

Strategic Approach of TARC to Animal Production Research in the Tropics

— Research Collaboration in the Past and toward the Future—

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Abstract

The Tropical Agriculture Research Center (TARC) has contributed to the solution of some of the technical difficulties, which tropical countries are facing in their effort to enhance agricultural production, through collaborative research carried out with institutes of a particular country or with international institutes for wider regional problems. The research on animal production has been intensified along with the accumulation of experience and technology adapted to the tropical conditions, for the last two decades since TARC's establishment in 1970. TARC, in cooperation with three related national institutes in Japan, places emphasis on the following aspects : (1) Prevention of diseases prevalent in the tropics, (2) Evaluation of tropical pastures and improvement of natural grasslands, (3) Evaluation of animal performance and improvement of genetic potential of local breeds, and (4) Improvement of animal nutrition and development of feed resources. This paper reviews the studies already carried out, and indicates the strategy of TARC, with special reference to the fields of animal nutrition and feed resources. In the tropics, the low productivity of ruminants is closely related to the low nutrient status of the animals associated with the limited availability of feed of low quality. Therefore, in future, research on animal nutrition should place emphasis on the following objectives : (1) Development of non-conventional feed resources such as crop residues and by-products, (2) Development of methods of storage of roughages to be used in the season when there is a shortage of feed, and (3) Enhancement of nutrient utilization of feed for the production of meat and milk.

General outline of TARC's research activities

The Tropical Agriculture Research Center (TARC) is one of the research institutes affiliated with the MAFF of Japan. Unlike the other institutes which carry out research primarily related to domestic agriculture, the Center is involved in agricultural research overseas, in particular, in the countries located in the tropical region.

In 1970 after a preparatory period of 5 years, the Center was established with the objective of promoting research collaboration with foreign institutes to enhance and strengthen the development of agricultural technology in the tropical countries as well as to gain and accumulate experience and knowledge relating to agriculture under tropical conditions.

During the last two decades, the organization and research activities of the Center have gradually expanded along with the expansion of the economy of Japan and growing interdependence among the nations worldwide. The Center which initially consisted of 53 staff members (43 researchers) presently numbers 141 staff members (102 researchers) (1991). The total budget, including personnel expenses, this year will slightly exceed ¥ 2 billion (US\$ 14.

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8 million).

The Center dispatches the researchers, after reaching a mutual understanding for the collaboration in the research subjects, to research institutes in a given tropical country or to international research organizations for addressing wider regional problems. So far, the research collaboration efforts have tended to be concentrated in the countries of Southeast Asia. At the same time, the activities have gradually involved countries in the other continents and the international agricultural research organizations under the CGIAR.

The Center covers all aspects of agriculture, including animal husbandry and forestry, except for fisheries. A close relationship with the other agricultural research institutes in Japan is maintained in order to dispatch suitable researchers for promoting collaborative research overseas in various fields of agriculture.

Lately, the Center has sent more than 100 researchers overseas annually (1985-1989), among which 41 researchers were dispatched on long-term assignments and 45 researchers on short-term assignments mostly to assist the researchers staying overseas. The researchers dealing with animal science and technology who were dispatched accounted for more than 10 % percent for both assignments.

The Center in Tsukuba, Ibaraki (109 members), consists of a Planning and Coordination Division, a Research Information Division and four Research Divisions. The main activity of the Research Information Division is to systematically collect, analyse and evaluate the information on agriculture in the tropics and national and international research organizations for constructing the data base pertaining to tropical agriculture and contributing to the formulation of research projects and the policy-making of the Center. Of the four Research Divisions, two Divisions carry out research programs mostly overseas in various fields of agriculture and the other two are Eco-Physiology Research Division and Marginal Land Research Division which conduct basic research in Tsukuba and overseas.

The center also has a branch on Ishigaki island, Okinawa (32 members), in which there are six laboratories and research mainly involves crop production under sub-tropical conditions.

Historical review of research collaboration in the field of animal production

Introduction

In many regions or countries in the tropics, as a result of population growth, the situation of the food balance, production and consumption, has deteriorated. According to FAO statistics, the developing countries had to support 48% more people on the same land area in 1988 compared with 1970. As the population is expected to increase most dramatically in the years ahead, such areas will have to support many more people in the near future. Due to the very limited area of undeveloped land that could become cultivated, intensification of food production will be a prerequisite to meet the food demand arising from population growth.

