruminants should be developed for the small farmer sector.

Suntraporn: I would only add that in development programs for livestock, we need to establish the expected environmental conditions which really can be provided by the farmers, and then develop the animals suited to these conditions.

Rendel: Dr. Suntraporn has put special emphasis on the buffalo. I would like to know more about your proposed programs, particularly with regard to evaluation of the local buffalo for beef and work. Also I understand work is being done on crossbreeding between Murrah and Thai buffalo, and I would appreciate more information.

Suntraporn: We have set up a Buffalo Research and Development Centre to coordinate the buffalo work being done by the Livestock Development Department research stations and by the Universities. Development work is being directed primarily towards the establishment of a new buffalo breeding herd using selected superior animals from the villages.

A herd of Murrah buffalo has been imported recently from India for crossbreeding experiments. Some frozen semen from Murrah in India was used in an initial crossbreeding program, but this was not successful as the conception rate was very low.

Subramaniam: I understand that it is the normal practice in Thailand to castrate the most vigorous and fast-growing males for farm work use. This will leave only the poorer quality animals to be used for breeding. How will your development program overcome this problem?

Suntraporn: As I indicated, we are trying to develop a new herd of superior animals. Young buffalo bull calves purchased from villages will be taken to special finishing farms for evaluation. Selection and breeding work will be done on these farms, and high performance bulls will be sent back to the villages to improve their herds.

ANIMAL GENETIC RESOURCES IN BANGLADESH

M.A. Hasnath

I. INTRODUCTION

Livestock play an essential role in the agricultural economy of Bangladesh. Most of the farmers own livestock primarily to provide draught power to prepare crop land and to transport produce and materials, while sale of eggs, milk and meat in the local markets provides additional cash income. Major income from the livestock population is obtained without any definite farming system, according to the individual farmer's capacity.

Data on the livestock of Bangladesh are:

1. Livestock species: Cattle, Buffaloes, Goats, Sheep, Chickens and Ducks.
2. Breeds: All species are indigenous and no breeds whatever can be distinguished at the moment.
3. Uses of various breeds:
   - Cattle - Draught power, milk, meat, hauling and skin.
   - Buffaloes - Draught power, transport, milk, meat and skin.
   - Goats - Meat and skin.
   - Sheep - Meat.
   - Chickens - Eggs and meat.
   - Ducks - Eggs and meat.
4. Population of livestock:
   - Cattle - 22.3 million head
   - Buffaloes - 0.9 million head
   - Goats - 6.8 million head
   - Sheep - 0.2 million head
   - Chickens - 64.4 million head
   - Ducks - 11.9 million head.

(These figures are from a Report of the Livestock Directorate of Bangladesh, 1977).

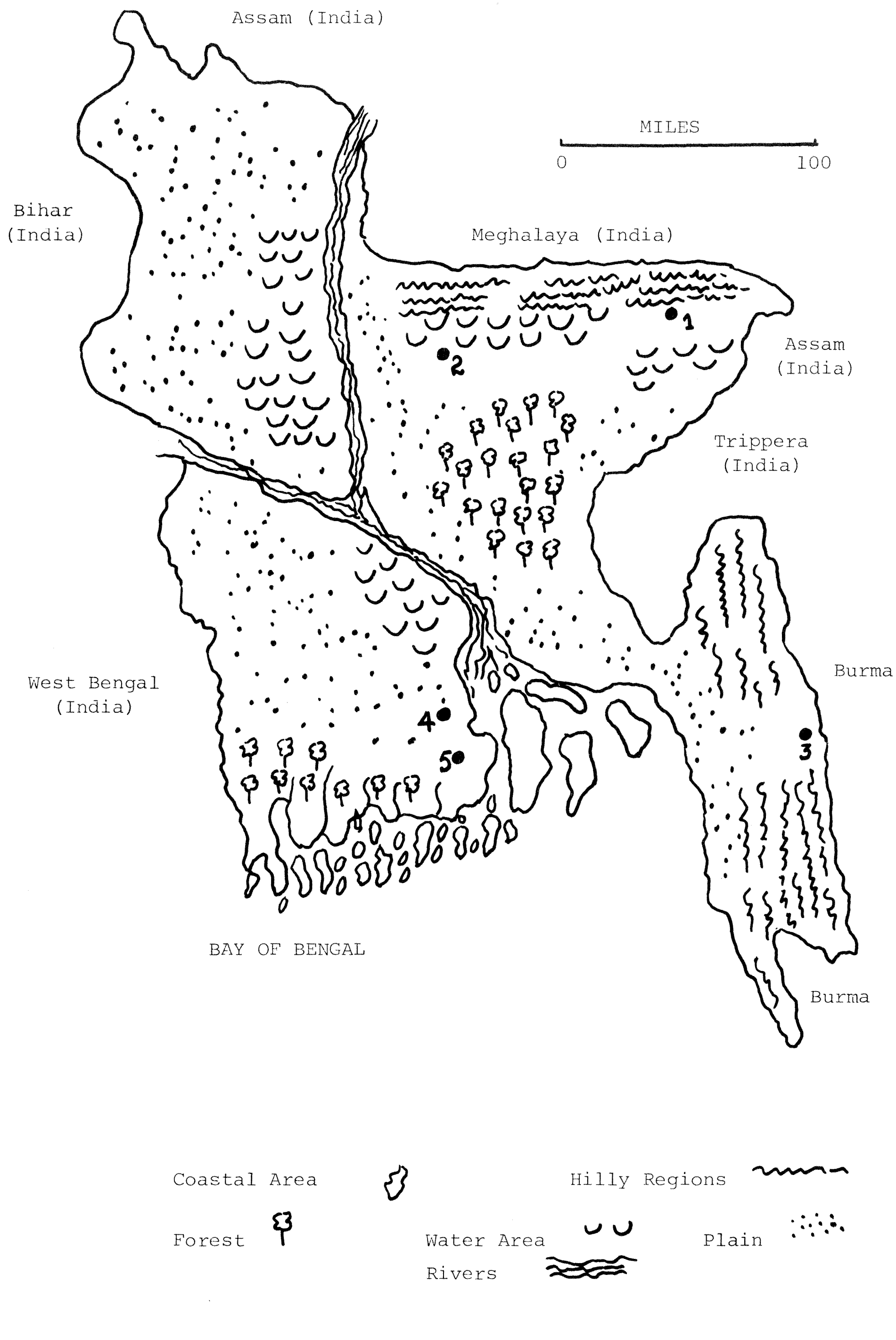
5. Livestock distribution map:

None is available except for buffaloes (Figure 1). Most other livestock populations are scattered throughout the country.

II. DESCRIPTION

1. Cattle:

Birth weight (kg)	--	10
Age at first heat (months)	--	26
Age at first calving (months)	--	36
Adult weight (kg)	--	257
Height at withers (cm)	--	109
Milk yield (kg per day)	--	0.9
Fat (percentage)	--	4.2



1. Sylhet 2. Mymensingh 3. Chittagong Hill Tracts
4. Barisal 5. Patuakhali
(These numbered points are buffalo areas)

Fig. 1 - Distribution of buffaloes in Bangladesh.

	Body temperature (^{o}C)	--	38.1
	Pulse (per minute)	--	62
	Respiration (per minute)	--	19
	Dry period (days)	--	150
	Lactation period (days)	--	250
	Calving interval (days)	--	415
	Service period (days)	--	120
2. Buffaloes:	Adult weight (kg)	--	450
	Milk production (kg per year)	--	1500
	Lactation period (days)	--	315
	Calving interval (days)	--	457
3. Goats:	Birth weight of kids (kg)	--	0.4
	Weaning weight of kids (kg)	--	8.8
	Weaning age (days)	--	131.4
	Weight at first conception (kg)	--	11.8
	Weight at first kidding (kg)	--	14.1
	Half yearly weight gain (kg)		
	3 months to 1 year old	--	4.5
	1 year to 2 years old	--	1.8
	2 years to 3 years old	--	1.8
	Adult weight of does (kg)	--	10.4
	Age at first conception (months)	--	10
	Length of oestrous cycle (days)	--	20
	Age at first kidding (months)	--	15
	Kidding percentage (does kidding/ does mated)	--	85
	Length of gestation (days)	--	143
	Twinning percentage (of does kidding)	--	45
	Number of services per conception	--	1.14
4. Sheep:	Birth weight (kg)	--	1.4
	Adult body weight (kg)	--	16.8
	Age at maturity (days)	--	433
	Fleece yield (g)	--	170
	Staple length (cm)	--	5
	Fineness (microns)	--	48
	True wool fibre (percent)	--	19
	Heterotypical fibres (percent)	--	11
	Medullated fibres (percent)	--	69

Some capable of lambing twice a year.
High percentage of twins.

III. ENVIRONMENT, MANAGEMENT AND FEEDING

1. Environment: See Appendix I.

2. Management and feeding:

Livestock in Bangladesh are the main sources of protein supply in terms of milk and meat. Their hides and skins are a valuable source for earning foreign currency. Dung is considered to be the best manure for increasing the fertility of land.

Cattle and buffaloes depend mainly for their feed requirements on roadside grass and most of the livestock, including goats, receive the lowest possible level of nutrition, in fact acting as scavengers around populated areas. At present the millions of cattle, buffaloes, sheep and goats are competing for survival on a ration that provides little more and often less than maintenance.

The incidence of livestock disease is also a great problem in the hot and humid climate. Parasitic diseases are very common and widespread. The Department of Livestock Services has been producing an annual average of 96.15 lakh doses of vaccines and sera for cattle and 123.62 lakh doses of vaccines for poultry.

The most prevalent cattle and buffalo diseases include rinderpest, anthrax, haemorrhagic septicaemia, black quarter and foot-and-mouth disease.

Diseases of goats include pleuropneumonia, anthrax and goat pox, while sheep suffer from sheep pox, sheep pneumonia and anthrax. Regular vaccination drives are undertaken by veterinary field staff to combat the diseases, and there are facilities for treating affected animals in veterinary hospitals.

IV. REPRODUCTION

Single births are general for cattle and buffaloes, but twinning is common in goats and sheep. There is high mortality in buffalo calves, as compared with other species.

V. BREEDING

Breeding of cattle aims at improving draught power throughout the country, as well as increasing milk production in special areas, particularly around the big cities and towns where there is a great demand for more milk. Introduction of exotic blood up to 25 percent is being allowed. Grading-up with suitable improved sub-continental breeds is being pursued. An intensive artificial insemination program is being adopted gradually. In accessible areas, improved breeding bulls produced in government farms are supplied for natural mating, at the rate of one bull for 50 cows per year.

The breeding programme is as follows:

(a) Selective breeding of native stock under a central registrar system based on productivity of dams.

(b) Cross breeding involving the grading up of native stocks to an exotic breed, up to the optimum combination permitted by the prevailing feeding and management conditions, the aim being to produce a new breed adapted to local conditions. Crossbred bulls are to be distributed.

Selection of bulls for breeding purposes and the breeding plan is based on the following criteria:

(i) Average lactation production
(ii) Average number of days in lactation
(iii) Weight average of each herd
(iv) Average age at maturity
(v) Average weight at maturity
(vi) Calving interval
(vii) Number of inseminations required per conception.

VI. PERFORMANCE

A systematic programme for proper care, management and feeding of cattle is carried out on Government farms, but on individual farms minimum care is practised. Small sheds are used; cows are milked twice a day, and given a minimum supply of feed. Hygienic milking, regular recording, and monthly weighing of all animals are the practice on Government farms only. Inadequate nutrition and hot or cold weather may contribute to intra-uterine and to post-partum deaths.

The productivity and viability of different classes of livestock maintained and bred by the average farmer are lower than when the same species are kept on Government farms.

A carcass weight of between 123-180 kg is the average for adult cattle, due to poor feeding and management conditions and possibly limitations imposed by genetic factors. The aim for sheep production is a carcass of 21 kg and wool production of 1.3 kg.

VII. POULTRY (Chickens)

Fowls are important creatures in the economy of Bangladesh as they supply eggs and meat, which are in great demand in the market. Each family keeps birds to meet their domestic requirements for quality protein and also to get some monetary benefit from sale of their products. The performance of native chickens in some of the economic traits are given below:

Day old weight (g)	--	28
4 week weight (g)	--	77
8 week weight (g)	--	175
12 week weight (g)	--	315
Average weekly weight gain (g)	--	24
Average annual egg production (no)	--	45
Average age at first egg (days)	--	175
Average weight of pullet (kg)	--	0.9
Average fertility (%)	--	83
Average hatchability (%)	--	52
Average egg weight (g)	--	35.5
Average age at maturity (days)	--	199
Average mature weight (kg)	--	1.3

Development must take place in the households of farmers in the mixed farming pattern of backyard poultry. Backyard poultry can be improved in a short time through the cockerel exchange programme. Under this programme all the local male birds will be withdrawn gradually and replaced by improved cockerels (White Leghorn male crossed with Australorp female and/or White Leghorn male crossed with R.I.R. female) in suitable numbers. After 8 months of supplying improved cockerels and withdrawing all local male birds, all local hens also will be withdrawn. As a result, the birds of the areas where the cockerel exchange programme has been implemented effectively, will have 50 percent of foreign blood, by virtue of which they will give better performance in terms of meat and egg production which is likely to be increased by 100 percent in the first year. By virtue of having 50 percent native blood it is expected these birds will retain their scavenging habits and resistance to local diseases under the local conditions of stress and strain.

Mortality of birds due to cold, known and unknown diseases, poor feeding practices, environmental influences and many parasitic and bacterial infections seems to be higher from one to eight weeks than at later ages. Normally native birds have single combs of varying colours and sizes. The birds are more resistant to local diseases than are exotic breeds. As most of the birds live by scavenging, no systematic breeding, feeding and management systems are practised by the farmers in their homesteads. Under farm conditions natural mating of one male to ten females is practised.

APPENDIX I

ENVIRONMENT

A. General

Bangladesh comprises the delta and lower flood plains of the Ganges, Brahmaputra, Tista and Meghna rivers, together with adjoining hill and piedmont areas, and is enclosed by the uplifted fault blocks of the Madhupur and Barind tracts. The climate is tropical monsoon, with rainfall ranging from 1250 to more than 3750 mm annually, occurring mainly in the six summer months. Flood plain sediments occupy more than 80 percent of the province on piedmont, riverine, estuarine and tidal landscapes. They are predominantly silts and clays, with sands found mainly in the extreme west and northwest. Tertiary and Pleistocene shales and sandstones occupy about 11 percent of the steeply dissected northern and eastern hills. The Madhupur clay, probably also of Tertiary age, occupies about 8 percent of the low, partly dissected, terrace-like, Madhupur and Barind tracts. Weathered minerals generally comprise less than 10 percent of the sand fraction in hill and terrace sediments, and in alluvium derived from them. Such minerals amount to 25-40 percent in the Brahmaputra, Tista, Ganges and lower Meghna deposits, which are particularly rich in biotite. The Ganges riverine and lower Meghna estuarine deposits are calcareous, but other deposits are not.

Four main seasons can be recognised, viz:

(a) The pre-monsoon season, in April-May, has the highest temperature and evaporation rates. Occasional heavy thunderstorms occur, irregular both in frequency and distribution. Cyclones are liable to affect coastal areas during this season.

(b) The monsoon season, in June-September, is the period of highest rainfall, humidity and cloudiness. 80-90 percent of the annual rainfall is normally received during this period.

(c) The post-monsoon season, in October-November, is hot and humid, but sunny, with heavy dewfall at night. There are occasional thunderstorms, particularly at the beginning of the period, and cyclones are liable to affect coastal areas.

(d) The dry season, in December-March, is relatively cool, dry and sunny. There are usually a few winter rains, but their occurrence is uncertain and the amounts received are usually small.

Vegetation: Much of the natural vegetation in the forest-covered hill areas, the well drained terrace land, the higher flood plain ridges and the saline tidal flood plain land, the poorly drained terraces covered by grass and reed swamps, the saline flood plain land, and small areas with grass and trees in parts of the eastern hill areas, has been cleared to make way for cultivation, with the encroachment of man in the area. Many recent flood plain soils have developed entirely under the influence of cultivated crops and weeds. Floating aquatic plants cover large areas of flooded land in the monsoon season and persist in some 'beels' and stagnant water channels throughout the dry season. Water-hyacinth (*Eichhornia crassipes*) is the most important of these plants.

B. Climate

Temperature: The mean annual temperature is everywhere about 26°C. Mean monthly temperatures range between about 18°C in January and 30°C in April-May. Extreme temperatures range between about 4°C and 43°C, except on the coast. Ground frost is occasionally experienced in exposed parts of the hill areas, but not in the plains.

Rainfall: Mean annual rainfall is lowest in the centre-west amounting to 1250-1500 mm. It increases northwards, eastwards and southwards to more than 2500 mm in the extreme northwest, near the northern and eastern hills and near the coast. It is highest in the extreme northeast, where it reaches 5000 mm. In all areas about 90 percent of the annual total occurs between mid-April and early October. The total varies considerably from year to year, mainly because of the unreliability of rainfall in the pre-monsoon season, and the irregular incidence of heavy rainfall periods within the monsoon season. Winter rainfall, when it occurs, may be either from local thunderstorms, or of a more sustained type from depressions that have crossed Pakistan and north India and may originally have developed over the Mediterranean Sea. Thunderstorms are usually accompanied by rainfall of high intensity and, more rarely, by hail. Sustained periods of heavy rainfall may occur during the monsoon season, sometimes giving as much as 125-250 mm rainfall in a day, or 500 mm or more in a week.

Evaporation: Evapotranspiration rates range from about 50-75 mm per month in December-February to 100-175 mm per month in April-May, and are generally about 100-125 mm per month during the monsoon season. Potential evapotranspiration rates derived from Penman's modified formula range from about 1175 mm per annum in the northeast to about 1300 mm in the centre-west. Mean excess evaporation over rainfall in the dry season ranges from about 200-250 mm in the centre and east to about 375-450 mm in the west and northwest. Excess of rainfall over evaporation in the rainy season ranges from about 750 mm in the lowest rainfall areas to more than 2500 mm in the highest.

Winds: Winds mainly come from between southwest and southeast during the pre-monsoon and monsoon seasons, and from between northwest and northeast during the post-monsoon and dry seasons. They are generally light. Squally winds of 48-96 km per hour or of occasionally higher force accompany thunderstorms (north-western), especially in the pre-monsoon period. The southern half of the province is also periodically affected by devastating cyclones. These are most liable to occur between mid-April and early June, and between mid-September and mid-December.

Day length and sunshine: Day length varies from 10.7 hours in December to 13.6 hours in June. Sunshine ranges from 5.4 to 5.8 hours per day in June-September to 8.5-9.1 in December-April. In the eastern border area, there is about one hour less sunshine per day in the monsoon season, and the coastal fringe has almost one hour more sunshine per day in the dry season.

APPENDIX II

Data on Bangladesh

Government:	People's Republic of Bangladesh
Location:	Between latitude north 20.75° and 25.75°, and between longitude east 88.30° and 92.75°
Area:	West Bengal and Assam on the north, Bay of Bengal and Burma on the south, Assam and Burma on the east and West Bengal and Bihar on the west

Land area:	144,000 km^2
Capital:	Dacca (area 260 km^2)
Human population:	78,400,000 (Tibbat, Mongolia and Dabir race)
G.D.P.:	US$ 6,325 per head of population (Agriculture contributes 58.7%)
Exchange rate:	US$ 1.00 = 15.5 Taka
Language:	Bengali, English
Principal crops:	Jute, rice, tobacco, tea, sugarcane, pulses, etc.
Principal industry:	Jute, sugarcane, paper, cloth, cement, natural gas, etc.
Sea port:	Chittagong, Chalna
Air port:	Dacca International, Chittagong, Jessore, Ishurdi, Sylhet, Cox Bazar, Comilla
Major imports:	Food grain, capital goods, petroleum and petroleum products, fertilizers, raw cotton and cotton yarns
Exports:	Jute 86.7%, tea 4.3%, leather 3.4% and others 5.6%
Average size of farm:	1 ha
Man and water ratio:	For every person 2.8 ha of water area
Flood land:	3,237,485 ha
Annual income from livestock:	One percent against 3% population
Draught animal requirements:	11 millions based on one pair to 1.62 ha
Slaughtered animals:	11 millions per annum
Production of milk per cow:	0.9 kg per day
Buffalo milk contribution:	Less than 50% of national products

Gap between production and need:

	Needs (000 tonnes)	Production (000 tonnes)
Milk and milk production	5,883,420	693,330
Meat	1,501,160	139,000
Eggs (no - thousands)	2,000,000	380,286

Annual per capita consumption of livestock production from 1965-70

	1965	1966	1967	1968	1969	1970
Milk and milk production (kg)	11.97	11.34	10.80	10.25	9.71	12.88
Meat (kg)	2.03	1.98	1.98	1.93	1.88	1.87
Egg (no)	6.1	5.9	5.8	5.8	5.3	5.1

ANIMAL GENETIC RESOURCES IN NEPAL

K.R. Keshary and N.P. Shrestha

I. INTRODUCTION

More than 92% of the Nepalese population depends on agriculture which contributes about 64% of the G.D.P. and accounts for 75% of the exports. Livestock plays a less important role than crops in the national economy as a whole (Table 1). However, the livestock role in crop production in the form of animal power and organic matter and fuel is important for raising the economy and improving the health of the human population by providing animal protein.

Table 1. Role of livestock in the national agricultural economy of Nepal

Agricultural products	Total value (Rs) in 000s (1969/70)	Percentage
Crops (Cereals)	5,138,691	81.09
Cash crops	320,092	5.05
Livestock products	878,329	13.86

Source: Neupane, F.P. (1977)

The per capita consumption of animal protein in Nepal is very low (Table 2) and the majority of the Nepalese population is underfed in this respect.

Table 2. Annual per capita consumption of animal protein in Nepal

Animal products	Amount
Meat (kg)	4.00
Milk (kg)	36.30
Butter (ghee-g)	665.00
Eggs (no.)	21.46
Fish (g)	450.00

Source: Neupane, F.P. (1977)

There is no reliable estimate of the livestock populations in Nepal, but available figures are given in Table 3. About half the cattle population are males and half females. Males are used mainly for ploughing, slaughtering of cattle being illegal in Nepal; this has resulted in an unproductive cattle population. The ratio of unproductive to productive cattle is about 9:1. There are 17% males among buffaloes and a very low number among goats and sheep. The ratio of unproductive to productive animals of these species is expected to be low as compared with that of the cattle population.

Table 3. Livestock Population of Nepal

Livestock species	Breed type	Uses	Total population (million)
Cattle	Achhame, Lulu	Draft, milk, manure and religious	6.45
Buffaloes	Parkote, Limee	Draft, milk, meat, and manure	3.76
Sheep	Bhyanglung, Baruwal, Kage and Lampuchhre	Draft, meat, wool, and manure	2.30
Goats	Chyangra, Sinhal, Nepali hill goat and Terai goat	Meat, milk, manure	2.30
Pigs	-	Meat	0.30
Yak and Chauries	-	Milk and draft	0.20
Horses and Mules	-	Draft	0.50
Poultry	-	Meat and eggs	21.20

Source: Agricultural Statistics of Nepal (1977)

About 68.0% of the total milk and 24.3% of the total meat supplies in the country are from buffaloes (Table 4). About 32.7% of the milk in the country is from cattle and a very small amount from sheep and goats. The figures shown in Table 4 may not be realistic, because production records are not properly kept.

Table 4. Total Animal Production in 1969/70

		Tonnes
Meat:	Buffaloes	19,000
	Poultry	17,500
	Pigs	4,200
	Goats	2,900
	Sheep	2,700
	Total:	46,300
		Litres
Milk:	Buffaloes	400,000
	Cows	178,000
	Others	4,000
	Total:	582,600
		Tonnes
Cheese		55,000
Ghee		9,000

II. BREED TYPES

Livestock and fodder research in Nepal is negligible, and even the basic data on animal breed types are not available. The research stations lack facilities, manpower, direction and motivation. Only the breed types of sheep and goats will be described here, with a brief general description of Yak (which is the male, the female being nak).

A. Sheep

There are four Nepalese breeds of sheep. They have undergone only natural and no artificial selection. The genetic variation can be expected to be high, but genetic parameters have not been estimated and there are as yet no plans for making such estimates.

1. Baruwal

This is the main hill sheep breed. It is a large Nepalese breed, weighing 30 to 40 kg. The legs are long, helping the animals to run fast and adjust to the nomadic conditions. The head is large, with small ears. The colour of the wool is generally white, but black and brown patches are also present on the body; sheep are sometimes covered with black wool, but seldom completely covered with brown. This breed is non-seasonal in breeding activity which takes place mainly in the month of May or June. The rams, but not the ewes, generally have long curled horns.

The breed is kept for both meat and wool, and in the far western regions for draft purposes also. It is the hardiest breed type in the country, and is more common in nomadic sheep farming in the medium high mountain ranges than in other areas.

2. Kage

The Kage is a smaller breed of mutton type, and is generally polled. Kage sheep are prevalent in the mountain valley regions of the country, particularly at elevations ranging from 600 to 1500 m. It is a subtropical breed with a medium-sized tail. The average body weight is about 16 to 18 kg. The wool is coarse, the amount produced being 332 g/shear/year. Generally this breed has no hair on the head and legs, and has a long neck. In appearance it resembles the Border Leicester breed.

The most important characteristic of this breed is that it is non-seasonal in its oestrus activity and the frequency of twinning is high. With good management and good feeding, two lamb crops can be obtained in a 14-month period. The colour is generally white, but other colours are sometimes found.

3. Bhyanglung

This is a Tibetan breed, found in the northern Chinese border of the country. It is kept and grazed at an elevation higher than 2000 m. Adult male sheep weigh about 30-40 kg and female 25-30 kg. The breed has finer wool than others in the country.

4. Lampuchhre

This breed resembles the Kage, but is larger and has a long tail. The adult body weight ranges from 20 to 40 kg, and the body is generally covered with coarse white wool.

B. Goats

Four breed types are common, each being specialized in its own system of management, related to the altitude and climate of the different regions of the country.

1. Chyangra

This type of goat (also called Kashmiri) originated from Tibet and is common in the northern border of the country. It adapts well to cool, dry and semi-desert snowy areas. The Chyangra found in Tibet and Mongolia is larger than that of Nepal. The small Nepalese type of Chyangra is also known as Chyapu. The male goat (buck) weighs about 50-60 kg and the doe about 40-50 kg. About 125 to 200 g of pasmina (cashmere) can be obtained from each animal. Only one kid in a year is common in Nepal.

2. Sinhal

This is a high hill goat, kept with Baruwal sheep, generally at an elevation of 1500 to 3000 m. The male goat weighs about 40 to 50 kg and female about 30 to 40 kg. The oestrus behaviour is non-seasonal and generally one kid is produced in a year, although twinning sometimes occurs. Both males and females have horns and medium size ears. These goats are generally black in colour, but white and brown patches are not uncommon.

3. Nepali hill

This type of goat is found between the Terai (lowland) and high mountain regions. The hill goat is smaller than the Sinhal, weighing about 25 to 30 kg. Two kid crops can be obtained easily from this breed in 14 months. Both sexes have horns and the body is multicoloured.

4. Terai goat

This type of goat has long ears and is not pure-bred. It resembles the Jamnapari, of which it is a cross. It is kept for both milk and meat purposes.

C. Yak

1. Yak and Nak

These are high altitude animals which live in the Himalayas at an altitude ranging from 4000 to 5500 m. They are kept specially for hybridization with cattle, their uses being for milk, wool and draught. The herds are kept in the high mountains at about 5000 m in July and August, and are moved to lower areas at about 4000 m at the beginning of September. These animals manage to keep their heads above the snow even when their bodies are covered, and can live without water and food for several days.

Both males and females are attractive to look at, with their long silken hair hanging below the neck, shoulders, stomach and thighs. The body, though heavy, is compact and well balanced. The legs are short and strong, and the hoofs are black, their pointed tips enabling them to run fast on the sloped areas.

The colour varies, though a mixture of black and white seems to be common; white, grey and black are also found in some animals. The yak is docile if gently handled, in spite of its semi-wild nature, but it becomes nervous when strangers approach. The udder is hidden completely within a thick growth of hair and is not well developed. The live weight of the yak ranges from 225 to 360 kg, and the nak weights about 180 to 360 kg.

2. Yak-Cattle Hybrid

Hybrids of yak and cattle are bred by traditional people of the Alpine region of Nepal. Two distinct types of hybrids are out-crossed from the yak and nak, and are named Urang Chauries and Dimjo Chauries. The elevation at which Dimjo is kept ranges from 3000 to 5000 m. Dimjo Chauries are hardier and can withstand low temperatures better than Urang Chauries. The live weights of the hybrids are as follow:

Female	Dimjo	Chauries	225-340 kg
Male	Dimjo	Zebkyo	250-390 kg
Female	Urang	Chauries	230-360 kg
Male	Urang	Zebkyo	300-400 kg

III. ENVIRONMENT, MANAGEMENT AND FEEDING

A. General Climate

Although Nepal lies near the northern limit of the tropics there is a very wide range of climates, from the tropical hot and humid summer of the Terai to the colder dry continental and alpine winter climate through the middle and mountainous sections. The amount of precipitation and range of temperatures vary considerably because of the exceptionally rugged surface areas of the country.

1. Precipitation

The mean annual precipitation ranges from more than 6,000 mm along the southern slopes of the Annapurna range in central Nepal to less than 250 mm in the northern central portion near the Tibetan plateau. Varying amounts ranging between 1500 mm and 2500 mm predominate over most of the country, the maximum occurring along the southern slope of the Mahabharat range and the Himalayan ranges in the eastern part of the country. On the average about 80% of the precipitation is confined to the monsoon period (June to September). The spring months are characterized by showers and windy weather, with high humidity. Snowfall is confined to the northern and western mountain regions, especially at and above an elevation of about 3500 meters.

2. Temperature

Summer and late spring maximum temperatures range from more than 40°C in the Terai to about 28°C in the mid-section of the country, May being the warmest month. Winter average maximum and minimum temperatues range from 23°C to 7°C, while the central valleys experience chilly weather with 12°C maximum and below-freezing minimum temperatures. Much colder temperatures prevail at higher altitudes.

B. Agricultural Environment

Agriculture varies greatly among the three principal regions of the Kingdom. The mountain areas have little scope for crop production, which is insufficient for the population. The middle hills are intensively farmed, and experience severe problems of erosion and loss of fertility. The Terai is the main area which produces exportable surplus food crops.

The livestock industry of Nepal is severely hampered by a combination of scarce feed resources and uncontrolled disease problems. Feed resources are largely dependent on crop residues and grain by-products. Grazing land is limited due to population pressure, and in the Terai it is restricted to road sides, river banks, paddy bunds and forest.

The tendency to raise large numbers of livestock, which exert a pressure on the scarce feed resources, and the prohibition on cattle slaughter have resulted in the accumulation of a large number of old and unproductive animals. The consequent pressure on the available grazing lands in the hills and the Terai has caused severe deterioration of the pastures with resulting lower animal production. In the hills this has led to problems of erosion and loss of fertility, and in the Terai to the replacement of pasture by unwanted species. Throughout the Terai and the hills the nutrition of the livestock is just sufficient at some seasons, and well below sufficiency for most of the year. This has resulted in lower production and lower resistance to diseases. Hay and silage making is not a common practice in the country.

Diseases represent the other major problem for livestock in Nepal. Foot and mouth disease in ruminants and pigs represents the most serious problem. Liver fluke is a serious parasitic disease in ruminants, while Newcastle disease and fowl pox are the main problems with poultry. Rinderpest of cattle and buffalo has been a serious disease, but the effects have been reduced following the initiation of a national livestock vaccination programme. Several other diseases are responsible for low production.

The government has recognized these problems, but because of limited resources and lack of skilled manpower little effort has been directed towards the livestock industry. Livestock research is negligible, under-staffed and under-financed. Training programmes have not provided sufficient personnel for the livestock industry. Extension in the livestock field is almost non-existent and effort has been mainly directed to crop programmes.

C. Management and feeding systems

1. Cattle and buffaloes

The buffaloes and cattle are generally shepherded either on common grazing areas or on road side areas. The milking animals are generally stall fed, with a small amount of concentrate (Kundo) and rice hay if grass is not available. The average size per farm of buffalo and cattle is about 6.4 animals, including large and small, with 1.49 million farms and a total number of 9.55 million of buffalo and cattle. The size of the herd ranges from one to fifty animals, including both cattle and buffalo. All the buffalo and cattle are kept in a shed during the night, some milking animals being kept in the shed all day as well. Calves are fed by supplying one full teat milk during the early stage and at later stages very little milk supplements the suckling. Small amounts of concentrate are fed to the calves in the form of Kundo. Both sexes of cattle are kept throughout life until natural death.

Though various diseases and parasites have been observed in the country, yet there is no disease or parasite control at national level, due to lack of human resources, techniques and funds. Diseases and parasites are a serious problem in reducing the productivity of animals.

2. Sheep and goats

All the high mountain sheep and goats (i.e. Baruwal sheep and Sinhal goats) are shepherded and are nomadic. The flocks are taken to lower areas at about 800 m elevation during the winter, and to higher alpine pasture areas as high as 5000 m elevation in summer. These flocks of sheep and goats graze in common pasture areas, in forested areas and in cultivated areas after the cereal crops have been harvested. Generally no supplementary feeding except ordinary salt is supplied in the farmers' flocks. The average size of the flock varies from a few animals to 1200, but one flock may comprise sheep and goats belonging to more than one farmer. These sheep and goats are generally not housed, but in severe winter when there is snow they are kept in a shelter and provided with hay. The ram lambs and male kids are castrated with a local stick and hammer method in some areas, and with an ordinary knife in others. Generally the lambs are castrated at about 6 months to one year of age. Weaning is not commonly practised, and the young are allowed to run with their mothers as long as they are kept in the flock. The ewes and female goats are kept for as long as 8-9 years. The male animals are sold when they are one year of age, if not castrated, and at about 3 years of age if they are. Young ones are also sold to slaughter houses for sacrificing purposes.

The Chyangra and Bhyanglung are managed in the same way, except that they are always kept at higher elevations. The other sheep breed types in the Terai and the hills have smaller flock sizes, ranging from a few animals to a maximum of a hundred, which are either fed indoors or shepherded in common grazing areas or in a forest, and kept in a shelter during the night.

3. Yak and nak

The yak and nak are never stalled except at the very young age of two to three months. The animals in some areas are tied to wooden pegs in the open, but the practice is not universal. During summer these animals are taken to a high altitude for grazing, and are kept at lower areas of 3000 meters during the winter months. Yak dig the snow for feed, and even without scraping with their feet they are capable of using pasture covered by loose snow about 8-12 cm deep. No concentrates are fed to these animals, but in severe winters boiled dried turnips with some hay and concentrates are given by some farmers.

The management of yak hybrids is similar, but they are kept at lower altitudes, ranging from 2500 to 4000 meters.

IV. REPRODUCTION

1. Cattle and buffaloes

Imported cattle semen is used for artificial insemination in areas easily accessible by roads. In other areas the males are left in the herd all the year round for natural mating. Only natural mating is practised with buffalo. The age at first calving varies with different farmers, ranging from 3 years upward in both cattle and the buffalo. Males are used when they are serviceable, at the age of 3 to 4 years. No twin calves have been observed, and the interval between parturitions ranges from 15 to 32 months.

2. Sheep and goats

It is a common practice among the farmers to keep the males always with the females in the flock, and no control against natural mating is practised. Generally 3 to 4 males are kept in a flock of 100 sheep. The age of rams at first service ranges from 1½ - 2 years of age. The first lamb crops are produced by ewes at the age of 2 - 2½ years. All the sheep are non-seasonal in their oestrous activity. In the Kage the lambing percentage is about 143%, triplets and quadruplets being found among 3 to 4% of the ewes. In the case of goats, twinning is also common and triplets and quadruplets are seen often. In the case of hill sheep and hill goats one lamb and one kid are obtained in a year, most young being born in the months of September to November.

The parturition interval for Kage sheep and for goats in the lower hills is about 7 to 8 months under good management systems. Sometimes two kid crops are obtained from certain she goats in a year. The lower hill goats attain their sexual maturity from the age of 9 months to one year and kids can be obtained between one year to 15 months of age. Lamb and kid mortalities are high under nomadic conditions, and range from 20 to 50%. Adult mortality is also high, ranging from 10 to 20%.

3. Yak and nak

Yak are late maturing, and the male attains sexual maturity at 2½ years. The nak has her first calf at 3 to 5 years of age. The calving interval is not less than one and often 1½ years. A nak may have as many as 12 calves during her life time. Twinning is very rare. The calves are born mostly in the months of June or July. Hybrid Chauries reach sexual maturity slightly earlier and yield higher quantities of milk than either of the parents. Female hybrids are fertile when mated with either parent, but the male calves are sterile.

V. BREEDING

1. Cattle and buffaloes

Male buffaloes and bulls in natural service are mostly home-bred. Some farmers are provided with cross-bred types from the government farms. Male buffaloes (Murrah) are purchased from India and are distributed to the farmers. In the case of cattle, progeny-tested semen is available from the Food and Agricultural Organization of the United Nations. The most common imported cattle breed is the Jersey, though Brown Swiss also have been successful in some areas of the country. The Friesian is just being introduced now.

2. Sheep

In the case of sheep, the Polwarth and the Rambouillet have been bred and kept for a long period and found satisfactory in cross-breeding for improving wool quality and increasing the amount of wool. These sheep are limited in number and are kept only in government farms. The Polwarth is not doing well in the nomadic system of sheep farming. The source of Polwarth males is the flock of 60 to 70 originally imported; low production, particularly in lamb numbers, might be due to inbreeding. The sources of males in the farmers' flocks are from within the home-bred types, except for some crossbred rams supplied by government farms. Merino and Border Leicester are just being introduced now.

No artificial selection has been practised in females, while males are selected on eye observation only. No quantitative measurements are taken as criteria for selection.

VI. PRODUCTION PERFORMANCE

1. Cattle and buffaloes

The production performances of cattle and buffaloes are given in Tables 5, 6 and 7. These figures are just a simple average of data on a few animals, and do not take into account the age of the animal, or the stage and season of lactation. The data of Table 5 and Table 7 were obtained from the Khumaltar Livestock Farm, where the environment is better than that in the other normal farms. From Table 5, 6, 7 it can be observed that under these conditions production can be increased two- to three-fold by simply introducing the foreign breed.

Table 5. Production performance of Jersey and Nepali cattle

Breed	Lactation period (days)	Milk yield/lact. (litre)	Milk yield/day (litre)
Jersey	354	1284	3.6
Jersey cross (50%)	333	1207	3.7
Nepali	235	324	1.1
Achhame	232	267	1.1

Table 6. Production performance of hill cattle and Brown swiss

Breed	Lactation period (days)	Milk yield/lact. (litre)	Milk yield/day (litre)
Brown Swiss	427	1222	2.86
F_1 Cross	362	921	2.54
F_2 Cross	389	937	2.40
Nepali (Hill)	371	322	0.87

Table 7. Production performance of buffalo

Breed	Milk yield/lact. (litre)	Lactation length (days)
Nepali (Limee)	255	121
50% Murrah	711	216
Murrah	1272	255

2. Sheep and goats

The wool production of Baruwal, Polwarth and their crosses (Table 8) and the wool production of Kage and Polwarth and their crosses (Table 9) showed that wool production can be increased two- to three-fold just by introducing the foreign breed in the country. The Baruwal breed is suitable for draught purposes while the Polwarth is not. However, animals which are 25% Polwarth and 75% Baruwal can be used for draught.

At this time the nomadic system of sheep farming seems to be better than the stationary type (Table 10), unless the environment of the stationary flock is improved.

Some data for Bhyanglung and Lampuchhre sheep are given in Table 11.

Measured production figures for goats are not available but some estimates are shown in Tables 12 and 13, which give some indication of the performance of the breed type.

Table 8. Average wool production of Polwarth and crosses with Baruwal

Breed	Wool yield (kg)	Staple length (cm)
Polwarth	2.61	9.66
Baruwal	0.87	12.40
25% Polwarth	1.41	11.60
50% Polwarth	1.57	10.35

3. Nak

The milk of Nak has a high fat content of 7-9%, with solids-not-fat of 10.9%. The colostrum contains 14% fat, 4.8% casein, 11.4% albumin and globulin and 1.9% lactose. The milk yield per cow is 1 to 3 litres per day. The average lactation period is about 7 to 9 months with a dry period of 6 months.

The Urang Chauries yield about 1.5 to 4 litres of milk and Dimjo Chauries 2 to 5 litres of milk per day. The butter fat percentage in Chauries milk ranges from 5 to 8%, while the milk of Dimjo Chauries has a slightly higher fat percentage.

Table 9. Average wool production and staple length of Kage and their crosses with Polwarth

Sheep type	Wool yield (g)	Staple length (cm)
Kage	333	6.1
50% Polwarth	782	6.4
75% Polwarth	1159	6.5

Table 10. Lamb and adult ewe mortality in nomadic and stationary flock of sheep in Guthi Chaur Sheep Farm, Jumla

Sheep type	Stationary (%)	Nomadic (%)	Average (%)
Adult Sheep	12	18	14
Lamb	53	26	41
Average	25	20	

Table 11. Production performance of Bhyanglung and Lampuchhre

Traits	Bhyanglung	Lampuchhre
Adult body weight (kg)	30-40	20-40
Wool yield (kg)	0.75-1.50	0.5-0.75
Staple length (cm)	12-15	-
Wool quality	Medium fine	Kempy

Table 12. Production performance of goats

Characteristic	Chyangra	Sinhal	Hill goat	Terai goat
Adult body weight (kg)	40-60	40-50	30-40	20-40
Pasmina yield (g)	125-200	100-150		
Milk yield			68 litres/lact.	0.5 litres/day

Table 13. Production performance of imported goats

Characteristic	Sanaan	Jamnapari	Barberi
Milk yield	343 litres/363 day	235 litres/261 day	244 litres/235 day
Body weight	69-90 kg	35-70 kg	25-50 kg

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J.N. Clarke

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ANIMAL GENETIC RESOURCES IN PAPUA NEW GUINEA

J.H.G. Holmes

I. GENERAL INTRODUCTION

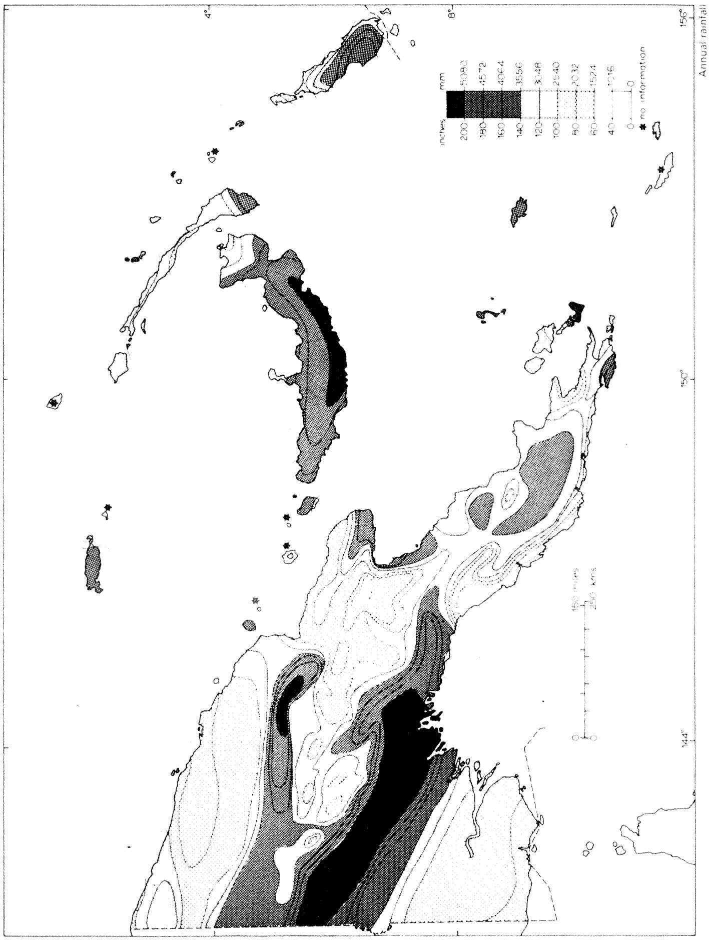
Being to the east of "Wallace's Line", Papua New Guinea (P.N.G.) has no indigenous mammals apart from marsupials and monotremes. All conventional commercial livestock have been introduced by man, the pig and poultry (Gallus domesticus) thousands of years ago, the ruminants, equines and other poultry only with the arrival of European settlers about a century ago.

P.N.G. lies just to the south of the equator; with mountains rising to over 4,500 m, it presents a wide range of climates, landforms, soils and vegetation (Maps 1-3). P.N.G. lies within the heavy precipitation belt of the humid tropics and well over half the country receives 2,500 mm rainfall or more per annum. The population lives mainly at sea level, in coastal and some inland areas, or at altitudes of 1,000-2,000 m in wide grassy valleys in the mountains which cover much of the country. The terrain between sea level and the high valleys is usually steep, covered mainly with primary rainforest and is more sparsely populated. Rain forest also occurs on the mountains above the populated valleys, up to 3,500 m. Climate, topography, soils, geology and vegetation for many areas have been described in great detail in a series of Land Research Reports (CSIRO 1964, 1965, 1967, 1968, 1969, 1970, 1971, 1972, 1973).

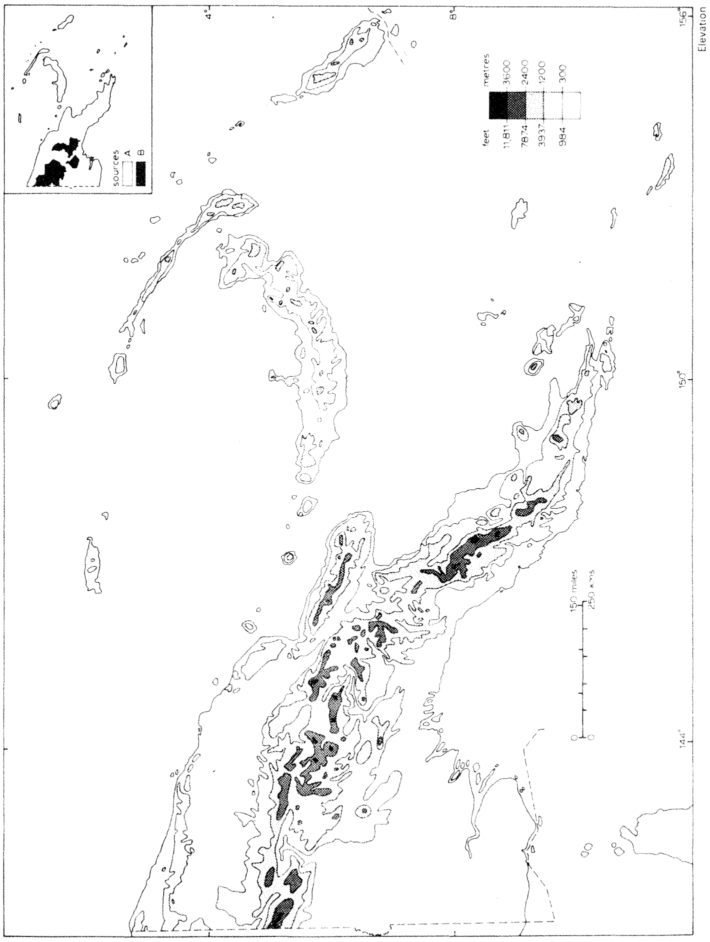
In consequence of the newness of commercial animal production, accurate performance data are lacking in many cases. The number of scientifically trained personnel in agriculture is very low, so rapid change cannot be expected in this situation. In many cases the data presented, rather than describing an indigenous population, demonstrate the performance of imported breeds and the results of crossbreeding.

P.N.G. was settled by Germany on the north and in the large islands of Manus, New Britain and New Ireland, and on the South by Australia. German settlers introduced water buffalo from Java and the Philippines, and cattle from Java and Thailand; both species were used extensively for meat and draught on coconut plantations along the coastal fringes. Javanese sheep ("Priangans") and European goats were used in the same areas for meat production. Other unrecorded importations doubtlessly occurred. Unfortunately the area of distribution of these four species coincided fairly closely with the areas of fighting during World War II. Very few animals survived and those cattle and buffalo which did became feral. The sheep survived in flocks in the central Highlands, but in small numbers. Australian settlers imported traditional British varieties of beef and dairy cattle, sheep and goats before the war. In the main, these were less successful in adapting to the environment, and also suffered from the demands of the war. Subsequently, the present population of cattle, buffalo and sheep has been built up from a very small basis in 1945, by importations from Australia. There were probably less than 500 of any of these species present in 1945, although the pre-war cattle population exceeded 30,000 and other species were present in large numbers.

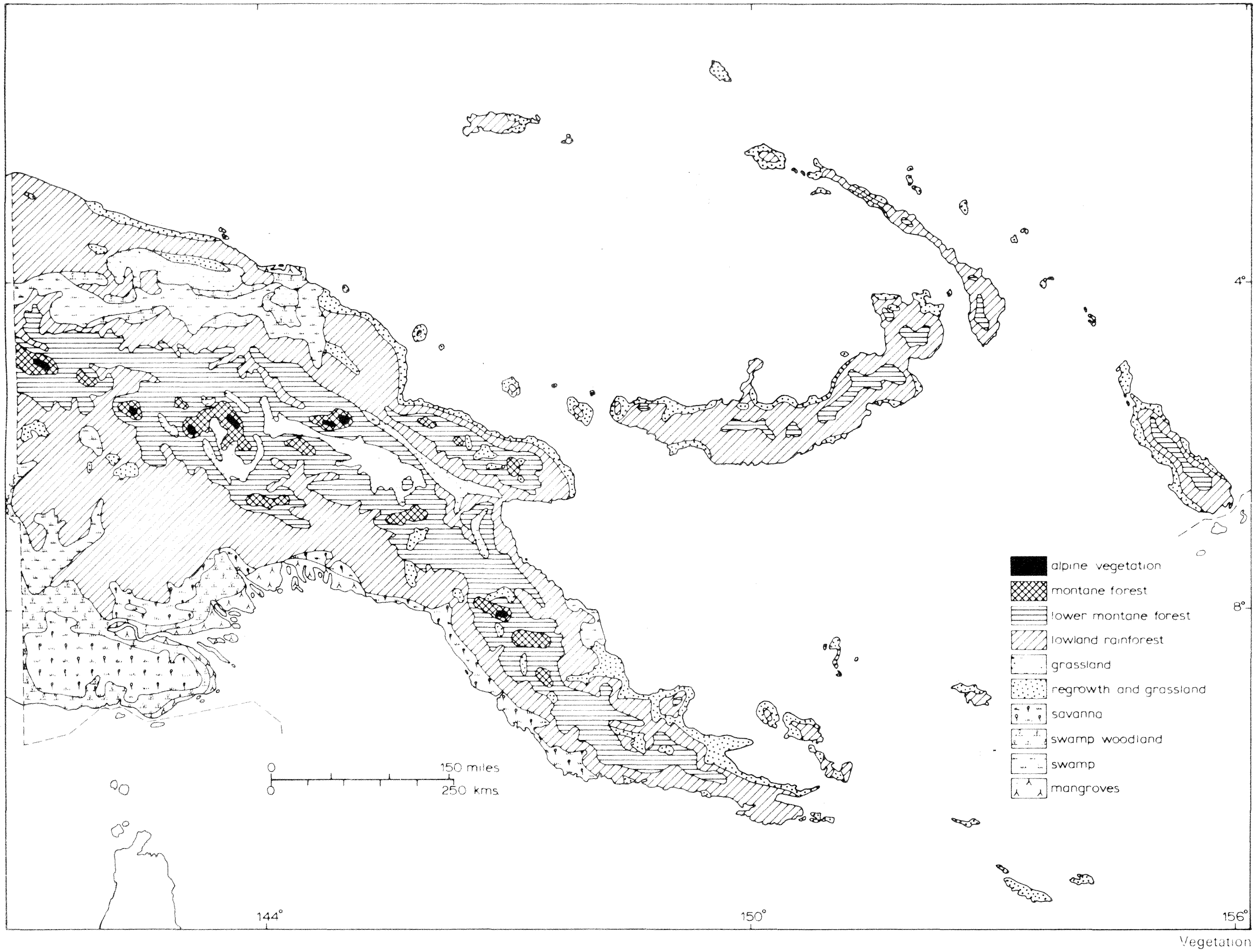
Species present include cattle (Bos taurus and Bos indicus), sheep (Ovis aries), goats (Capra hircus), water buffalo (Bos bubalis), pigs (Sus scrofa and Sus scrofa papuensis), fowls (Gallus domesticus), Guinea fowl (Numida meleagris), ducks (Anas platyrhynchus and Cairina moschata), geese (Anser anser) and turkeys (Meleagris galloparvo).



Map 1 - The distribution of annual rainfall (Source: Department of Geography, University of Papua New Guinea (1970) An Atlas of Papua New Guinea. Collins Longman).



Map 2 - The distribution of elevation (Source: Department of Geography, University of Papua New Guinea (1970) An Atlas of Papua New Guinea. Collins Longman).



Map 3 - Types of vegetation (Source: Department of Geography, University of Papua New Guinea (1970) <u>An Atlas of Papua New Guinea</u>. Collins Longman).

II. BREEDS, USES AND NUMBERS OF EACH SPECIES

A. Beef Cattle

	Number
Beef crossbreds (half to 3/4 Brahman with Shorthorn, Hereford, Aberdeen Angus, and others)	120,000
Dairy (Friesian, A.I.S., Jersey and crossbreds)	3,000
Santa Gertrudis	500
Brahman	1,000
Droughtmaster	500
"Javanese Zebu"	2,000

No cattle are used for draught, and apart from dairy cattle all are used exclusively for beef production. A leather tannery is under construction. Total obtained by actual count, but numbers of purebreds estimated.

B. Sheep

	Number	
"Priangan"	1,400	
Corriedale	300)	
Perendale	250)	imported from New
Rommey Marsh	150)	Zealand in 1975
Border Leicester x Merino	130	imported from Australia in 1979
"Priangan" x N.Z. crossbreds	600	

The "Priangan" sheep are probably of Java origin but the breed is uncertain. The main use of sheep is for meat. Wool is used for carpet weaving in a small-holder industry and skins are used as floor coverings. The "sheep industry" is still very experimental. Numbers by actual count.

C. Goats

All are crossbreds adapted locally, and derived from a series of imports of European milch goats, mainly Saanen and Toggenberg. It is thought that there is no tropical breed represented. Goats are used for meat; although milk production is beginning in some areas. Numbers are unknown, but are estimated to be between 2,000 and 6,000.

D. Buffalo

Swamp buffalo 2000
Uses, mainly meat, some draught animals (perhaps 100).
Population by actual count.

E. Pigs

Imported Breeds	Number of sows
Tamworth	100
Berkshire	100
Saddleback	200
Large White	500
Large Black	200

Native pigs 1.5 x 10^6, including all sexes and ages. Native x European crossbreds - 2,000 sows. Specific breeds by actual count. Native pigs by estimates.

The main functions of the native pigs are aesthetic and cultural; their importance is as a measure of prestige, wealth and as an exchange medium. European pigs are used for pork production (no bacon is produced in P.N.G.).

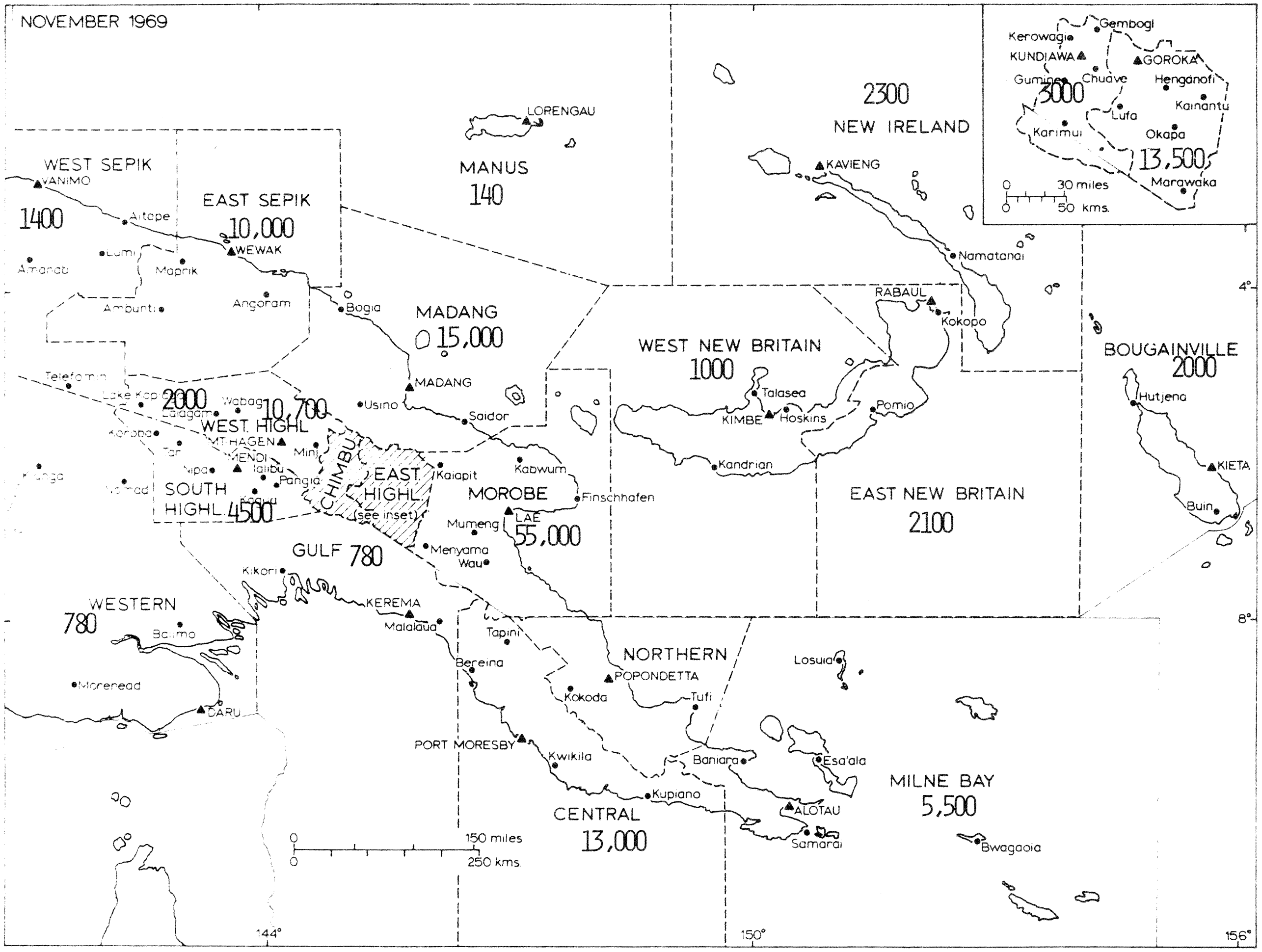
F. Poultry

Chickens:	Small holder:	Native village birds	2,000,000 estimated
		Australorp) Rhode Island Red) Sussex)	x Village birds 1,000,000
		all used mainly for meat.	
	Large scale producers:		
		Hybrid broilers	3,500,000/yr from parent stock in Australia and New Zealand.
		Hybrid layers	120,000
Guinea fowl:		meat	1,000
Ducks:	Muscovy	meat	50,000
	Khaki Campbell and Rouen	eggs and meat	2,000
Chinese Geese:		meat	200
Turkeys:		meat	200

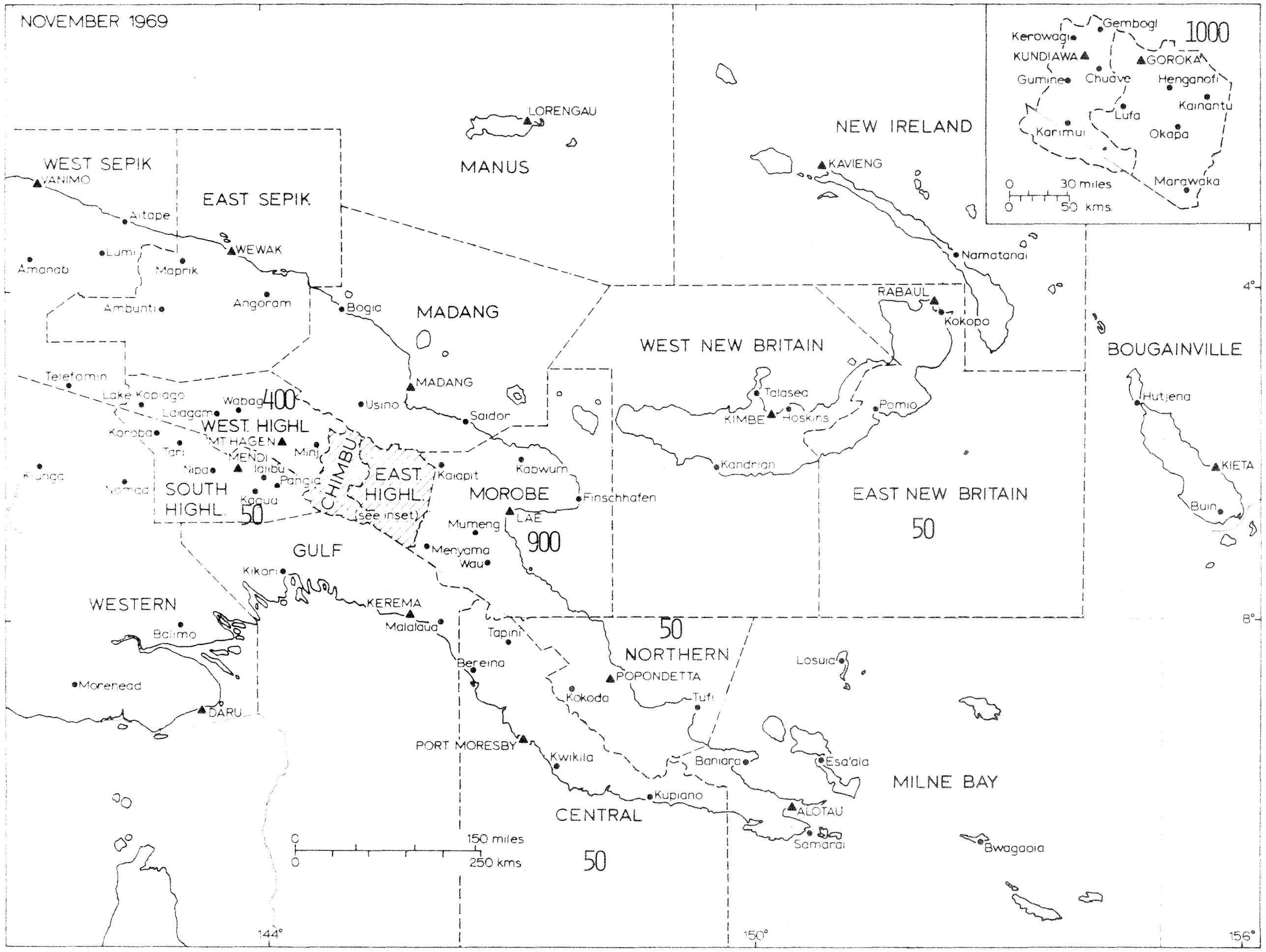
Cassowaries are used for meat. They are of great cultural significance but meat production is very small. Their price (up to K400 = US$560) reflects their cultural value, not productive value.

III. LIVESTOCK DISTRIBUTION

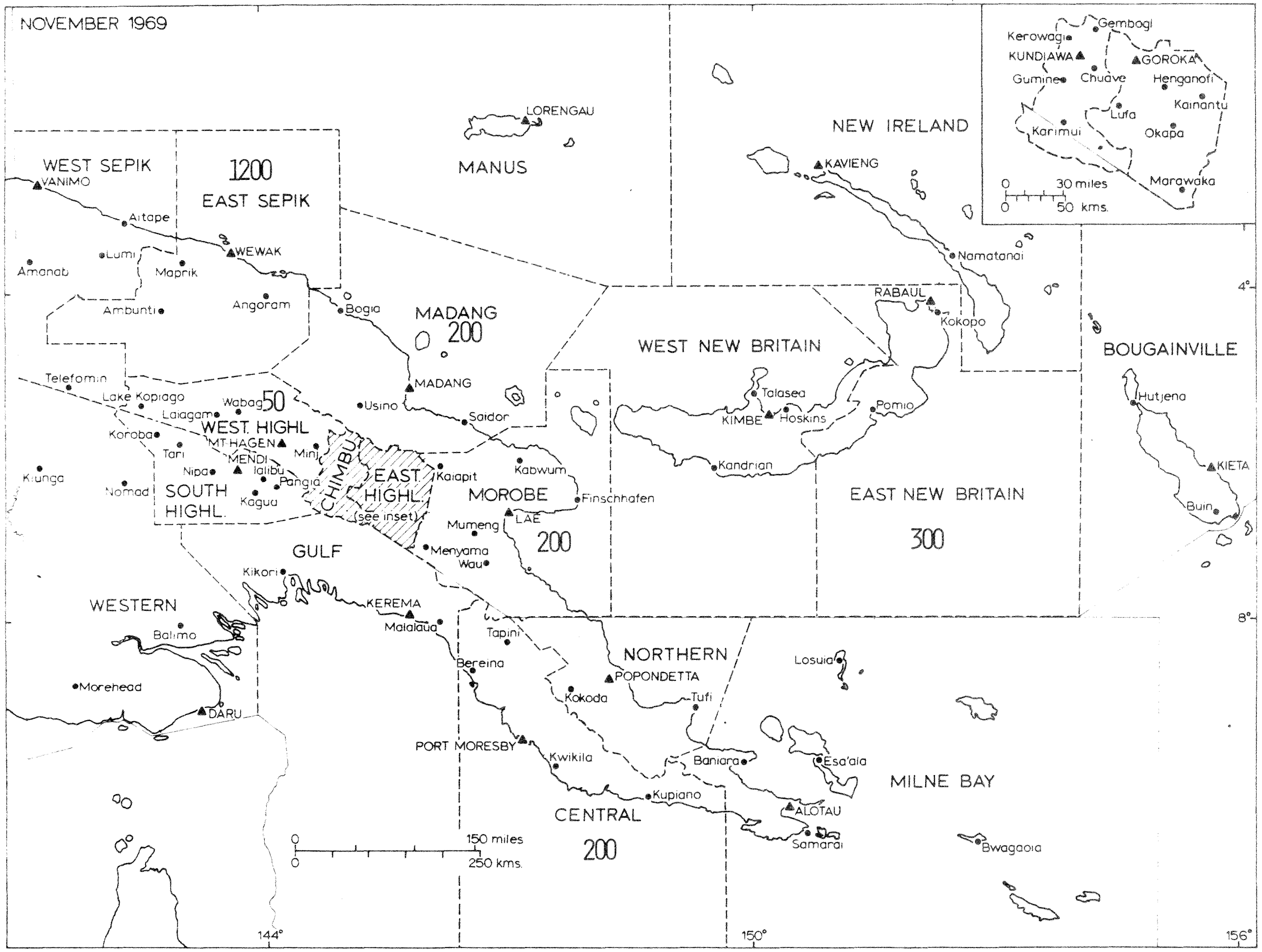
Distributions for cattle, sheep and buffalo are shown in Maps 4,5 and 6 respectively. For goats, accurate data are not available, but they are found mainly in Morobe, Eastern Highlands, Chimbu, Western Highlands, Enga and Southern Highlands. Pigs are distributed throughout P.N.G. associated with village populations, with native pigs found predominantly in the Highlands. Non-native pigs are located mainly around Lae and Port Moresby. The distribution of poultry is similar to that for pigs; they are found in most villages but less in Highlands than lowlands. Commercial enterprises are concentrated around Lae and Port Moresby.



Map 4 - The distribution of cattle by province as at June, 1976
(Source: Department of Geography, University of Papua New Guinea (1970) An Atlas of Papua New Guinea. Collins Longman).



Map 5 - The distribution of sheep by province as at June, 1977
(Source: Department of Geography, University of Papua New Guinea (1970) An Atlas of Papua New Guinea. Collins Longman).



Map 6 - The distribution of buffalo by province as at June, 1978 (Source: Department of Geography, University of Papua New Guinea (1970) An Atlas of Papua New Guinea. Collins Longman).

IV. CATTLE

A. Description

1. Size

	Bulls (kg)	Cows (kg)
Brahman Crossbred	600-900	400-600
Brahman	550-750	350-500
Droughtmaster	650-950	400-600
Santa Gertrudis	800-900	450-600
"Javanese Zebu"	500-580	320-410

Dairy: No data available; estimates for Friesians - bulls 700 kg, cows 450 kg (others, A.I.S. and Jersey, much smaller). No data on either height or chest girth for any breed.

2. Colour

Brahman crossbred: All colours, white, brindle, fawn, reds and black.

Brahman: Hair: white, bulls may be silver, grey or black over shoulder and rump. Some red Brahmans, bulls black shoulder and rump. No black in coat of cows. Skin: usually black, 5% have unpigmented skin.

Droughtmaster: Hair red, skin brown.

Santa Gertrudis: Hair darker red than Droughtmaster, skin brown.

"Javanese Zebu": Any colour; fawn common, with a black line along the spine. Black, white and pied also occur. Skin black, brown or white.

Dairy: Friesians - Normal black and white.

A.I.S.: Red on brown skin.

Jersey: Fawn.

3. Coat

Short coats predominate in all breeds. In the highlands a few animals have shaggy coats, but this is very rare in the lowlands.

4. Ears (Sizes are estimates, not measured)

Crossbred: 20-30 cm.
Brahman: long pendulous 30-40 cm.
Droughtmaster: Not quite as long and pendulous, 20-30 cm.
Santa Gertrudis: Similar to Droughtmaster.
"Javanese Zebu": Small, 15 cm, held horizontally, pointed tips.
Dairy: Normal for breed.

5. Hump

Humps are larger in bulls than in cows wherever they occur.
Crossbred: overhanging or pyramidal.
Brahman: overhanging.
Droughtmaster: pyramidal.
Santa Gertrudis: pyramidal.
"Javanese Zebu": overhanging or pyramidal.
Dairy: No hump.

6. Horns

Crossbreds: Up and out curve, or up and back. Variable colour and size.

Brahman: Very few polled animals. Upswept with a twist, black, up to 50 cm.

Droughtmaster: Brown, variable, many polled or with scurs. Up to 60 cm; the largest horns extend laterally.

Santa Gertrudis: Brown or light colour. Curve forward and down in some, 40 cm maximum.

"Javanese Zebu": Variable colour and direction, many curve up and forward, not twisted.

Friesians and other dairy: Standard for breed.

7. Udder

Brahman Crossbred:	Medium to large udder and teats.
Brahman:	Medium udder and teats.
Droughtmaster:	Larger udder and teats.
Santa Gertrudis:	Large udder and teats.
"Javanese Zebu":	Small neat close-attached udder and small teats.
Dairy:	Large.

8. Tail

Normal for cattle (not measured).

9. Temperament

Crossbred: Quiet if handled frequently. Those from large ranches, expecially if based on Angus breeding, are much more excitable.

Brahman: Placid if handled frequently and correctly, can be excitable if handling poor, or if run in large herds.

Droughtmaster and Santa Gertrudis: Normally placid.

"Javanese Zebu": Quiet but alert in the field if handled carefully; otherwise very excitable and nervous in confinement in yards or pens or in presence of dogs.

All the above are good mothers, very aggressive when the calf is small.

Dairy: Placid due to frequent handling.

10. Reaction to Sun

Dairy types react adversely to heat and sun. Others do not suffer; although they may seek shade to rest on hot days, they will graze in the midday sun.

11. Disease Resistance

Javanese are the most resistant to ticks and screw worm, markedly more than Brahman; then Brahman crossbred, Droughtmaster, Santa Gertrudis. Dairy cattle are susceptible.

Ticks are only found in a small area of P.N.G. In lowlands, intestinal worms are usually not a problem. Lung worm affects cattle in high country (2000 m +). Weaners of all breeds seem affected by worms in the Highlands. No comparative studies have been made. There are few major diseases of cattle in P.N.G.

B. Environment, Management and Feeding

1. Environment

Cattle are run in several different environments:

(i) Under coconuts, as grass removers, often with poor management and overstocking to maximise grass removal, on flat land usually close to the sea: pastures are Imperata, and a wide variety of other grasses and weeds. Soils often coral based, very alkaline. Climate; hot and humid.

(ii) Lowland valleys, e.g. Markham. Most important site: drier climate (1,200 - 1,800 mm rain), flat or gentle slopes, free draining alkaline soils. Hotter during day, cooler at night than coast: pastures Imperata, Themeda, and Saccharum.

(iii) Cleared rainforest: Hot, humid, flat or sloping, high rainfall, variable soil quality, pastures Brachiaria mutica, Paspalum, Saccharum, often becoming overgrown by returning rainforest.

(iv) Hills, from 0-2,000 m, gentle to steep slopes, fire climax pastures of Imperata and Themeda in drier areas, Saccharum in wetter and higher areas. Few trees, cooler climate, strong sun.

(v) Mountain valleys: 1,000-2,000 m, surrounded by rainforest or grassy hills: may be wet, swampy (Saccharum) or dry (Imperata) merging with area (iv); cooler climate, strong sun.

(vi) Sepik Plains: Vast area of poor, phosphate deficient, acidic clay soils, hot and humid, low lying, Imperata, Themeda, Saccharum and Ischaemum grassland. Potential cattle country, more suited to buffalo.

Cattle are very new on the village scene and have not established their status yet. Prestige value is high but harmonious integration into subsistence agriculture has yet to occur. Many small holder developments have not been successful and establishment of a stable cattle industry is some time off.

2. Feeding

Grazing is almost always fenced. Most pasture is native to the area; pasture improvement with tropical legumes and grasses is occurring but quite slowly. Semi-improvement with legumes is more common. In cleared rain forest, initial full improvement is the rule or regrowth takes over. Grazing is stationary, rarely rotational. No supplements are fed apart from salt and in some areas, phosphate. Stall feeding is not practised.

3. Management

(i) Size of herds: Large ranches have 200 to 8,000 head; small holders, 0-5 head 24%, 5-10 head 23%, 11-20 head 26%, 21-60 head 24% and 61-120 head 3%.

(ii) Proportion of Males: 1 bull for up to 40 females. About 1/3 of the herd are mature breeders. Few steer fattening enterprises.

(iii) Housing: Not practised.

(iv) Water: Natural.

(v) Castration: Most males are castrated by knife, before 6 months.

(vi) Weaning: On large holdings weaning is usually carried out at 7-9 months; rarely occurs on small holder farms.

(vii) Diseases and treatment: Diseases are rare; rinderpest, foot and mouth, brucellosis, vibriosis, trichomoniasis, tuberculosis, ephemeral fever, pleuropneumonia and other plagues do not occur. Infectious bovine rhinotracheitis - Infectious pustular vaginitis occurs: no treatment.

Boophilus microplus infestation occurs in limited areas in Papua, and is endemic in feral Rusa deer. Cattle are dipped in Asuntol, DDT, etc. Babesiosis occurs occasionally. In Madang and Morobe Provinces - buffalo fly: treatment is to spray with DDT.

Throughout P.N.G.: Chrysomia bezziana - Old World screw worm fly: treat with Lindane - based ointment.

Liver fluke in central area of Highlands: cattle are drenched with Zanil (ICI). Round worms usually unimportant except in weaners in Highlands, drenched with Nilverm (ICI). Treatment is not often carried out on small holdings.

(viii) Age at turn off: Males 7-12 years, females 10-12 years, castrates 2-4 years, cull heifers two years old.

C. Reproduction

(i) Mating system: free. A.I. has been used in a few special situations.

(ii) Ratio of males : females: Small holders: 1 bull for 2 to 40 females. Large holdings: 1 bull to 40-50 cows.

(iii) Age at first use: males 2½ years.

(iv) Age at first parturition: 2½ to 4 years.

(v) Seasonality of oestrus: very little - less oestrus in drier season in some areas, judged by calving records of research stations.

(vi) Births: little seasonal variation, more may occur at beginning of wet season in some highland areas.

(vii) Proportion of non-parous mated females: low on large holdings, higher on small holdings (but probably due to lack of bull in most cases).

(viii) Multiple births: very rare.

(ix) Calving interval: Varies from 11 months for "Javanese Zebu" and 13 months for Brahman crossbreds under good conditions to 14 months for "Javanese Zebu" and 2-2½ years for Brahman crossbreds under poor conditions.

(x) Mortality: Large and small holdings: very low. Some weaners in the Highlands die of internal parasites. Some new calves die of screw worm strikes on the navel. There is little information on small holdings but what there is indicates little problem except from these causes.

D. Breeding

(i) Males: Home bred (and a few imported from Australia) on large holdings. Small holdings were established with a bull, mainly in the last 5-10 years, now buying new bulls. A.I. and hiring of bulls are not practised.

(ii) Selection criteria: Large government stations: Bulls selected on weaning weight, post-weaning gain by weighing, temperament and if possible, polledness. Heifers selected on same criteria and subsequently on calving records.

Large private holdings: Similar criteria and ages (weaning, and post weaning to two years old) but visual assessment, not weighing.

Small holders: no selection practised yet.

(iii) Crossbreeding: Not a recognised practice. Many large holdings are or have been grading up to a 5/8 - 3/4 Brahman, but none systematically cross-breed between two breeds.

E. Performance

(i) No special attention is given to productive animals in most cases.

(ii) Milk: Dairies have nearly all failed in the last 6 years; production was only 5-10 litre/day from Friesians due to many mismanagement factors. Milk production of beef cattle unknown.

(iii) Meat: On the best country, steers are fat at 2 years old. Brahman weigh 450 kg. Droughtmaster and Santa Gertrudis 500-550 kg, "Javanese Zebu" 350 kg and Brahman crossbred 450-500 kg. On slightly poorer country, animals from large holdings may be older and thus bigger before reaching desired fatness. From many small holders, 3-4 year old steers, thin, weighing 350-450 kg are marketed. This poor performance is often due to lack of salt. Well grown and "finished" steers dress out at 56-59% with 5-10 mm back fat. "Javanese Zebu" dress at 60% with more fat despite slower growth rates and smaller carcasses.

(iv) Draught: Not practised with cattle.

V. SHEEP

A. Description

1. Size

	Male (kg)	Female (kg)
Corriedale	60	45-55
Romney Marsh	60	40-48
Perendale	60	43-50
Border Leicester x Merino		40-55
"Priangan"	40-60	25-45
"Priangan" Crossbreds	50-60	40-50

2. Colour

Corriedale, Romney Marsh, Perendale, Border Leicester x Merino: White fleece and skin.

"Priangan": White hair, white skin 50%, black hair, black skin 15%, others are light or dark brown, black and white, or brown and white, with no pattern. A specific pattern in about 15% of animals consists of black muzzle, eyebrows, ears and feet, with some brown markings on the face, the rest of the body ranging from white to dark brown. Many white animals have a brown patch on the back of the neck at birth, but this fades by maturity.

"Priangan" crossbreds: all white.

3. Coat

Corriedale, Romney Marsh, Perendale, Border Leicester x Merino produce wool normal for these breeds, but yields are low at 1 to 2.5 kg per year. Perendales and Border Leicester crosses are bareheaded.

For "Priangans", most of the coat is hair and kemp. Some (10%) have fleeces which are mainly wool. In cases of animals with black and white coats, either colour may be hair or wool. Black wool has no regular crimp. Yields range from 250 g hair to 1.2 kg wool and hair per year. Length 2-10 cm. No curl. The fleece cover is complete at birth but in many animals the long fleece disappears; first the belly, brisket and neck next, then sides and back; at 4 year old the entire coat may be hair, 1 cm long. About 20% of animals reach this fleeceless state. Males may have a tuft of straight hair 15 cm long on the throat. "Priangan" crossbreds may have all hair or all wool coats, or a mixture.

4. Ears

Perendale: prick ears.

Corriedale, Romney, Border Leicester x Merino, "Priangan" crossbreds: horizontal ears.

"Priangan": drooping ears.

5. Horns

Only "Priangan" males have horns, only 40% with true horns, 10% with scurs, 2-5 cm long. Horns are half circle, black on dark headed animals; white on light animals, with a diameter of curvature of 15 cm usually.

6. Udders

	Width	Length	Depth
Perendale	up to 15 cm	up to 10 cm	up to 10 cm
Romney Marsh	up to 15 cm	up to 10 cm	up to 10 cm
Corriedale	up to 15 cm	up to 10 cm	up to 10 cm
"Priangan"	up to 10 cm	up to 8 cm	up to 8 cm

Teats are placed obliquely on Perendale and "Priangan", vertically on others.

7. Tails

Corriedale, Romney Marsh, Perendale, Border Leicester: long not fat, usually docked.

"Priangan": shorter thin tails.
"Priangan" crossbreds: long tails, not fat.

8. Temperament

All can be very docile if herded. All, if well fed, are good protective mothers. Some "Priangan" when poorly fed, will desert their lambs. If twins are born, underfed "Priangan" ewes will choose one, actively reject the other.

9. Reaction to heat and direct sun

Perendales are the most sensitive to the sun. "Priangan" and Border Leicester x Merino will graze in midday sun in lowlands, but seek shade to rest. Others won't leave shade in lowlands at midday.

10. Disease resistance

Resistance to round worms and fluke (which occur only in the Highlands) is very poor and these are a major cause of death. The incidence of screw worm strikes for 1974 in the Highlands was:

"Priangan"	0%
Corriedale	13%
Perendale	17%
Romney Marsh	74%

The incidence was much less in the second year. "Priangan" in the lowlands do suffer strikes. Strikes are not confined to wounds but can occur anywhere on the body. They often lead to septicaemia and death unless systemic antibiotics are used.

B. Environment, management and feeding

Environment is as for cattle. Sheep are run successfully from 0-2,000 m elevation and from 1,250 mm to 5,000 mm rainfall.

1. Status

Mainly experimental; about six hundred are in small holder projects, the rest on Government and Mission Stations.

2. Grazing systems

Government Stations: All fenced and often penned at night, to reduce predation by village dogs.

Small holders: Most are fenced, some herded.

Pastures in the Lowlands are Buffel grass, _Themeda_, _Brachiaria mutica_, _Paspalum_, _Imperata_, and in the Highlands are _Themeda_, _Kikuyu_, _Vigna_ and _Desmodium_ on small holdings; also _Brachiaria decumbens_, _Stylosanthes_ and _Imperata_ on Government Stations.

Stationary or rotational grazing systems are used. Supplementary feeding as salt blocks and some grain is given to ewes on Government Stations. Some smallholders feed salt and cooked sweet potato.

Stall feeding is not practised.

3. Management

(i) Size of flocks:

Smallholders 5-40.
Missions and jails 50-150.
Agricultural Colleges and University 60-120.
Main Government Stations (2) 700.

(ii) Proportions of males and females: Smallholders: half have wethers only, other flocks, 50% male, 50% female.

(iii) Housing or penning: All have housing at night to protect from rain, pigs, dogs and thieves.

(iv) Water supply: Natural or bores.

(v) Castration: Most smallholders and institutions do, but one Government Station does, one doesn't. Castration at 4-6 weeks, by rubber ring on larger flocks, by knife on small holdings.

(vi) Weaning: institutions wean at 3-4 months; smallholders don't wean. Weaners may be supplemented with good pasture.

(vii) Disease situation: Screw Worm - Treated with Lindane ointments and antibiotics. Very widespread and severe problem with some breeds. Round Worms - on heavy set stocking a major problem. Monthly drenching is practised. Herded or lightly stocked sheep: no problem. Liver Fluke - in some of Highlands is treated by drenching. Clostridial disease - vaccination is practised in some herds. Non-specific pneumonias and enteritis also occur.

(viii) Age kept: Males to 4 or 5 years. Females die of old age at 7-9 years. Castrates and turn-off males sold at 18 months - 2 years.

C. Reproduction

(i) Mating system: free.

(ii) Ratio of males to females: Smallholders, 1 ram with 3-5 ewes usually. Some, 1 or 2 with 10-25 ewes. Large flocks, usually 2 rams at once with 30-150 ewes. Young rams may also be present if weaning is not practised.

(iii) Age at first use: Males 9 months - 15 months.

(iv) Age at first parturition: "Priangan" 15 months. Temperate breeds at 18 months - 2 years.

(v) Seasonality: At Department of Primary Industry stations in Lowlands, conception rates are greatest in November - December and June (based on birthdates) due to onset of wet seasons. In Highlands, peak oestrus (based on teasing) in January - February and May. In both areas, some conceptions occur in each month of the year.

(vi) Lambing: Lowlands, peak in April - May and December. Highlands peak in June and October and November.

(vii) Infertile ewes: 25-30%.

(viii) Multiple births: Lowlands: 2-5% triplets, 5-20% twins. Varies with nutrition, and therefore with season, with more multiple births in May. In Highlands: twins 0-5% in N.Z. sheep, 10-30% in "Priangan" on smallholdings. Varies with nutrition.

(ix) Parturition interval: Among breeders in Lowlands 7-12 months, some 18 months (perhaps produced unrecorded dead lamb). Highlands: Sheep imported from New Zealand 7-13 months, varies in different areas.

(x) Mortality: Lowlands: At birth - At Erap only, 20-30% due to birth of very small lambs, 1 kg or less, weak or born dead, and mis-mothering. To weaning, 10-15% due to dogs, enteritis or poor mothering. Post weaning 5%. Adult 15% per year.

Highlands: In 1975-76 mortalities among sheep imported from New Zealand were high, due to inexperience of shepherds. 1978 mortalities were:

Perinatal	2%
To weaning	7%
Post-weaning	5%
Adult (Annual rate)	6%

These ewes are now 6 to 7 years old; death rate may increase next year.

"Priangan" on small holdings - little data, but mortality seems to be low, except that outbreaks of parasitism occur.

D. Breeding

(i) Source of males: Home bred in larger flocks, with some trading between institutions. Small holders, initially bought but now home bred.

(ii) Selection criteria: Live weight at weaning and at maturity, and wool production and colour at 18 months.

(iii) Crossbreeding: All N.Z. and Australian ewes are mated to "Priangan". "Priangan" ewes are not mated to temperate breeds.

E. Performance

(i) Special attention for animals in production: nil.

(ii) Body weights: For all breeds, 80% are between 10 to 18 kg at weaning. Males are 2 kg heavier at weaning, at 3-4 months.

Weight at	Ewes (kg)	Rams (kg)
1 year	20-30	25-40
Slaughter at 18 months-2 years	30-40	33-45
Dressing percentage - 52		

Fat cover, varies with nutrition; low unless mature (2 years or older), rams have very little fat.

(iii) Fleece characteristics: At Erap in the Lowlands -

	"Priangan (10 ewes)	"Priangan" crossbreds (10 ewes)
Yield (greasy)	150-720 g	400-2,000 g
Mean fibre diameter for individuals	33-67 μm	23-32 μm
Range of fibre diameter	14-200 μm	14-100 μm
Medullation	9-56%	0-38%
Length	2-8 cm	4-12 cm

Highlands: Perendale, Corriedale and Romney wethers - 1.48 kg/year, range 1-2.5 kg. No yield or fibre data.

VI. GOATS

A. Description

1. Size

Males 40-50 kg, females 30-40 kg. No data on height and girth.

2. Colour

Many are white, others are black and white, blue roan, brown and white; in Alpine and Toggenberg face markings occur; some have pink skin, some are pigmented.

3. Coat

Usually short; some have long hair on the hind legs. There is no mohair or cashmere.

4. Ears

Small and erect.

5. Horns

Few are polled. Horns usually curl up and back. Some males have twisted horns, up to 40 cm long, horns may be black or unpigmented.

6. Udder size

Up to 10 cm front to back, 15 cm wide, 20 cm long. Teats are in the normal lateral position.

7. Tail

Short thin, upright.

8. Temperament

Alert and lively.

9. Reaction to heat and sunlight is to seek shade.

10. Resistance to disease

Seems great as mortalities in experimental flocks are low.

B. Environment, management and feeding

The status of goats is low; they are run by smallholders only. Goats may be tethered, herded, fenced or allowed free range, on fallow ground, old vegetable gardens, road sides and on bare hills not suitable for vegetable growing. Such bare hills are often covered with Themeda. No formal rotation system is used. No stall feeding is practised.

(i) Size of flocks: Flocks range from 2 to 30, with a mean about 10 in most areas. Near Sialum, Morobe Province, flocks of hundreds graze Themeda range.

(ii) Ratio of sexes: unknown.

(iii) Goats are often housed at night to protect from rain and predation.

(iv) Water supply: natural sources.

(v) Castration is not usual.

(vi) No weaning or supplementary feeding occurs.

(vii) Disease situation is unknown. Haemonchus and Screw worm are important. Incidence of disease is low.

(viii) Ages to which animals are kept: unknown.

C. Reproduction

(i) Mating system: free.

(ii) Ratio of males to females: High, perhaps 20-30% of the flock.

(iii) Age at first use: At puberty, 6-8 months.

(iv) Age at first parturition: 12 months.

(v) Seasonality: Births occur in all seasons.

(vi) Infertile females: Proportion is unknown, but probably very few.

(vii) Multiple births: Proportion of twins 38-50%, triplets 10% (based on less than 100 observations).

(viii) Parturition interval: Ranges from 180-270 days, mean is 230 days.

(ix) Mortality: About 10% of kids, then below 5% per year.

D. Breeding

Males are home bred, no selection is practised, and no formal cross breeding occurs.

E. Performance

No special conditions are provided for productive animals. Milk production is unknown and currently unimportant.

Meat: Kids are about 10-14 kg at 3-4 months old. Slaughter is between 6 and 12 months, at 20-30 kg, or at 12-24 months at 30 kg under slower growing conditions. Carcass yield is 50% with no subcutaneous fat.

VII. WATER BUFFALO

A. Description

1. Size

Adult males 500-600 kg, adult females 350-500 kg. Wither height and chest girth unknown.

2. Colour

90% are grey, with two pale "chevrons" on the throat. 10% are non-pigmented but become heavily "freckled" with age.

3. Coat

Up to 5 cm of coarse hair at birth. Mature animals are nearly hairless. Marked hair whorls occur on neck and flank. Hair is usually brown or black.

4. Ears

Large, held horizontally.

5. Hump

Males have heavy shoulders, no true hump.

6. Horns

Less than 1% are polled. Polled bulls are cryptorchid and sterile; polled cows are fertile.

Horns are heavy, black and long, up to 80 cm in old animals; much thicker in bulls. They curve out and back in nearly all cases.

7. Udder

Small, teats are small and hang perpendicularly.

8. Tail

Short and thin.

9. Temperament

Very docile.

10. Reaction to heat and sunlight

Extreme reaction to direct sun is to wallow. Great distress if wallow is not available.

11. Resistance to disease

Great resistance to most diseases, seem to be very healthy animals. Resistant to screw worm - strikes are very rare and maggots placed in wounds do not grow normally. Neoascaris vitellorum is a problem with new calves.

B. Environment, management and feeding

The main buffalo population is in the Sepik Plains area, which is characterised by high humidity, high rainfall and poorly drained, phosphate deficient soils which produce pasture of low productive capacity. Other areas include the high altitude (1,500-2,500 m) swamps of Western Highlands, Southern Highlands and Enga Provinces, while small herds are also found in coastal areas, in Madang, Morobe, East New Britain and Central Province (see Maps 1,5).

Grazing is under fenced conditions. Pasture is usually Imperata, Saccharum and other wet ground species. Neither supplementary feeding nor stall feeding are practised.

(i) Size of herds: Herds consist of one of over 1,000 head, three of over 100, and a number of small herds (10-20), plus individual draught animals.

(ii) Ratio of sexes: Most males are castrated. In large herds, males 5%, castrates and immature males 35%, females of all ages 60%.

(iii) Housing: not practised.

(iv) Water: natural, usually swampy ground.

(v) Castration: Generally performed by knife at 6-7 months. Earlier castration is difficult due to patent inguinal canals.

(vi) Weaning: At 7 months, no supplementary feeding.

(vii) Disease situation: *Neoascaris vitellorum* is a problem, treated with Piperazine at 1 week of age. No other important diseases.

(viii) Ages to which animals are kept: Males kept to 12-15 years, females to 20 years or more. Castrates slaughtered at 2½ years old.

C. Reproduction

(i) Mating system: Free.

(ii) Ratio of males to females: Up to 1:40, less on small holder projects.

(iii) Age at first use: At 2½-3 years.

(iv) Age at first parturition: 3 years 3 months.

(v) Seasonality of oestrus: Not recorded.

(vi) Seasonality of births: Not recorded.

(vii) Proportion of infertile females: Less than 10%.

(viii) Multiple births: None recorded in hundreds of births.

(ix) Interval between parturitions: 13-15 months.

(x) Mortality: Perinatal: 10%, often smothered in wallows. To weaning and subsequently, less than 3% per annum.

D. Breeding

(i) Source of males: Home bred (bought by small holders with first purchase of females).

(ii) Selection criteria: At weaning (7 months) and at 18-24 months on growth rates. Females selected on breeding performance.

(iii) Crossbreeding: No "Breeds" available, therefore crossbreeding not used.

E. Performance

(i) Special feeding: None.

(ii) Milk: Not milked.

(iii) Meat: Growth 0.4-0.6 kg/day to weaning, 0.2-0.4 kg subsequently. Slaughter at 2½-3½ years, 400-500 kg live weight; carcass yield 54-55%. Carcasses have external fat, no marbling, dark meat.

(iv) Draught: Use just developing for carts and rice production. No productivity figures available.

VIII. PIGS

A. Description

1. Size

European breeds: Boars to 250 kg, sows to 200 kg. Wither height and girth not recorded.

Native Pigs: Boars to 180 kg, sows to 150 kg, at 3 years old. The native pig is a short, fat, long nosed animal.

2. Colour

Native Pig: Mainly black, spotted black, white, red and grey. New born piglets are often striped horizontally, red and black. Some have black skins, more are white. Muzzle, anus and ears normally black skin.

3. Coat

Ordinary pig bristles. Male native pig has a mane of erect bristles on the neck. All breeds have straight hair.

4. Ears

Erect.

5. Udder

European breeds - 14 teats, Native - 10-12. In native pigs, udder larger at rear.

6. Tail

European: Normal tails, some curl.
Native Pig: Tail is longer, straight, with hairs 5-8 cm long. Functions as fly swat.

7. Temperament

European: Docile.
Native: If husbanded, usually very docile.

8. Reaction to heat and sunlight

All pigs dislike strong sun and seek a wallow.

9. Resistance to disease

Resistance to a variety of lice, mange mites, internal parasites is not unusually strong.

B. Environment, management and feeding

Pigs are found associated with human habitats in all climatic zones, usually managed by women. Their status is extremely high, as they are central in all important occasions, births, deaths, marriage etc. Commercial pig farming is not as high a status enterprise.

The Native Pig is grazed in small groups; sometimes tethered by front foot. They are fenced out of vegetable gardens, but not kept in sties. Tethering may be systematically rotational. They are supplementary fed sweet potato, taro, cassava and sago. It is estimated that hand feeding provides 70% of energy and 50% of protein.

1. Stall feeding

(i) Native Pigs: May be housed at night, under or in the owner's house at times. Very few are housed at all times. In some areas, large forest paddocks are used, with no housing. Housing is to protect from predation and also for hand-feeding, mainly with raw roots and scraps. Weaners may receive cooked roots; rations range from 500 to 3,000 g/day (wet weight). The roots are usually chopped up.

(ii) Commercial European pigs are fed imported rations or similar rations based on local grain and imported protein concentrates, in conventional (Western) systems.

2. Size of Herd

Native Pigs: 2 sows and offspring per woman is the usual maximum. Younger women have fewer pigs. Perhaps 95% of Highlands households have a few pigs, while fewer lowlanders own pigs.

European: Only 4 piggeries have over 50 sows.

3. Proportions of males and females

Native: 10% entire males, 40% castrates, 50% females.

4. Housing

Native pigs housed at night in bush material shelters. European pigs penned all the time.

5. Water supply

Native Pigs: Natural sources of water.

European: Rain water or town supply.

6. Castration

Native Pigs: using a bamboo knife at 6-9 months of age.

European Pigs: Usually not castrated.

7. Weaning

Native Pigs: 2-6 months, then supplemented with cooked roots, greens and fresh earthworms collected by the women while gardening.

European Pigs: Weaned at 8 weeks.

8. Disease

Native pigs are often malnourished, sometimes seasonally. Lungworm, spread by ingestion of earthworms, causes pneumonia, often leading to death. Kidney worm and ascarids are severe. Anthrax (non-pathogenic for other species) occurs occasionally. *Clostridium welchii* type C and swine pox are problems. Sick stock are secluded and treated with herbal recipes. Anthrax cases are usually buried, external parasites may be removed by hand, and pigs may be shaved to reduce lice infestations.

9. Age to which kept

Native pigs: 3-7 years depending on cultural requirements, boars up to 10 years.

European Pigs: Boars and sows 3 years, porkers 6 months.

C. Reproduction

1. Mating system

Native Pigs: Taken to boar, service paid for. In some areas, all males are castrated and wild pigs are relied on for service, but this is rare.

European Pigs: Controlled mating in pens.

2. Ratio of males to females

1 boar/10 sows.

3. Age at first use

Native males 12 months

European males 8 months

4. Age at first parturition

Native 15 months.

European 11 months.

5. Seasonality of oestrus

Native Pigs may be affected by nutrition in some areas. Little is known, but no planned seasonal mating occurs. European pigs breed at all seasons.

6. Proportion of infertile females

Native Pigs: Up to 40% of mated females do not produce young, due to Brucellosis.
European Pigs: 3% of sows and 15% of gilts return to heat.

7. Litter size

Native Pigs: 1st litter 2-6, mean 4.5
3rd litter 3-9, mean 6.1
5th litter 2-8, mean 5.0
European: Average 7-8/litter.

Hybrid vigour has been recorded for number weaned per sow at 8 weeks:

Site	European	European x Native	Native
Goroka (1,600 m)	4.3	6.6	5.1
Erap (100 m)	6.1	8.0	5.8

8. Interval between parturitions

Native pigs: at least 1 year in the village. Native and European: 6 months in sty with good feeding.

9. Mortality

	Native	European
Perinatal	20%	13%
To weaning	5%-10%	5%
Post-weaning	10%	1%
Adults (annual)	20%	1%

D. Breeding

(i) Males: In the villages, boars are bought or hired for service, often from other villages. Commercial piggeries import boars from Australia or breed their own. No A.I. is practised.

(ii) Selection criteria: Village (Native) pigs are selected on dam performance, number born and reared, vigour and disease resistance. Selected gilts stay with the sow for one year. Selection is based on first 1 or 2 litters. The boar is also selected on dam performance. Growth rate is not considered very important.

Commercial piggeries select replacement sows on growth rate to weaning (usually visually assessed) and dam performance. Boars are selected on the same criteria.

(iii) Crossbreeding: Native pigs are crossbred if sires are available. This has been going on since 1946, but in the villages, crossbred pigs have a low survival rate, so the genetic change has not been great. Black and red breeds are preferred due to susceptibility of white pigs to sunburn.

E. Performance

Lactating or pregnant native sows receive more sweet potato and are herded onto better ground. Prior to ceremonial pig kills, pigs may be fattened with an increased ration of sweet potato. European pigs receive conventional "Western" management. Weaners receive a 20% protein ration, porkers to 55 kg and milking sows receive 16% protein, non-lactating sows receive 14% protein.

Native pigs in villages grow at 30-120 g/day, averaging 60 g/day. If well fed they grow 130-280 g/day, averaging 200 g/day at 9 months. Growth is slower after weaning. The native pig is a short, dumpy, fat animal which fattens at light weights. At 50 kg carcass, yield is 78%, lean to fat ratio is 2:1. All parts are consumed except for gut contents.

European pigs grow 0.45 kg/day, reaching 55 kg at 18-20 weeks. Weaning weights are low. Carcass yield is 70-72% with 1 cm back fat and lean to fat ratio of 4:1.

IX. POULTRY

A. Description

1. Village chickens

<u>Size</u>: Male 1.8 kg, female 1.4 kg.
<u>Feather colour</u>: Very diverse, more brown than any other colour.
<u>Feather length and cover</u>: Short feathers except rooster tails, legs not feathered.
<u>Comb</u>: Single.
<u>Special features</u>: Very hardy. Hens will go broody. Low production.
<u>Temperament</u>: Flighty.
<u>Response to heat, disease and parasites</u>: Resistant.

2. Hybrid chickens: Meat birds

<u>Size</u>: 2 kg at 9 weeks.
<u>Feather colour</u>: White.
<u>Feather Length</u>: Short, legs not feathered.
<u>Comb</u>: Rose comb.
<u>Special features</u>: Highly bred hybrids imported from Australia and New Zealand. Parent stock now imported to P.N.G. In 1980, grandparent stock will be imported.
<u>Temperament</u>: Quiet.
<u>Resistance to heat, disease, parasites</u>: Not good. Kept in shaded pens, intensively raised.

3. Hybrid chickens: Layers

<u>Size</u>: 2 kg mature weight.
<u>Colour</u>: White, short feathers, legs not feathered.
<u>Comb</u>: Single.
<u>Special features</u>: Highly specialised imported lines, as for meat birds.
<u>Temperament</u>: Flighty, especially when hot.
<u>Reaction to heat</u>: Little mortality but production falls.
<u>Resistance to parasites and diseases</u>: Poor.

4. Guinea Fowl

<u>Size</u>: Mature, both sexes 1.5 kg.
<u>Feather colour</u>: Grey-blue, white speckles. Short, thick feather cover.
<u>Comb</u>: Callus.
<u>Temperament</u>: Flighty.
<u>Resistance to heat and disease</u>: Good except during wet season.

5. Ducks

<u>Muscovy</u>

<u>Size</u>: Males 4-5 kg, females 3-3.5 kg.
<u>Feathers</u>: white and black, short, legs bare.
<u>Comb</u>: No comb, fleshy face.

Temperament: Tame.
Resistant to heat, but not to direct sun.
Resistance to disease and parasites: Very good.

Khaki Campbell and Rouen

Size: Males 3-3.5 kg, females 3 kg.
Colour: Brown females; males brown with bronze neck and head.
No comb on fleshy face.
Temperament: Flighty.
Resistance to heat, direct sun and disease: All good.

6. Geese

Size: Males 7 kg, females 5 kg.
Colour: Grey, short feathers, dense cover.
Comb: Callus.
Temperament: Aggressive.
Resistant to heat, sun and disease.

7. Turkeys

Size: Males 10-12 kg, females 6-7 kg.
Colour: Bronze turkeys, short feathers, well covered, big tail.
Comb: Wattles and snood.
Temperament: Flighty.
Resistance to heat and sun: Quite poor.
Resistance to disease: Good.

B. Environment, management and feeding

1. Village chickens

Chickens are found wherever man has settled, mainly coastal or to 2,000 m. They run free in the villages, feeding on scraps and scavenging, but may be housed at night.

(i) Size of flock: 5-10 per family, may be hundreds in a village.

(ii) Ratio of males: High, from 10% to 50%.

(iii) Rearing: Natural incubation and rearing.

(iv) Disease: Coccidiosis is important in young birds. Predators, village dogs and pigs cause losses. Internal parasites, hookworms, ascarids are important in older birds. No preventive or treatment methods.

(v) Age kept: Die at 2-3 years.

2. Meat birds

Commercial production is mainly in the lowlands. Birds are housed on deep litter (coffee hulls, etc.), grass roof, wire netting walls.

One big company produces 20,000/week with contract raising by 120 small holders each raising batches of 1,000-5,000 birds/year. This is a half time job, not of high status.

(i) Density: 0.1 sq m/bird, 1,000 per pen.

(ii) Pen feeding: Self feeders. Broiler starter crumbles - 22% protein, 1.5 kg consumed in four weeks. Broiler finisher pellets - 19% protein, 3 kg consumed in next 4-5 weeks.

(iii) Water: Bamboo or galvanised iron troughs.

(iv) Flock size: 100-500.

(v) Male to female ratio: 1:1.

(vi) Rearing: 30 cm high tin surrounds, with a cover and kerosene heater in highlands, no cover or heat in lowlands.

(vii) Diseases: Coccidiosis - treat with medicated feed. Navel ill - no treatment. No significant internal parasites.

(viii) Age kept: 8-9 weeks.

3. Hybrid layers

Commercial production in the tropical lowlands, birds are reared on deep litter, kept in cages or deep litter during laying.

(i) Density: 0.2 sq m/bird during rearing, 0.3 sq m during laying, if on litter. Cages are 30 cm square.

(ii) Pen feeding: Deep litter, self feeders; cages use a trough. Pullet starter - 20% protein, 1.7 kg consumed in 6 weeks. Pullet developer - 15% protein, 7.5 kg to 22 weeks. Layer - 16% protein, 43 kg consumed 22-52 weeks.

(iii) Water: Troughs for deep litter. Nipples for cages.

(iv) Flock size: A few have 250-1,500 birds, most production comes from flocks of 5,000-40,000.

(v) Male to female ratio: All females.

(vi) Rearing: In intensive brooders.

(vii) Disease: Marek's disease - vaccination practised. Coccidiosis - feed medicated rations.

(viii) Age kept: 18 months.

4. Guinea fowl

Kept in the coastal regions, and managed in open range or deep litter (10 - 20 birds/pen).

(i) Feeding: Starter, developer and layer rations, as for layers. Intake 120 g/day while in lay.

(ii) Water: as for layers.

(iii) Flock size: 10 - 20.

(iv) Male to female ratio: 1 : 1.

(v) Rearing: Artificial brooders with heat even in the Lowlands.

(vi) Diseases: Coccidiosis - medicated feed. Few other diseases known.

(vii) Age kept: Killed at 16 weeks for meat, layers kept to 3 years old.

5. Ducks

Normally kept in swampy areas with a lot of shade, from sea level to high altitude swamps (2,000 m). Duck production is very new in villages, but is beginning to achieve importance in areas with no alternative livestock. There is only one large scale, semi-intensive farm. Most are small scale and free range.

(i) Feeding: Large scale - grain and concentrates fed in morning. In villages, fed same subsistence diet as villagers, then free range, but penned at night. Feed quantities are not known.

(ii) Flock size: One with 1000; 20 small holders well established, 20 - 50 birds, another 300 smallholders recently established.

(iii) Ratio of males to females: From 1 : 5 to 1 : 1.

(iv) Rearing: Natural.

(v) Disease: Normally very healthy. Malnutrition may occur due to limitation of range because of predators. Botulism occurs but there is no treatment.

(vi) Age kept: Males slaughtered at 20 weeks, females 3 years.

6. Geese and turkeys are quite unimportant and mainly experimental at this stage.

C. Reproduction

(i) Mating system: Free.

(ii) Ratio of males to females:

Villages	1:1
Commercial layers	1:12
Guinea fowl	1:1
Ducks	1:5 to 1:1
Turkeys	1:3 to 1:4
Geese	1:1 pair bonding

(iii) Age at first use - Males (weeks) Age at first egg - Females (weeks)

	Age at first use - Males (weeks)	Age at first egg - Females (weeks)
Village chickens	when mature	30
Commercial chicken	20	22
Guinea fowl	20	27
Ducks	27	27
Turkeys	27	32
Geese	30	32

All eggs are used for hatching in village chickens. All others discard eggs in first 2 weeks of lay.

(iv) Fertility (%) Hatchability of fertile eggs (%)

	Fertility (%)	Hatchability of fertile eggs (%)
Village	90	60
Commercial	80	75
Guinea fowl	90 - 95	85
Ducks	90	80
Turkeys	50	30
Geese	60	40

(v) Incubation: Village chickens and ducks - natural. Commercial chickens, guinea fowl and turkeys - artificial incubators (electric, forced draught). Geese - hatched under Muscovies.

(vi) Mortality (%):

	0 - 6 weeks	6 weeks - maturity	Mature (per year)
Village chickens	10 - 20	20 - 30	10 - 20
Broilers	3 - 10 to 9 wks	-	-
Layers	4	8	12
Guinea fowl	30	2 - 3	1 - 2
Ducks	2	4	4
Geese	2	4	4
Turkeys	50	5	5

D. Breeding

(i) Source of males:

Village chickens	home bred
Commercial	imported
Guinea fowl	bought
Ducks	home bred
Turkeys	bought
Geese	bought

(ii) Selèction criteria:

Village chickens	none
Commercial chickens	hybrid lines from Australia
Others	no systematic selection yet

(iii) Crossbreeding: Very little.

E. Production

(i) Special feeding: Not practised by smallholders. Large scale commercial enterprises with any species follow conventional feeding practices using commercial bagged feed.

(ii) Eggs:

	Number	Weight (g)	Age at turn off (years)
Village chickens	50	40 - 45	Kept for life
Commercial	200 - 220	50 - 60	1.5
Guinea fowl	70	35 - 40	-
Ducks	80	70 - 100	3
Geese	30	90 - 120	5
Turkeys	40	70 - 90	4

(iii) Meat:

	Age and Weight at Slaughter (weeks)	(kg)	Yield (%)	Fatness
Village chickens	30	1.5	-	nil
Broilers	9	1.5 - 2	70-72	adequate
Ducks	16	3.4	80	adequate
Turkeys	16	7	85	adequate
Guinea fowl	16	1.5	70-72	adequate
Geese	20	6.7	85	adequate

Culled egg producing birds of all species weigh little more than these slaughter birds.

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Specific references have not been given in the text, as very little detailed work has been done. Some relevant published papers are listed below. Other sources of information included: Government Research Station records and reports, Provincial Veterinary Officer's reports, Department of Primary Industry Reports, University of Papua New Guinea Research Reports.

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ANIMAL GENETIC RESOURCES IN SRI LANKA

E.F.A. Jalatge

I. INTRODUCTION

The Republic of Sri Lanka is an island situated within the tropics between northern latitudes 5° 55' and 9° 50', and eastern longitudes 79° 42' and 81° 51'. The island covers an area of 65,000 sq. km (25,322 sq. miles) with a maximum North-South length of 435 km (270 miles) and East-West width of 225 km (140 miles).

In Sri Lanka exotic breeds of cattle, buffaloes, goats, sheep, pigs and poultry are being maintained for the supply of milk, meat and eggs for domestic consumption. Population numbers are in Table 1.

Table 1. Livestock and Poultry Populations ('000s)

	1962(a)	1970(b)	1973(a)	1976(c)
Cattle	1364	1593	989	910
Buffaloes	596	736	387	387
Goats	309	556	284	277
Sheep	40	27	17	-
Pigs	50	180	42	34
Poultry	3765	6856	3668	3070

(a) All island Agricultural census figures
(b) Village Headman returns as reported by Dept. of Census and Statistics
(c) Projected figures

A. Cattle

Indigenous (Sinhala breed) and exotic breeds of cattle are being maintained for the supply of milk, meat and draught power.

The country can be divided into several zones according to the elevation from mean sea level and the breeding program differs according to the zone.

(i) Hill-country Zone: Over 910 m above mean sea level, where the climate is mild, exotic European breeds such as Friesians, Ayrshires, Jerseys, Shorthorns are kept without difficulty. Good quality temperate grasses (e.g. Kikuyu, paspalum) can be grown, and most of the indigenous cattle in this area have now been up-graded to temperate breeds, by artificial insemination.

(ii) Mid-country Zone: This is part of the hill country, up to 910 m above mean sea level. The zone receives adequate rainfall throughout the year, but at certain times of the year the temperature is unfavourable for rearing temperate breeds of cattle under grazing management systems. However, with adequate skill, such cattle breeds can be maintained in this zone, by resorting to zero grazing whenever the climate becomes unfavourable.

(iii) Coconut-growing Zone: This area, also referred to as the "coconut triangle", is bordered on one side by the sea coast, 45 km south to 100 km north of Colombo, other borders running to a town called Kurunegala in the north central part of the country. The main crop in this region is coconut, and cattle are grazed under the palms. Pasture varieties such as Brachiaria brizantha, mutica and miliformis are the popular forms of grasses in the area.

Indigenous and Indian breeds of cattle (Sindhi, Kangayam, Haryana, Tharpakar) can easily be maintained in this zone. The indigenous cattle are being crossbred with superior Indian breeds, such as Sindhi, to give an increased production of milk and heavier adult weight.

Cattle are also bred to bulls of temperate breeds (Jersey, Friesian, Ayrshire and Shorthorn) in order to get a better crossbred animal. In this instance the recommended cross-breeding system is a rotational breeding scheme, using bulls of superior Indian breeds and temperate breeds.

(iv) Dry Zone: The rest of the island is known as the dry zone, and about 60% of the cattle population are located in it. They are mainly indigenous cattle, with a low level of production.

Diseases such as haemorrhagic septicaemia and foot and mouth occur regularly, and the Government offers free vaccination against them. It is not possible to control these diseases in certain areas, however, because of poor accessibility and inadequate veterinary coverage.

Indigenous cattle in this zone are being upgraded, using bulls of superior Indian breeds such as Sindhi, Tharpakar and Sahiwal. The Indian breed Khillari is very popular for its superior draught power.

B. Buffaloes

More than 90% of the buffaloes found in the country are swamp-type water buffaloes, mainly kept for draught power.

Buffaloes are used in various stages of preparing land for paddy (rice) cultivation, and for threshing paddy after harvesting. Despite mechanization of paddy cultivation in most parts of the country, buffaloes are still very popular, due to low cost, and because they can be used in areas not accessible to tractors.

The Government of Sri Lanka maintains herds of superior Indian milk breeds of buffaloes such as Murrah and Surti. The bulls of these breeds are being used to upgrade the local buffaloes to produce milk and also to obtain a heavier mature animal.

C. Goats

Most of the goat population in Sri Lanka consists of the local indigenous goats, which have a mature weight of about 18.2 kg yielding a carcase weight of about 8.1 kg on slaughter.

The Government maintains imported Indian breeds such as Jamnapari in some of the Government farms. Indian breeds give a heavy mature weight, and when crossed with local goats give an F_1 animal with a better growth rate and heavier carcase weight.

The local goat is a poor producer of milk, and up to now breeding efforts have been directed to obtaining a heavier animal for increased meat production. However, with the increase in the price of cow's milk, the demand for a milk type of goat has increased.

Importation of milk breeds of goats, for crossing with local goats to produce progeny with a better milk supply is receiving the attention of the Sri Lanka Government.

D. Sheep

Local sheep are few in number and are kept mainly for the supply of mutton. Their mature weight is similar to that of goats (18 kg), yielding a carcase weight like that of the goat. They yield a very small amount of coarse wool, normally used in making carpets and rugs.

The Government has started a program of upgrading local sheep by crossing them with exotic breeds (mainly Dorset Horn). The Government is also aiming to popularize sheep-farming in certain parts of the country, and with this in view is importing South Indian breeds of sheep, such as Bannur and Red Madras, which are similar to the local sheep, and are mainly for meat production.

E. Pigs

Pig breeding is popular in the Western coastal area, close to Colombo. The breeds maintained are mostly Large White, Middle White, Landrace and Berkshire. Most of the pig breeders cater to the growing demand for pork and bacon in Colombo.

The pig population, like the poultry population, has shown a decline since 1970. This is due to the limits imposed by the availability of grain (maize) and other animal feed ingredients such as coconut meal.

F. Poultry

The poultry industry in Sri Lanka expanded up to 1970, when grain (maize) and other ingredients used in poultry mash, such as coconut meal were freely available. At present there is a limit to the production of poultry feed, imposed by lack of availability of maize and coconut meal. The coconut crop has dwindled over the years, and domestic consumption of coconuts has increased. As a result there is a decrease in the number of nuts used for extraction of oil, and a consequent shortage of coconut meal. As there is no known ingredient of animal feed available in large quantities which could be used in poultry mash as an alternative to coconut meal, poultry mash production is limited.

However, 20% of the poultry population in the country is still maintained under back-yard poultry management, and is not dependent on the availability of formulated poultry feed. In order to expand this sector of poultry husbandry, the Government is issuing crossbred poultry (Rho White) chicks (Rhode Island Red male X White Leghorn female) to farmers who could rear them for egg production with any available feed.

There are many franchise poultry breeders importing their parent stock birds from abroad. These breeders sell commercial broiler chicks and day-old pullets of egg-laying breeds to farmers located all over the island.

In addition the Government also maintains parent stock birds of Rhode Island Red and White Leghorn breeds in the main poultry research farm near Kandy. Parent stock chicks are made available from this farm to regional farms having facilities to incubate eggs.

II. BREEDS, MANAGEMENT AND PERFORMANCE

A. Cattle

1. Indigenous

More than 85% of the national herd consists of indigenous cattle, known as the Sinhala breed. These are smaller than imported temperate breeds, and have no specific colour, showing an assortment ranging from pure white, black or brown to a mixture of brown and white or black and white. Shades of colour may also vary.

The animals have small ears and no hump, except sometimes when crossed with Indian breeds. Horns are normally black, length and direction varying from animal to animal.

Indigenous cattle are normally docile, but resist close examination and handling. They are very resistant to heat and parasitic diseases such as tick-borne fever.

Mature weights, reached after 4 years, vary from 159 to 181 kg. Under good management a cow may yield 100 gallons (= 455 litres) of milk per lactation (See Table 2).

In most areas the farmers have one or two animals, tethered and housed at night and tied outside for grazing during day time. They feed on unimproved varieties of grass normally found on the road side and on village parks and playgrounds. Most farmers give cut grass to their animals at night.

Female animals are mated when they are about 3 years of age. It is customary to avoid mating on the first two occasions when the cows show heat; on the third they are put to the village bull. The cows are very regular at calving with a low percentage of calving difficulties.

In the Dry Zone of Sri Lanka large herds of cattle are managed in areas where natural grasslands are available. They run as one herd, and the females are served by bulls in the same herd. The owners brand their animals for easy identification, and the herds are rounded up occasionally to sell the surplus animals and excess bull calves to the butcher. However, the owners are now becoming interested in selling milk from these animals, especially to the National Milk Board of Sri Lanka, the Government organization for collection and distribution of milk in the country. The N.M.B. is offering attractive prices for raw milk.

Indigenous cows are poor producers of milk, and are normally milked only in the morning. The calf is allowed to remain with its mother throughout the day, and separated from her in the evening. In the morning it is allowed to suckle for a very brief period, and after the 'let down' of milk the cow is stripped leaving a little for the calf. This way the calves remain healthy and their growth is unimpaired.

There is a growing tendency among village farmers to castrate surplus bull calves. Some of them have their animals castrated by the burdizzo method at the nearest veterinary clinic, while others still resort to manual crushing of the testicles when the animals are small. Some of the castrated animals are used to pull carts; they are easy to handle.

2. Exotic temperate breeds

Exotic breeds of cattle were first imported into Sri Lanka when the country was under British colonial rule. The Government now maintains purebred Friesian, Ayrshire and Jersey breeds in Government farms located in the Hill country Zone. The animals graze on pasture, mainly of kikuyu (*Pennisetum clandastinum*), and in addition are given concentrates, depending on their level of production. The concentrate consists of grain, coconut meal, rice bran and mineral mixture.

These Government Farms have been in existence for a long time, and appreciable numbers of surplus stock have been issued to farmers in Hill and Mid-country Zones, as well as in the Coconut-growing Zone. Bull calves also have been issued to farmers to upgrade their stock.

The Government Department of Animal Production and Health also maintains an effective artificial insemination service, mainly in the Hill and Mid-country Zones and in the Coconut-growing Zone. Semen of temperate breeds is available to breeders in the Hill and Mid-country Zones, as well as deep-frozen semen sometimes.

In the coconut-growing areas semen from temperate breeds as well as from imported Indian breeds (Sindhi, Sahiwal) is made available, so that breeders can program a rotational system of mating to upgrade their stock.

Table 2 gives production data for temperate cattle breeds on Government Farms.

Table 2. Some Production Statistics of Dairy Cattle in Government Farms

Breed	305 day yield (kg)	Age at first calving (months)	Calving interval (days)	Length of lactation (days)
Sinhala	450	45	405	189
Sindhi	1080	46	416	242
Jersey	2320	30	351	-
Dairy Shorthorn	1740	41	384	-
Ayrshire	2820	40	484	-
Friesian	3230	40	520	-

3. Exotic Indian Breeds

The Government also maintains purebred Indian breeds of cattle in some of the Livestock Farms in the Dry Zone of Sri Lanka. Bull calves from these herds are either issued to farmers in the Dry Zone for a nominal amount, or are sent to Government Stud Centres located in the Dry Zone or in coconut-growing districts of the country. Both schemes are designed to upgrade the low producing indigenous stock by cross-breeding.

The Government also maintains herds of purebred Indian breeds (Khillari, Kangayam) reputed to be good draught animals. The males are castrated when young, and are said to be ideal as cart bulls. They are very docile and are capable of pulling heavy loads. At the moment there is a heavy demand for cart bulls, and the Government Farms are unable to meet the demand.

B. Buffaloes

Local buffaloes are maintained mainly for draught power in the paddy growing districts. Their average mature weight (4 years of age) is about 272 kg, and their average carcase weight about 136 kg. Females are poor producers of milk, and their udders are under-developed. They are very docile and in between work they relish wallowing in water or muddy ponds.

In the villages of the paddy growing districts of Sri Lanka each household owns about two or more buffaloes. Some of the more affluent farmers could own up to about 10 animals. When not being used for paddy cultivation work, they are let off to the jungle to find their own feed. They are branded with large letters for identification at a distance, and to prevent them from roaming over long distances, animals are tethered in pairs before being driven to the jungle.

Seasonality in calving has been observed in local and Indian breeds of buffaloes. This has been found to be due more to nutritional causes than to any other reason.

The Government maintains exotic Indian breeds of buffaloes (Murrah and Surti) in Government Livestock Farms located in the Dry Zone. These animals graze on Brachiaria pasture supplemented with concentrate feeding according to their levels of production. Male calves of these breeds are used in cross-breeding programs designed to upgrade the local buffalo.

Buffaloes are very susceptible to diseases such as foot and mouth and haemorrhagic septicaemia.

C. Goats

Indigenous goats are small in size, their mature weight being about 18 kg, and are bred mainly for meat. They vary in colour, and are regular breeders.

Goats are normally reared in the scrub-jungle regions of Sri Lanka, where ample browsing areas are available. They are very resistant to parasitic and other diseases.

The Government has embarked on a program of upgrading this stock by the use of superior males of Indian breeds, such as Jamnapari.

D. Sheep

There is a small number of indigenous sheep in the country. Their mature weight is about 18 kg, and they yield coarse wool used in the manufacture of rugs and carpets.

E. Pigs

Imported varieties of pigs are maintained both in Government Farms and by private breeders. Breeding stock is made available to farmers from Government Farms through the extension staff of the Department of Animal Production and Health. There are no major infectious diseases among them.

In addition to these imported animals, indigenous pigs (wild boars) are available in jungles and sanctuaries. These are not being used in any breeding program, due to their poor quality.

F. Poultry

At the moment the country's poultry population is in the region of 3 million birds. About 80% of this number is maintained under the deep litter system of management. In and around cities, where eggs can be easily marketed, the tendency is to have large farms, with layers numbering 5-50 thousand housed under one roof. In other parts of the island the average flock size is around 100 birds, reared in a deep-litter house, where the birds are managed by the housewife to augment the family income.

The biggest feed suppliers are the Oils and Fats Corporation and the British Ceylon Corporation (both Government owned).

The Government Farms issue day-old chicks to farmers through the extension staff of the Department of Animal Production and Health, as well as issuing month-old birds to those who are unable to brood their own chickens.

The birds are vaccinated against fowl pox and ranikhet diseases by the staff attached to the veterinary surgeons of the Department of Animal Production and Health.

Most farmers are able to brood their own chickens, providing the necessary warmth by using hurricane lamps or high powered bulbs. They are conversant with the feeding and management techniques involved in rearing the birds to laying stage.

Most poultry farmers are conscious of the economics of poultry management, and most cull their laying birds at 18 months of age.

In addition to Government poultry farms, private franchise breeders also issue commerical pullets of laying breeds to farmers who patronise their services.

All poultry farmers who rear their birds under the deep litter system are dependent on the availability of formulated poultry rations to expand their activities. Because of the scarcity of coconut meal and maize feed, already discussed, manufacturers are unable to meet the demand for more feed, and some of the large poultry breeders are now mixing their own feed.

Twenty percent of the national poultry flock is reared under back yard conditions. Each household rears an average of about 10 birds. They may be let out to find their own feed or they may be restricted to a limited area and fed with household refuse. They are housed only in the night. The Government is encouraging more people to take up back-yard or semi-intensive systems of poultry management, by making available a crossbred chick (Rho white) which could thrive under difficult conditions.

Broiler production is also very popular mainly to supply the demand for broilers in towns and by the tourist industry. Broiler chicks are made available by Government farms or by private franchise agents. Due to the poor quality of the mash the broilers take 12-14 weeks to reach a live weight of 1.1-2.0 kg.

6. DOCUMENTATION FORMS FOR LIVESTOCK BREEDS

Society for the Advancement of Breeding Researches in Asia and Oceania

(S A B R A O)

Documentation of livestock breeds

Notes on completion of forms

1. The Workshop on Animal Genetic Resources, held by SABRAO at Tsukuba, Japan, 3-7 September, 1979, recommended that standard forms be prepared for the documentation of performance of livestock breeds in the Region.

2. Drafts of such forms were compiled at the Workshop, and have now been studied in further detail, particularly with a view to standardizing the presentation for the different species.

3. Examination of the draft forms led to the conclusion that each should be in two parts:

   Schedule I: containing a general description of each breed

   Schedule II: containing actual performance data collected on a particular flock or herd, or from a particular survey

4. The form for each species has therefore been re-organized into two parts, Schedule I and Schedule II. There might well be several copies of Schedule II associated with only one Schedule I, where several sets of data were available for the same breed.

5. Data may not be available to answer all questions. Where there is no information, the words "no data" should be written against the question. (This is to ensure that the question has not been missed by chance.) Answers should not be guessed.

6. Schedule I is to be completed by ticking appropriate squares, or indicating a figure in a square where requested. Additional written information is sought in some cases (e.g. "State colour").

7. Schedule II has some squares to be ticked, but also asks for actual measurements. In most cases, means and either ranges or standard deviations (S.D.) are requested. The standard deviation is preferable if available.

   For climate data, ranges for annual averages are sufficient.

8. At the end of each schedule, a request is made for references to published material (books, journal articles, conference proceedings, or reports) or unpublished material (reports, internal memoranda). If the number of these is large, reference can be made to review articles or bibliographies. If none of these exist, the list can be confined to material written from 1970 onwards. (Reviews prior to 1970 should of course be included.) Extra pages should be used for these references, as required.

9. These forms are on trial. It is recognised that modifications will have to be made, but it is hoped everyone will cooperate in giving them a good trial, and making suggestions for their improvement.

10. Completed forms should be sent to:

Dr. Y. Yamada,
Division of Animal Breeding and Genetics,
National Institute of Animal Industry,
Yatabe, Tsukuba,
Ibaraki, 305
JAPAN.

S A B R A O

Documentation of livestock breeds

CATTLE AND BUFFALOES

Country . . . . Date form prepared . . . / . . . / . . . (Day / Month / Year)

Species . . . . By whom prepared

Breed . . . . Name . . . .

Strain . . . . Organization . . . .

(If a cross, specify the original breeds. In the case of buffalo, specify river or swamp type and crosses of these.)

SCHEDULE I - GENERAL DESCRIPTION

A. ORIGIN

Indigenous	Exotic	
☐	☐	Date of introduction . . . .

B. USE

(Number squares in order of importance, and leave blank if animals not used for that purpose. If two purposes are equally important, give them the same number.)

Milk	Meat	Draught	Other (specify)
☐	☐	☐	☐
			. . . .
			. . . .

C. APPEARANCE

1. Coat

(a) Colour

(If possible, indicate in each square the percentage of animals of each colour or with each marking).

(i) Body colour or patterns

(If different for male and female, specify separately for each sex.)

Solid	Pied	Spotted	Fawn
☐	☐	☐	☐
(State colour)	(State colours)	(State colours)	
. . . .	. . . .	. . . .	
	. . . .	. . . .	

continued overpage

Brindle	Roan	Albino	Albinoid
☐	☐	☐	☐

(ii) Colour markings

Chevron	Muzzle ring
☐	☐

(b) Hair

(i) Length

Short (under 1 cm)	Medium (1-2 cm)	Long (over 2 cm)
☐	☐	☐

(ii) Sheen

Glossy	Dull
☐	☐

(iii) Curl

Curly	Straight
☐	☐

(iv) Diameter

Fine	Coarse
☐	☐

2. Skin

Colour, pigmentation

White	Pigmented (specify colour or colours)
☐	☐
	. . . .
	. . . .

Localized	Uniform
☐	☐

3. Head

(a) Shape

Long	Wide	Concave	Convex
☐	☐	☐	☐

(b) Horns

(i) Presence or absence

	Horned	Polled
Male	☐	☐
Female	☐	☐

(ii) Shape

	Straight	Curved	Coiled	Scur
Male	☐	☐	☐	☐
Female	☐	☐	☐	☐

(iii) Size

	Small	Medium	Large	Very large (e.g. Swamp Buffalo)
Male	☐	☐	☐	☐
Female	☐	☐	☐	☐

(iv) Colour

Specify

Male . . . .

Female . . . .

(c) Ears

(i) Direction

Horizontal	Drooping
☐	☐

(ii) Size

Small	Medium	Large
☐	☐	☐

4. Body

(a) Shape

Massive	Angular
☐	☐

(b) Hip

Horizontal	Sloped
☐	☐

(c) Hump

	Prominent	Intermediate	Low	Absent
Male	☐	☐	☐	☐
Female	☐	☐	☐	☐

(d) Dewlap

	Heavy	Intermediate	Light
Male	☐	☐	☐
Female	☐	☐	☐

(e) Navel flap

	Small	Large
Male	☐	☐
Female	☐	☐

(f) Sheath

	Loose	Tight
Male	☐	☐

5. Udder

(a) Size

Small	Intermediate	Large
☐	☐	☐

(b) Shape

Trough ☐ Hanging ☐

(c) Shape of teats

Cylindrical ☐ Tapered ☐ Bulbous ☐

(d) Size of teats

Small ☐ Medium ☐ Large ☐

(e) Placement of teats

Equally spaced ☐ Irregular ☐

(f) Relative size of quarters

Front quarters: Larger ☐ Smaller ☐

6. Tail

Short ☐ Medium ☐ Long ☐

D. TEMPERAMENT

Docile ☐ Wild ☐

E. REACTION TO HEAT AND SOLAR RADIATION

General observations . . . .

. . . .

. . . .

(Specific details under experimental conditions to be given in Schedule II)

F. RESISTANCE TO PARASITES AND DISEASES

General observations . . . .

. . . .

. . . .

(specific details in Schedule II)

G. HERD SIZE

Number of animals in each:

Government farm	Commercial farm	Village
		Individually owned
Mean	Mean	Mean . . . .
Range	Range	Range . . . . . .
		Communally owned
		Mean . . . .
		Range . . . . . .

H. REFERENCES

Please give details of any relevant documents (books, journal articles, conference proceedings, published or unpublished reports) . . . .

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SCHEDULE II - PERFORMANCE

S A B R A O

Documentation of livestock breeds

CATTLE AND BUFFALOES

Country . . . .
Species . . . .
Breed . . . .
Strain . . . .

Date data collected . . . / . . . / . . . (Day / Month / Year)
By whom collected:
Name . . . .
Organization . . . .
Place . . . .
Date form prepared . . . .
By whom . . . .

A. PRODUCTION DATA

1. Body weight and size

(a) Males and females

At		Age (months)		Number of Animals		Body weight kg		Wither height cm		Heart girth cm	
		M	F	M	F	M	F	M	F	M	F
Birth :	Mean										
	Range or S.D.*										
Weaning :	Mean										
	Range or S.D.										
Yearling :	Mean										
	Range or S.D.										
Adult :	Mean										
	Range or S.D.										

* S.D. = Standard deviation

(b) Castrates (if available)

At		Age (months)	Number of Animals	Body weight kg	Wither height cm	Heart girth cm
Birth :	Mean					
Range or S.D.						
Weaning :	Mean					
Range or S.D.						
Yearling :	Mean					
Range or S.D.						
Adult :	Mean					
Range or S.D.						

2. Reproduction

(a) Mating system

Natural uncontrolled	Natural controlled	Artificial insemination
☐	☐	☐

(b) Ratio males : females (for mating): . . . .

(c) Number of animals recorded

Males: . . . . .

Females: . . . . .

(d) Age at puberty (months):

Males: Mean . . . . . Range or S.D. . . . . . .

Females: Mean . . . . . Range or S.D. . . . . . .

(e) Age (months) at first:

Mating: Males: Mean . . . . . Range or S.D. . . . . . .

Parturition: Females: Mean . . . . . Range or S.D. . . . . . .

(f) Oestrus:

Length of cycle (days) Mean . . . . . Range or S.D. . . . . . .

Duration (hours) Mean . . . . . Range or S.D. . . . . . .

(g) Gestation period (days): Mean . . . . . Range or S.D. . . . . . .

(h) Calving interval (days): Mean . . . . . Range or S.D. . . . . . .

(i) Seasonality of calving:

Number of months in which calves dropped: Mean . . . . . Range or S.D. . . . . . .

Actual months: . . . .

(j) Calving ease:

(give details)

No assistance . . . .

Medium assistance . . . .

High level assistance . . . .

(k) Calf crop:

(i) Natural mating:

	1st parturition	Later parturitions	Overall
Calves born per 100 females put with bull	. . . .	. . . .	. . . .

(ii) Artificial insemination:

	1st parturition	Later parturitions	Overall
Females failing to come on heat as % of females in herd	. . . .	. . . .	. . . .
Calves born per 100 females inseminated	. . . .	. . . .	. . . .

(l) Twinning rate:

	1st parturition	Later parturitions	Overall
Percent of females with twins:			
As % of females calving	. . . .	. . . .	. . . .
As % of females put to male	. . . .	. . . .	. . . .

(m) Lethal genes:

None known ☐ Some known ☐

Effect, and percent affected . . . .

. . . .

(n) Specific reproductive disorders

None present ☐ Some present ☐

Describe, and give frequency . . . .

. . . .

. . . .

3. Milk production

(a) Feeding conditions under which records obtained

Grazing only	Grazing and concentrates	Confined or stall-fed - forage only
☐	☐	☐
Grasses and grazing system	Specify concentrates and give quantity per day	Specify forages and give quantity per day
. . . .	. . . .	. . . .
. . . .	. . . .	. . . .
. . . .	. . . .	. . . .

Confined or stall-fed - forage and concentrates	Feeding regime according to lactation stage or daily milk yield - state which
☐	☐
Specify forages and concentrates and give quantity per day	Describe
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .

(b) Type of milking

Hand	Machine	
	with let-down by calf	without let-down by calf
☐	☐	☐

(c) Milk yield

Measurement	Lactation							
	1st		2nd		3rd		4th or later	
No. animals measured								
No. milkings/day								
	Mean	Range or S.D.*	Mean	Range or S.D.	Mean	Range or S.D.	Mean	Range or S.D.
Age (years)								
Milk yield per day (kg)								
Lactation period (days)								
Milk yield per lactation (kg)								
Fat per lactation:†								
Percent								
kg								
SNF per lactation:†								
Percent								
kg								
† If these not available, then:								
Day of lactation (one day basis):								
Fat %								
SNF %								
Ease of milking (milking rate)								
Ratio of yield front : rear quarters								

* S.D. = Standard deviation

4. Beef production

(a) Feeding conditions under which records taken

Grazing only	Grazing and concentrates	Confined or stall-fed - forage only
☐	☐	☐
Grasses and grazing system	Specify concentrate and give quantity per day	Specify forages and give quantity per day
. . . .	. . . .	. . . .
. . . .	. . . .	. . . .
. . . .	. . . .	. . . .

Confined or stall-fed - forage and concentrates	Other comments
☐	☐
Specify forages and concentrates and give quantity per day	If needed
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .

(b) Body weights and gains - finishing

Characteristic	Unit	Measure	Age (days)			Weight, number or %		
			M*	F*	C*	M*	F*	C*
Number of animals	-	-						
Weaning weight**	kg	Mean						
(................)		Range or S.D.						
Initial body weight	kg	Mean						
		Range or S.D.						
Final body weight	kg	Mean						
		Range or S.D.						
Fattening period	days	Mean						
		Range or S.D.						
Average daily gain	kg	Mean						
		Range or S.D.						
Age at slaughter	days	Mean						
		Range or S.D.						
Weight at slaughter	kg	Mean						
		Range or S.D.						
Dressing percentage								
Warm carcase	%	Mean						
		Range or S.D.						
Cold carcase	%	Mean						
(Complete whichever applies)		Range or S.D.						
Total feed consumed***								
Forage (air dry)	kg	Mean						
		Range or S.D.						
Concentrates (air dry)	kg	Mean						
		Range or S.D.						

* M = Male; F = Female; C = Castrate.

** Specify if adjusted to specific age, and if so, what age.

*** Where animals are at pasture, it may not be possible to complete this section.

5. Work

(a) Number of animals recorded

Male	Female	Castrate
. . . .	. . . .	. . . .

(b) Type of work

	Ploughing	Transport (carrying or packing)	Traction (drawing a load)
Male	☐	☐	☐
Female	☐	☐	☐
Castrate	☐	☐	☐

Tools:	Load:	Type of cart:
Male:	M	M . . . .
Female	F	F . . . .
Castrate	C	C . . . .
Soil type:		Single or paired:
Male		M . . . .
Female		F . . . .
Castrate		C . . . .
Single or paired:		Load:
Male		M . . . .
Female		F . . . .
Castrate		C . . . .

(c) Endurance

(i) Length of continuous time at work (according to (b) - hours)

Male . . . .
Female . . . .
Castrate . . . . . .

(ii) For ploughing:

Hectares/hour or day	Working hours/day
Male	M . . . .
Female	F . . . .
Castrate	C . . . .

(d) Age at first work (months)

Mean	Range or Standard deviation
Male	. . . .
Female	. . . .
Castrate	. . . .

(e) Age at last work (months)

Mean	Range or Standard deviation
Male	. . . .
Female	. . . .
Castrate	. . . .

(f) Under experimental conditions

(i) Willingness to work (number of stoppages during a given work)

Mean	Range or Standard deviation
Male	. . . .
Female	. . . .
Castrate	. . . .

(ii) Maximum pulling power (kg - by dynamometer)

Mean	Range or Standard deviation
Male	. . . .
Female	. . . .
Castrate	. . . .

(iii) Endurance (given load x maximum work period - kg by dynamometer)

Mean	Range or Standard deviation
Male	. . . .
Female	. . . .
Castrate	. . . .

B. OTHER ASPECTS OF PERFORMANCE

1. Reaction to heat and solar radiation

(To be completed where actual experiments have been done)

(a) Under field conditions

(i) No. of animals tested . . . .

(ii) Sex and age . . . .

(iii) Simplified heat tolerance test. Relative increase, before and after exposure to solar radiation, in:

Rectal temperature . . . .

Pulse rate . . . .

Respiration rate . . . .

(Specify method) . . . .

. . . .

(iv) Describe environmental factors at time of test:

Air temperature (^{o}C) . . . .

Humidity . . . .

Wind velocity . . . .

Others . . . .

(v) Other reactions

Salivation . . . .

Opened mouth . . . .

Tongue exposed . . . .

Others . . . .

(b) In climatic chamber

Describe concisely all aspects of test, including number, age and sex of animals

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

2. Resistance to parasites and diseases

(To be completed where specific information is available. Discuss in particular ticks, helminths, liver fluke, theileriosis, rinderpest, foot-and-mouth, haemorrhagic septicaemia, any others.)

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. . . .

C. CONDITIONS UNDER WHICH DATA IN SCHEDULE II COLLECTED

1. Geographic region . . . .

2. Annual rainfall (mm) Mean . . . . Range . . . .

3. Type of rainfall

Seasonal	Non-seasonal	Other (specify)
☐	☐	☐

Season . . . .

Duration (weeks) . . . .

4. Average maximum temperature ($^{\circ}$C)

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

5. Average minimum temperature ($^{\circ}$C)

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

6. Average maximum humidity

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

7. Average minimum humidity

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

8. Type of management

(a) Place where data obtained

Government farm	Commercial farm	Village (communal)
☐	☐	☐

(b) Management system

(i) Grazing

Grazing only			Grazing + supplement		
Tethered	Herded	Fenced	Tethered	Herded	Fenced
☐	☐	☐	☐	☐	☐

Specify grasses, legumes, etc. . . . .

. . . .

Specify supplement (amount and type) . . . .

. . . .

Zero grazing	Stocking rate for grazing
☐	

Specify grasses legumes, etc. given (amount and type) . . . .

. . . .

. . . .

(ii) Housing

None	At night all year	At night in summer, wholly in winter
☐	☐	☐

(iii) Confinement

None (except during handling)	Yarded at night
☐	☐

(iv) Drenching and dipping regimes (against internal and external parasites)

Drench used . . . .

Frequency . . . .

Type of dip: Bath . . . .

Shower . . . .

Dip used . . . .

Frequency . . . .

(v) Vaccination (against disease)

Give details, including age of animals, disease, vaccine and frequency . . . .

. . . .

. . . .

D. REFERENCES

Please give details of any relevant documents (books, journal articles, conference proceedings, published or unpublished reports)

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

S A B R A O

Documentation of livestock breeds

SHEEP AND GOATS

Country . . . .

Species . . . .

Breed . . . .

Strain . . . .

Date form prepared (Day / Month / Year) . . . / . . . / . . .

By who prepared

Name . . . .

Organization . . . .

SCHEDULE I - GENERAL DESCRIPTION

A. ORIGIN

Indigenous ☐ Exotic ☐ Date of introduction . . . .

B. USE

Number squares in order of importance, and leave blank if animals not used for that purpose. If two purposes are equally important, give squares the same number.

Fibre	Meat	Milk	Skins
☐	☐	☐	☐
Fur	Draught	Manure	Other (specify)
☐	☐	☐	☐

. . . .

. . . .

. . . .

C. APPEARANCE

1. Coat

(a) Type

Wool No medullation	Wool Slightly medullated	Wool Highly medullated	
☐	☐	☐	
Hair No usable fine undercoat	Hair Usable fine undercoat	Mohair Little kemp	Mohair Much kemp
☐	☐	☐	☐

Specify . . . .

. . . .

(b) Length

Very short (under 1 cm)	Short (1 and under 2 cm)	Medium (2 and under 4 cm)	Long (4 cm and over)
☐	☐	☐	☐

(c) Glossiness or lustre

Goats		Sheep	
Glossy	Dull	Lustrous	Non-lustrous
☐	☐	☐	☐

(d) Curl or crimp

Goats		Sheep	
Curly	Straight	Crimped	Straight
☐	☐	☐	☐

(e) Fineness (General Description - Details in Schedule II)

Fine (21 μm or less)	Medium (22-26 μm)	Coarse (more than 26 μm)
☐	☐	☐

2. Colour

(a) Body (coat)

If possible, indicate in each square the approximate percentage of animals of each colour.

White	Completely pigmented		Partly pigmented (specify colour or colours)
	One colour (specify)	More than one (specify)	
	. . . .	. . . .	. . . .
	. . . .	. . . .	. . . .
		. . . .	. . . .

(b) Head and Points

White	Pigmented (specify colour or colours)
	. . . .
	. . . .

(c) Skin (body)

White	Pigmented (specify colour or colours)
	. . . .
	. . . .

(d) Muzzle and anus

White	Pigmented (specify colour)
	. . . .

3. Head

(a) Horns

(i) Presence or absence

	Horned	Polled
Male		
Female		

(ii) Shape

	Straight	Curved	Coiled	Scur
Male				
Female				

(iii) Size

	Small	Large
Male		
Female		

(b) Ears

(i) Presence

Present	Absent

(ii) Direction

Erect	Hanging

(iii) Size

Small	Medium	Large

(c) Wattles

Present	Absent

(d) Beard

	Present	Absent
Males	☐	☐
Females	☐	☐

4. Tail

Thin	Fat	Fat rump
☐	☐	☐

Short	☐	Long wedge	☐
Medium	☐	Long broad	☐
Long	☐	Short wedge	☐
		Short broad	☐

5. Other features

(a) Ruff on brisket

	Present	Absent
Males	☐	☐
Females	☐	☐

(b) Udder

Small	Medium	Large
☐	☐	☐

(c) Super-numerary teats

	Present	Absent
	☐	☐
	Yes	No
Functional	☐	☐
	Yes	No
With extra mammary tissue	☐	☐

D. TEMPERAMENT

Docile ☐ Wild ☐

E. REACTION TO HEAT AND SOLAR RADIATION

General observations . . . .

. . . .

. . . .

(Specific details to be given in Schedule II, if experimental evidence available)

F. RESISTANCE TO PARASITES AND DISEASES

General observations . . . .

. . . .

. . . .

(Specific details to be given in Schedule II, if experimental evidence available)

G. FLOCK SIZE

Number of animals in each:

Government farm	Commercial farm	Village
		Individually owned
Mean	Mean	Mean . . . .
Range	Range	Range . . . .
		Communally owned
		Mean . . . .
		Range . . . .

H. REFERENCES

Please give details of any relevant documents (books, journal articles, conference proceedings, published or unpublished reports).

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SCHEDULE II - PERFORMANCE

S A B R A O

Documentation of livestock breeds

SHEEP AND GOATS

Country . . . . Date data collected . . . / . . . / . . . (Day / Month / Year)

Species . . . . By whom collected:

Breed . . . . Name . . . .

Strain . . . . Organization . . . .

Place . . . .

Date form prepared . . . .

By whom . . . .

A. PRODUCTION DATA

1. Body weight and dressing percentage

(a) Males and females

At	Age	Sex	Litter size at birth	No. of animals	Body weight (kg) Mean	Body weight (kg) Range or S.D.*	Dressing % Mean	Dressing % Range or S.D.
Birth	-	Male	Single				-	
			Twin				-	
			3 or more				-	
	-	Female	Single				-	
			Twin				-	
			3 or more				-	
Weaning	days	Male	Single					
			Twin					
			3 or more					
		Female	Single					
			Twin					
			3 or more					
Slaughter	days	Male	Single					
			Twin					
			3 or more					
		Female	Single					
			Twin					
			3 or more					
First mating	mths	Male	Single				-	
			Twin				-	
			3 or more				-	
		Female	Single				-	
			Twin				-	
			3 or more				-	
Maturity	yrs	Male	Single					
			Twin					
			3 or more					
		Female	Single					
			Twin					
			3 or more					

* S.D. = Standard deviation.

(b) Castrates

At	Age	Sex	Litter size at birth	No. of animals	Body weight (kg) Mean	Range or S.D.*	Dressing % Mean	Range or S.D.
Weaning	days	Castrate	Single					
			Twin					
			3 or more					
Slaughter	days	Castrate	Single					
			Twin					
			3 or more					
Maturity	yrs	Castrate	Single					
			Twin					
			3 or more					

*S.D. = Standard deviation.

2. Body size

(a) Males and females

At	Age	Sex	Litter size at birth	No. of animals	Wither Height (cm) Mean	R/SD*	Chest girth (cm) Mean	R/SD	Body length (cm) Mean	R/SD
12-18 mths	mths	Male	Single							
			Twin							
			3 or more							
		Female	Single							
			Twin							
			3 or more							
Maturity	yrs	Male	Single							
			Twin							
			3 or more							
		Female	Single							
			Twin							
			3 or more							

* Range or standard deviation.

(b) Castrates

At	Age	Sex	Litter size at birth	No. of animals	Wither height (cm) Mean	R/SD*	Chest girth (cm) Mean	R/SD	Body length (cm) Mean	R/SD
12-18 mths	mths	Castrate	Single							
			Twin							
			3 or more							
Maturity	yrs	Castrate	Single							
			Twin							
			3 or more							

* Range or standard deviation.

3. Reproduction

(a) Mating system

Natural uncontrolled (males always with females)	Natural controlled (specify)	Hand service	Artificial insemination
☐	☐	☐	☐
	Males with females for . . . . . weeks Males with females always but mating prevented by		

(b) Ratio males : females for mating: . . . .

(c) Number of animals recorded

Males . . . .

Females . . . .

(d) Age at puberty (months)

Males: Mean . . . . . Range or S.D. . . . .

Females: Mean . . . . . Range or S.D. . . . .

(e) Age in months at first:

Mating: Males: Mean . . . . . Range or S.D. . . . .

Parturition: Females: Mean . . . . . Range or S.D. . . . .

(f) Oestrus:

(i) Length of cycle (days): Mean . . . . . Range or S.D. . . . .

(ii) Duration (hours): Mean . . . . . Range or S.D. . . . .

(iii) Seasonality:

Number of months each year females on heat: Mean . . . . . Range or S.D. . . . .

Actual months . . . .

How observed:

Months in which lambs dropped	Continuous oestrous records
☐	☐

(g) Gestation period (days): Mean . . . . Range or S.D. . . . .

(h) Interval between parturitions (days): Mean . . . . Range or S.D. . . . .

(i) Length of post-partum anoestrus (days): Mean . . . . Range or S.D. . . . .

(j) Lambing or kidding percentage:

(expressed as number of offspring per female put with the male (or teased for AI or hand service)):

	1st parturition	Later parturitions	Overall
Born	. . . .	. . . .	. . . .
Marked*	. . . .	. . . .	. . . .
Weaned	. . . .	. . . .	. . . .

* State when marking occurs - at end of lambing, or other time.

(k) If possible, give following numbers:

		1st parturition	Later parturitions	Overall
Total no. of females put with males or teased for AI or hand service		. . . .	. . . .	. . . .
No. which produced:				
At birth	0			
	1			
	2			
	3 or more offspring			
At weaning	0			
	1			
	2			
	3 or more offspring			

4. Milk production (for dairy animals)

(a) Milking technique

Hand	Machine	
	With let-down by lamb or kid	Without let-down by lamb or kid
☐	☐	☐

(b) Milk yield

Measurement	Lactation					
	1st		2nd		3rd or later	
No. of animals measured						
No. of milkings per day						
	Mean	Range or S.D.	Mean	Range or S.D.	Mean	Range or S.D.
Age (years)						
Milk yield per day (kg)						
Lactation period (days)						
Milk yield per lactation (kg)						
Fat percent						
SNF percent						

(c) Feeding

Give details of any special feed given to milking animals (in addition to general management outlined in Section C)

. . . .

. . . .

5. Fleece production

(a) Components - Percent

True fibre (without medulla)	or	Heterotype (interrupted small medulla)	Hair (Medulla more than 60% of diameter)	Kemp (shed fibre)
☐		☐	☐	☐

Estimated by:

Weight	Count
☐	☐

(c) Number of shearings per year . . . .

(c) Measurements

Age (months)	Was there a prior shearing	Approx growth period (months)	Sex	Greasy weight (kg)	Percent clean yield (%)	Clean weight (kg)	Staple length (cm)	Average fibre diameter: Overall (μm)	Non-medullated fibres (μm)	Medullated fibres (μm)
6	No		M:*							
			Mean							
			R/SD**							
			F:*							
			Mean							
			R/SD							
			C:*							
			Mean							
			R/SD							
12	No		M:							
			Mean							
			R/SD							
			F:							
			Mean							
			R/SD							
			C:							
			Mean							
			R/SD							
	Yes		M:							
			Mean							
			R/SD							
			F:							
			Mean							
			R/SD							
			C:							
			Mean							
			R/SD							
18	Yes		M:							
			Mean							
			R/SD							
			F:							
			Mean							
			R/SD							
			C:							
			Mean							
			R/SD							
Later (state age)	Yes		M:							
			Mean							
			R/SD							
			F:							
			Mean							
			R/SD							
			C:							
			Mean							
			R/SD							

* M = Male; F = Female; C = Castrate

** R/SD = Range or standard deviation (between individuals in one flock)

B. OTHER ASPECTS OF PERFORMANCE

(To be completed where actual experiments done)

1. Efficiency of conversion of feed to product

(a) Average daily gain in body weight/feed consumed

(i) Mean . . . . Range or S.D. . . . .

(ii) Number of animals observed . . . .

(iii) Age (weeks) at start . . . .

(iv) Length of feeding period (weeks) . . . .

(v) Sex . . . .

(vi) Method of feeding

Ad libitum ☐ Controlled (specify) ☐

. . . .

. . . .

(vii) Details of feed . . . .

(b) Weight of clean fleece/feed consumed

(i) Mean . . . . Range or S.D. . . . .

(ii) Number of animals observed . . . .

(iii) Age at start (give unit) . . . .

(iv) Length of feeding period (give unit) . . . .

(v) Sex . . . .

(vi) Method of feeding

Ad libitum ☐ Controlled (specify) ☐

. . . .

. . . .

(vii) Details of feed . . . .

. . . .

2. Reaction to heat and solar radiation

(a) Under field conditions

(i) Number of animals tested . . . .

(ii) Sex and age . . . .

(iii) Relative increase, before and after exposure, in:

Rectal temperature . . . .

Pulse rate . . . .

Respiration rate . . . .

(Specify method) . . . .

. . . .

(iv) Describe environmental factors at time of test:

Air temperature (°C) . . . .

Humidity . . . .

Wind velocity . . . .

Others . . . .

(v) Other reactions:

Salivation . . . .

Opened mouth . . . .

Tongue exposed . . . .

Others . . . .

(b) In climatic chamber

Describe concisely all aspects of test, including number, age and sex of animals

. . . .

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3. Resistance to parasites and diseases

(Discuss where specific information is available, giving details of diseases and evidence for resistance)

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C. CONDITIONS UNDER WHICH DATA IN SCHEDULE II COLLECTED

1. Geographic region . . . .

2. Annual rainfall (mm): Mean . . . . Range . . . .

3. Type of rainfall

	Seasonal	Non-seasonal	Other (specify)
	☐	☐	☐
Season	. . . .		. . . .
Duration (weeks)	. . . .		. . . .

4. Average maximum temperature (°C):

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

5. Average minimum temperature (°C):

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

6. Average maximum humidity:

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

7. Average minimum humidity:

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

8. Type of management

(a) Place where data obtained

Government farm	Commercial farm	Village
☐	☐	☐

(b) Management system

(i) Grazing

Grazing only			Grazing + supplement		
Tethered	Herded	Fenced	Tethered	Herded	Fenced

Specify grasses, legumes, etc.

Specify supplement. (amount and type)

Zero grazing

Stocking rate for grazing

Specify grasses legumes, etc. given (amount and type)

(ii) Housing

None

At night all year

At night in summer, wholly in winter

(iii) Confinement

None (except during handling)

Yarded at night

(iv) Drenching and dipping regimes (against internal and external parasites)

Drench used . . . .

Frequency . . . .

Type of dip: Bath . . . .

Shower . . . .

Dip used . . . .

Frequency . . . .

(v) Vaccination (against disease)

Give details, including age of animals, disease, vaccine and frequency

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D. REFERENCES

Please give details of any relevant documents (books, journal articles, conference proceedings, published or unpublished reports)

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S A B R A O

Documentation of livestock breeds

PIGS

Country . . . .

Species . . . .

Breed . . . .

Strain . . . .

Date form prepared . . . / . . . / . . . (Day / Month / Year)

By whom prepared

Name . . . .

Organization . . . .

SCHEDULE I - GENERAL DESCRIPTION

A. ORIGIN

Indigenous ☐ Exotic ☐ Date of introduction . . . . . .

B. USE (Number squares in order of importance)

Meat ☐ Skin ☐ Manure ☐ Religious ☐

Bristle ☐ Others (specify) ☐

. . . .

. . . .

C. APPEARANCE

1. Colour

(a) Predominant colour (indicate proportions of animals)

White ☐ Red ☐ Black ☐ Others (specify) ☐

. . . .

. . . .

(b) Pattern (where proportions of animals)

Solid ☐ Belted ☐ Spotted ☐ Others (specify) ☐

. . . .

. . . .

(c) Result when mated with other breeds (indicate proportions of animals)

White	Red	Black	Others (specify)
☐	☐	☐	☐
			. . . .
			. . . .

2. Head

(a) Face

Dish-like	Convex	Long snout	Other (specify)
☐	☐	☐	☐
			. . . .
			. . . .

(b) Ears

(i) Position

Erect	Floppy	Other (specify)
☐	☐	☐
		. . . .
		. . . .

(ii) Size

Small	Medium	Large	Other (specify)
☐	☐	☐	☐
			. . . .
			. . . .

(c) Tusks

Present	Absent
☐	☐

Shape . . . .

Size . . . .

3. Body

(a) Body shape

Barrel-like	Long	Short	Low-set
☐	☐	☐	☐

Loin and rump well-developed	Other (specify)
☐	☐
	....
	....

(b) Tail

(i) Length

Short	Medium	Long
☐	☐	☐

(ii) Shape

Curled	Straight	Others (specify)
☐	☐	☐
		....
		....

(c) Teats

(i) Number

No. normal pairs	No. blind pairs	Others (specify)
....	....	....
		....

Total no. pairs

....

(ii) Placement

Regular	Irregular	Other (specify)
☐	☐	☐
		. . . .
		. . . .

D. TEMPERAMENT

Docile	Nervous	Other (specify)
☐	☐	☐
		. . . .
		. . . .

E. REACTION TO HEAT AND DIRECT SOLAR RADIATION

Tolerant	Not-tolerant
☐	☐

(General observations - specific details in Schedule II)

F. RESISTANCE TO PARASITES AND DISEASE (tick square if resistant)

Internal parasites (specify which)	External parasites (specify which)	Infectious diseases (specify which)
☐	☐	☐
. . . .	. . . .	. . . .
. . . .	. . . .	. . . .

Others (specify)

☐

. . . .

. . . .

(General observations - experimental details in Schedule II)

G. HERD SIZE

Number of animals in each:

Government farm		Commercial farm		Village	
				Individually owned	
Mean......	Range	Mean	Range	Mean	Range .....
				Communally owned	
				Mean	Range ......

H. REFERENCES

Please give details of any relevant documents (books, journal articles, conference proceedings, published or unpublished reports)

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SCHEDULE II - PERFORMANCE

S A B R A O

Documentation of livestock breeds

PIGS

Country . . . .

Species . . . .

Breed . . . .

Strain . . . .

Date data collected (Day / Month / Year) . . . / . . . / . . .

By whom collected

Name . . . .

Organization. . . . .

Date form prepared (Day / Month / Year) . . . / . . . / . . .

By whom . . . .

A. PRODUCTION DATA

1. Body weight and composition

At	No. of animals			Age (state unit)	Body weight (kg)			Back fat thickness			Dressing %		
	M*	F*	C*		M	F	C	M	F	C	M	F	C
Weaning : Mean													
Range or SD **													
Slaughter : Mean													
Range or SD													
First mating : Mean													
Range or SD													
Full grown : Mean													
Range or SD													

* M - males, F - females, C - castrates, ** S.D. - Standard deviation.

2. Reproduction

(a) Mating system

Natural uncontrolled	Natural controlled	Artificial Insemination
☐	☐	☐

(b) Ratio males : females at mating . . . .

(c) No. animals recorded

Males . . . .

Females . . . .

(d) Age at puberty (weeks)

Males :	Mean	Range or SD . . . .
Females : (1st oestrus)	Mean	Range or SD . . . .

(e) Age at first (weeks):

Mating (male) :	Mean	Range or SD . . . .
Parturition (female) :	Mean	Range or SD . . . .

(f) Oestrus:

Length of cycle (days):	Mean	Range or SD . . . .
Duration (hours) :	Mean	Range or SD . . . .

(g) Gestation period (days) : Mean . . . . Range or SD . . . .

(h) Interval between parturitions (days):

Mean . . . . Range or SD . . . .

(i) Litter Size:

	Parity	Average	Range or SD
At birth	1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9		
	10		

	Parity	Average	Range or SD
At weaning	1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9		
	10		
(j) Percent females failing to produce a litter	1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9		
	10		

(k) Lethal genes: None known ☐ Some known ☐

Effect and percent affected . . . .

C. REACTION TO HEAT AND DIRECT SOLAR RADIATION

Panting ☐ Salivating ☐ Stops eating ☐ Coma ☐

Death ☐ Others (specify) ☐

. . . .

. . . .

State environmental conditions at time of observations:

Air temperature (°C) . . . .
Humidity . . . .
Wind velocity . . . .
Others . . . .

D. RESISTANCE TO PARASITES AND DISEASE

Give details of experimental work on resistance

. . . .
. . . .
. . . .

E. CONDITIONS UNDER WHICH DATA IN SCHEDULE II COLLECTED

1. Geographic region . . . .

2. Annual rainfall: Mean . . . . Range . . . .

3. Type of rainfall:

Seasonal ☐ Non-seasonal ☐ Other (specify) ☐

Season . . . .
Duration . . . .
. . . .
. . . .

4. Average maximum temperature (°C)

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

5. Average minimum temperature (°C)

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

6. Average maximum humidity

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

7. Average minimum humidity

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

8. Type of management

(a) Place where data collected

Government farm	Backyard farm (10% income from pigs)	Medium size farm (50% income from pigs)
☐	☐	☐

Large-size farm (90% income from pigs)	Village (mainly home consumption)	Others (specify)
☐	☐	☐
		....
		....

(b) Management system

Grazing	Grazing with supplement (specify)	Housed (specify housing and feed)	Other (specify)
☐	☐	☐	☐
	....	....	....
	....	....	....

F. REFERENCES

Please give details of any relevant documents (books, journal articles, conference proceedings, published or unpublished data)

....

....

....

....

....

S A B R A O

Documentation of livestock breeds

CHICKENS

Country . . . .

Species . . . .

Breed . . . .

Strain . . . .

Date form prepared . . . / . . . / . . . (Day / Month / Year)

By whom prepared

Name . . . .

Organization . . . .

SCHEDULE I - GENERAL DESCRIPTION

A. ORIGIN

Indigenous ☐ Exotic ☐

B. USE

Meat ☐ Eggs ☐ Dual purpose ☐

Other (specify -
fancy, fighting, medicine,
ornamental, etc.)

☐

. . . .

C. APPEARANCE

1. Colour

(a) Plumage (give genotype if known) . . . .

White ☐ Coloured (specify) ☐

(b) Skin

White ☐ Yellow ☐ Others (specify) ☐

. . . .

(c) Shank

	Present	Absent
Dermal melanin	☐	☐
Epidermal melanin	☐	☐
Id gene	☐	☐

2. Comb

Single	Rose	Pea	Others (specify)
☐	☐	☐	☐
			. . . .

3. Ear lobe

White	Red	Mixed
☐	☐	☐

4. Feathering

(a) Body

Complete	Incomplete	Naked
☐	☐	☐

(b) Shank feather

Present	Absent
☐	☐

5. Other characteristics

(a) Wattles

(i) Type

Double	Single
☐	☐

(ii) Colour

Red	Others (specify)
☐	☐
	. . . .

(b) Spur

	Absent	Single	Multiple
Male	☐	☐	☐
Female	☐	☐	☐

(c) Polydactylism

Absent	Present
☐	☐

D. HEAT TOLERANCE

Tolerant	Not tolerant
☐	☐

(General observations - details in Schedule II).

E. DISEASE RESISTANCE

Note tolerance, resistance or susceptibility to specific diseases, if any information is available
(General observations - details in Schedule II).

. . . .

. . . .

. . . .

. . . .

F. FLOCK SIZE

Number of birds in each:

Government farm — Commercial farm — Village

Individually owned

Mean . . . . Range . . . . Mean . . . . Range . . . . Mean . . . . Range . . . .

Communally owned

Mean . . . . Range . . . .

G. REFERENCES

Please give details of any relevant documents (books, journal articles, conference proceedings, published or unpublished reports).

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. . . .

. . . .

SCHEDULE II - PERFORMANCE

S A B R A O

Documentation of livestock breeds

CHICKENS

Country . . . .

Species . . . .

Breed . . . .

Strain . . . .

Date data collected (Day / Month / Year) . . . / . . . / . . .

By whom collected

Name . . . .

Organization . . . .

Date form prepared (Day / Month / Year) . . . / . . . / . . .

By whom . . . .

A. PRODUCTION DATA

1. Body weight

At	No. of birds		Age (weeks)				Body weight (kg)			
	M	F	Males		Females		Males		Females	
			Mean	Range or SD*	Mean	Range or SD	Mean	Range or SD	Mean	Range or SD
8 weeks (or specify)										
Sexual maturity										
Adult										
Marketing										

* S.D. - Standard deviation

2. Conformation

Good ☐ Medium ☐ Poor ☐

3. Egg production

   (a) Number of eggs per year

   Mean . . . . Range or S.D. . . . .

   (b) Average egg weight from 10-month old females

   Mean . . . . Range or S.D. . . . .

   (c) Number of months kept for egg production

   Mean . . . . Range or S.D. . . . .

   (d) Shell colour

   White ☐ Brown ☐ Others (specify) ☐

4. Fertility and Hatchability

   (a) Fertility %: Mean . . . . Range . . . .

   (b) Hatchability %: Mean . . . . Range . . . .
   (on fertile eggs)

   (c) Hatchability %: Mean . . . . Range . . . .
   (on total eggs set)

5. Viability percent

   (a) 0-6 months: Mean . . . . Range . . . .

   (b) After 6 months: Mean . . . . Range . . . .

6. Broodiness

   Broody ☐ Non-broody ☐

B. BREEDING

1. Type of mating

   Natural uncontrolled ☐ Natural controlled ☐ Artificial insemination ☐

2. Size of breeding flock

   Number of males . . . .

   Number of females . . . .

3. Ratio of males : females (for mating) . . . .

4. Incubation

Natural ☐ Artificial ☐

5. Breeding system

Random mating ☐ Inbreeding ☐ Cross-breeding (specify) ☐

. . . .

C. HEAT TOLERANCE

Give specific details of any observations on heat tolerance

. . . .

. . . .

. . . .

. . . .

D. DISEASE RESISTANCE

Give specific details of any observations on disease resistance

. . . .

. . . .

. . . .

. . . .

E. HOUSING AND MANAGEMENT

1. Type of housing

Range without shelter ☐ Range with shelter ☐ Confined ☐

Litter floor ☐

Slatted floor ☐

Litter-slatted ☐

Cages (including batteries) ☐

Others ☐

Specify . . . .

2. Artificial lighting

Absent ☐ Present (specify) ☐

. . . .

3. Feed

Commercial (specify) ☐ Self-prepared (specify) ☐ Domestic discard ☐

. . . .

Scavengers ☐

4. Feed supplements

Given (specify) ☐ Not given ☐

. . . .

F. CONDITIONS UNDER WHICH DATA IN SCHEDULE II COLLECTED

1. Geographic region . . . .

2. Annual rainfall (mm): Mean . . . . Range . . . .

3. Type of rainfall

Seasonal ☐ Non-seasonal ☐ Other (specify) ☐

Season . . . .

Duration (weeks) . . . .

4. Average maximum temperature (^{o}C)

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

5. Average minimum temperature (^{o}C)

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

6. Average maximum humidity

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

7. Average minimum humidity

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

8. Place where data obtained

Government station ☐ Commercial farm ☐ Village ☐

G. REFERENCES

Please give details of any relevant documents (books, journal articles, conference proceedings, published or unpublished reports)

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. . . .

. . . .

. . . .

S A B R A O

Documentation of livestock breeds

DUCKS

(including Muscovy and Geese)

Country . . . . Date form prepared . . . / . . . / . . . (Day / Month / Year)

Species . . . . By whom prepared

Breed . . . . Name . . . .

Strain . . . . Organization . . . .

SCHEDULE I - GENERAL DESCRIPTION

A. ORIGIN

Indigenous ☐ Exotic ☐

B. USE

Meat ☐ Eggs ☐ Dual purpose ☐ Other (specify - fancy, fighting, medicine, ornamental, etc.) ☐ . . . .

C. APPEARANCE

Colour

(a) Plumage

White ☐ Coloured (specify) ☐ . . . .

(b) Skin

White ☐ Yellow ☐ Other (specify) ☐ . . . .

(c) Shank

White ☐ Yellow ☐ Other (specify) ☐ . . . .

D. HEAT TOLERANCE

Tolerant ☐   Not tolerant ☐

(General observations - details in Schedule II)

E. DISEASE RESISTANCE

Note tolerance, resistance or susceptibility to specific diseases, if any information is available.
(General observations - details in Schedule II)

. . . .

. . . .

. . . .

F. FLOCK SIZE

Number of animals in each:

Government farm	Commercial farm	Village
		Individually owned
Mean ..... Range	Mean ..... Range	Mean ..... Range ....
		Communally owned
		Mean ..... Range ....

G. REFERENCES

Please give details of any relevant documents (books, journal articles, conference proceedings, published or unpublished reports).

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. . . .

SCHEDULE II - PERFORMANCE

S A B R A O

Documentation of livestock breeds

DUCKS

(including Muscovy and Geese)

			Day	Month	Year
Country	Date data collected		. . . /	. . . /	. . .
Species	By whom collected				
Breed		Name	. . . .		
Strain		Organization	. . . .		
			Day	Month	Year
	Date form prepared		. . . /	. . . /	. . .
		By whom	. . . .		

A. PRODUCTION DATA

1. Body weight

At	No. of birds		Age (weeks)				Body weight (kg)			
	M	F	Males		Females		Males		Females	
			Mean	Range or SD*	Mean	Range or SD	Mean	Range or SD	Mean	Range or SD
8 weeks (or specify)										
Sexual maturity										
Adult										
Marketing										

* S.D. - Standard deviation

2. Conformation

Good	Medium	Poor
☐	☐	☐

3. Egg Production

(a) Number of eggs per year

Mean . . . . Range or S.D. . . . .

(b) Average egg weight from 10-month old females

Mean . . . . Range or S.D. . . . .

(c) Number of months kept for egg production

Mean . . . . Range or S.D. . . . .

(d) Shell colour

White ☐ Brown ☐ Other (specify) ☐

. . . .

4. Fertility and Hatchability

(a) Fertility %: Mean . . . . Range . . . .

(b) Hatchability %: Mean . . . . Range . . . .
(on fertile eggs)

(c) Hatchability %: Mean . . . . Range . . . .
(on total eggs set)

5. Viability percent

(a) 0-6 months: Mean . . . . Range . . . .

(b) After 6 months: Mean . . . . Range . . . .

6. Broodiness

Broody ☐ Non-broody ☐

B. BREEDING

1. Type of mating

Natural uncontrolled ☐ Natural controlled ☐ Artificial insemination ☐

2. Size of Breeding Flock

Males . . . .

Females . . . .

3. Ratio males : females (for mating) . . . .

4. Incubation

Natural ☐ Artificial ☐

5. Breeding System

Random mating Inbreeding Cross-breeding (specify)

☐ ☐ ☐

C. HEAT TOLERANCE

Give specific details of any observations on heat tolerance

. . . .

. . . .

. . . .

D. DISEASE RESISTANCE

Give specific details on any observations on disease resistance

. . . .

. . . .

. . . .

E. HOUSING AND MANAGEMENT

1. Type of Housing

Range without pond Range with pond Confined (specify)

☐ ☐ ☐

. . . .

2. Feed

Commercial (specify) Self-prepared (specify) Domestic discard

☐ ☐ ☐

. . . .

Scavengers

☐

3. Feed supplements

Given (specify) Not given

☐ ☐

. . . .

F. CONDITIONS UNDER WHICH DATA IN SCHEDULE II COLLECTED

1. Geographic region . . . .

2. Annual rainfall (mm): Mean . . . . Range . . . .

3. Type of rainfall

	Seasonal	Non-seasonal	Other (specify)
	☐	☐	☐
Season			. . . .
Duration (weeks) . .			. . . .

4. Average maximum temperature (^{o}C)

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

5. Average minimum temperature (^{o}C)

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

6. Average maximum humidity

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

7. Average minimum humidity

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

8. Place where data obtained:

Government station	Commercial farm	Village
☐	☐	☐

G. REFERENCES

Please give details of any relevant documents (books, journal articles, conference proceedings, published or unpublished reports)

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. . . .

. . . .

. . . .

S A B R A O

Documentation of Livestock Breeds

TURKEYS

Country		Date form prepared	Day . . . / Month . . . / Year . . .
Species		By whom prepared	
Breed		Name	. . . .
Strain		Organization	. . . .

SCHEDULE I - GENERAL DESCRIPTION

A. ORIGIN

Indigenous ☐ Exotic ☐

B. USE

Meat type ☐ Others (specify) ☐

. . . .

C. APPEARANCE

1. Colour

(a) Plumage

White ☐ Bronze ☐ Other (specify) ☐

. . . .

(b) Skin

White ☐ Other (specify) ☐

. . . .

(c) Shank

White ☐ Black ☐ Other (specify) ☐

. . . .

2. Feathering

(a) Body

Complete	Incomplete	Naked
☐	☐	☐

(b) Shank feather

Present	Absent
☐	☐

3. Other characteristics

(a) Spur

	Absent	Single	Multiple
Male	☐	☐	☐
Female	☐	☐	☐

(b) Polydactylism

Absent	Present
☐	☐

D. HEAT TOLERANCE

Tolerant	Not tolerant
☐	☐

(General observations - details in Schedule II)

E. DISEASE RESISTANCE

Note tolerance, resistance or susceptibility to specific diseases, if any information is available.

(General observations - details in Schedule II)

. . . .

. . . .

. . . .

. . . .

F. FLOCK SIZE

Number of birds in each:

Government farm		Commercial farm		Village Individually owned	
Mean	Range	Mean	Range	Mean	Range . . . .
				Communally owned	
				Mean	Range . . . .

G. REFERENCES

Please give details of any relevant documents (books, journal articles, conference proceedings, published or unpublished reports).

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SCHEDULE II - PERFORMANCE

S A B R A O

Documentation of livestock breeds

TURKEYS

Country . . . .

Species . . . .

Breed . . . .

Strain . . . .

Date data collected (Day / Month / Year) . . . / . . . / . . .

By whom collected

Name . . . .

Organization . . . .

Date form prepared (Day / Month / Year) . . . / . . . / . . .

By whom . . . .

A. PRODUCTION DATA

1. Body weight

At	No. of birds		Age (weeks)				Body weight (kg)			
	M	F	Males		Females		Males		Females	
			Mean	Range or SD*	Mean	Range or SD	Mean	Range or SD	Mean	Range or SD
16 weeks (or specify)										
Sexual maturity										
Adult										
Marketing										

* S.D. - Standard deviation

2. Conformation

Good ☐ Medium ☐ Poor ☐

3. Egg production

(a) Number of eggs per year:

Mean . . . . Range or S.D. . . . .

(b) Average egg weight from 10-month old females:

Mean . . . . Range or S.D. . . . .

(c) Number of months kept for egg production:

Mean . . . . Range or S.D. . . . .

(d) Shell colour

Lightly tinted ☐ Heavily tinted ☐

4. Fertility and hatchability

(a) Fertility % : Mean . . . . Range . . . .

(b) Hatchability % : Mean . . . . Range . . . .
(on fertile eggs)

(c) Hatchability % : Mean . . . . Range . . . .
(on total eggs set)

5. Viability %

(a) 0-6 months : Mean . . . . Range . . . .

(b) After 6 months: Mean . . . . Range . . . .

6. Broodiness

Broody ☐ Non-broody ☐

B. BREEDING

1. Type of mating

Natural uncontrolled ☐ Natural controlled ☐ Artificial insemination ☐

2. Size of breeding flock

Number of males . . . .

Number of females . . . .

3. Ratio Males : Females (for mating) . . . .

4. Incubation

Natural ☐ Artificial ☐

5. Breeding system

Random mating ☐ Inbreeding ☐ Cross-breeding (specify) ☐

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C. HEAT TOLERANCE

Give specific details of any observations on heat tolerance

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D. DISEASE RESISTANCE

Give specific details of any observations on disease resistance

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E. HOUSING AND MANAGEMENT

1. Type of housing

Range without shelter ☐ Range with shelter ☐ Confined (specify) ☐

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2. Artificial lighting

Absent ☐ Present ☐

3. Feed

Commercial (specify) | Self-prepared (specify) | Domestic-discard

☐ ☐ ☐

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Scavengers

☐

4. Feed supplements

Given (specify) | Not given

☐ ☐

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F. CONDITIONS UNDER WHICH DATA IN SCHEDULE II COLLECTED

1. Geographic region . . . .

2. Annual rainfall (mm) Mean . . . . Range . . . .

3. Type of rainfall:

Seasonal | Non-seasonal | Other (specify)

☐ ☐ ☐

Season . . . .

Duration (weeks) . . . .

4. Average maximum temperature (^{o}C)

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

5. Average minimum temperature (^{o}C)

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

6. Average maximum humidity

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

7. Average minimum humidity

Summer . . . . Winter . . . . Annual . . . .
(where no seasons exist)

8. Place where data obtained

Government station	Commercial farm	Village
☐	☐	☐

G. REFERENCES

Please give details of any relevant documents (books, journal articles, conference proceedings, published or unpublished reports)

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熱 研 資 料

No. 1．タイ国の米穀経済

2．インドにおける農業関係試験研究事情調査報告書

3．フィリピン，インドネシアにおける農業関係試験研究事情調査報告書

4．東南アジアにおける農業関係試験研究事情調査報告書

5．ヨーロッパ，アフリカにおける農業関係試験研究事情調査報告書

6．沖縄における農業関係試験研究事情調査報告書

7．東南アジア等における森林資源およびその開発と利用

8．マレイシア，サバ州における農業関係試験研究事情調査報告書

9．戦前戦時における台湾農業技術の発達

10．西アフリカ熱帯造林技術の発達

11．北，中南米における農業関係試験研究事情調査報告書

12．インドネシア，フィリピンおよび台湾における畑作病害

13．パキスタンにおける農業および試験研究事情調査報告書

14．中華民国（台湾）における農業関係試験研究事情調査報告書

15．タイおよびフィリピンにおける農業機械の利用研究事情調査報告書

16．熱帯農産物の利用加工に関する研究事情調査

17．マレイシアにおける農業研究推進のための調査報告書

18．東南アジアの畜産に関する調査報告書

19．フィリピン，インドネシアにおける畑作関係試験研究事情調査報告書

20．インドとの農業技術研究協力に関する予備調査報告書

21．フィリピンに発生しているココヤシのカダンカダン病に関する調査報告

22．西部ジャワ水田地帯の農業経営実態調査報告

23．水稲高収量品種の導入と農業経営

24．沖縄の桑に関する調査報告書

25．インドネシアの豆類に関する生産および研究事情調査報告書

26．タイおよびインドネシアのトウモロコシべと病に関する調査報告書

27．東南アジアにおけるイネノシントメタマバエの研究協力設立に関する調査報告書

28．フィリピンのマンゴー栽培地におけるミバエ類調査報告書

29．沖縄におけるさとうきびを中心とする作付方式に関する研究

30．東南アジアにおける香辛料の栽培加工に関する調査報告書

31．熱帯畑作の開発に関する調査報告書（ブラジル）

32．〃（インドネシア）

33．Rice plant-and leafhopper incidence in Malaysia and Indonesia

34．東南アジアの畜産

35．インド・スリランカ・タイにおける水稲害虫研究の現状

36．ブラジルの稲作

37．熱帯畑作の開発に関する調査報告書ーフィリピンー

38．セラードに関するシンポジウムⅢ抄訳

39．オーストラリアにおける牧草導入事情調査報告書

40．スリランカにおける水稲栽培の農業気象的研究

41．東南アジアにおける雑草問題の現状と今後

42．ばれいしょ遺伝資源の探索，導入，保存と育種利用に関する調査報告書

43．The Brown Planthopper in India and Sri Lanka

44．ブラジルにおける大豆栽培の調査研究報告書

45．Field Observations and Laboratory Analyses of Paddy Soils in Thailand

46．フィリピンのマメ類，とくにMungbeanの生産・研究事情調査報告書