In the tropical region, animals, especially ruminant animals, have originally played an important role in diversified farming systems of rural agriculture. In integrated farming systems combining crop production with animals, large ruminants provide draught power for land cultivation and supply products such as milk and meat for self-consumption and as a source of income. In the highly arid areas, ruminant production is the most important way to utilize lands unsuited to crop production. However, the productivity of ruminant animals is very low, as shown in Table 1, although substantial progress has been made in animal science and technology worldwide.

Table 1 Land use and ruminant productivity in developed and developing countries

	World	Developed		Developing			
		N. America	W. Europe	Africa	Lat. Amer.	West Asia	East Asia
Land use, %							
Arable land and land under permanent crops	11	13	25	7	9	7	32
Permanent pasture	25	15	18	27	28	22	4
Forest and woodland	31	34	34	27	48	8	38
Other land	33	38	23	39	15	63	26
Ruminant production							
Ruminant population, 10 ⁶ LU	1,570	112	104	174	326	77	441
Permanent pasture/LU, ha	2.1	2.4	0.7	3.7	1.7	3.5	0.1
Meat production, 10 ⁶ mt	59.2	12.0	9.9	3.2	9.2	2.7	3.9
Per ruminant LU, kg	38	107	95	18	28	35	9
Milk production, 10 ⁶ mt	523.9	74.2	135.7	9.4	40.7	16.8	66.4
Per ruminant LU, kg	334	660	1,305	54	125	217	161

Source : FAO, 1989.

Note : LU ; Unit of large ruminant. East Asia ; except China and Mongolia.

TARC's strategy

To promote animal production in the tropical region through research collaboration, the Center places emphasis on four themes in three fields of animal husbandry :

- 1 Prevention of animal diseases prevalent in the tropical region (Animal Health).
- 2 Evaluation of grasses adaptable to tropical conditions and improvement of natural grasslands (Grasslands).
- 3 Evaluation of animal performance and improvement of genetic potential of local breeds (Animal Production).
- 4 Utilization of local feed resources and improvement of animal nutrition (Animal Production).

The Center promotes research collaboration overseas in keeping a close contact with the National Institute of Animal Health (NIAH), National Grassland Research Institute (NGRI) and National Institute of Animal Industry (NIAI) in Japan.

The collaborative activities initiated in 1967 dealt first with Animal Health, followed by Grasslands and Animal Production in 1972. The approach to research on animal husbandry in the tropics was a difficult problem to solve at the early stage of collaboration chiefly due to the very site-specific conditions of animal raising and the lack of experience of Japanese researchers. Through the collaborative activities pursued for about 20 years, the Center is now fully qualified for promoting international collaborative research in these fields of animal husbandry.

The research subjects carried out since then and currently undertaken are listed in Tables 2, 3 and 4 for the fields pertaining to Animal Health, Grasslands and Animal Production, respectively. Research highlights and research priorities in the future are outlined below according to the themes mentioned above.

1 Prevention of animal diseases prevalent in the tropical region

Highlights

Research on Foot-and-Mouth disease : This disease which is distributed worldwide causes considerable damage to ruminant production, although no outbreaks have been recorded in Japan. The collaborative activities (1967-1977) enabled to improve the diagnosis

Table 2 Research subjects already completed and currently undertaken in the field of Animal Health

Subject	Year	Country
The diseases studied are as follows:		
(a) Foot-and-Mouth disease	1967-1977	Thailand
(b) Hog cholera	1972	Malaysia
(c) Bovine mastitis	1976-1979	Sri Lanka
(d) Tropical diseases of bovidae	1977-1982	Malaysia
(e) Leucocytozoonosis of chickens	1977-1980	Malaysia
(f) Hemorrhagic septicemia	1978-1979	Sri Lanka
(g) Endoparasitic diseases	1982-1983	Sri Lanka
(h) Theileriosis	1980-	ILRAD (Kenya) and Malaysia

Table 3 Research subjects already completed and currently undertaken in the field of Grasslands

Subject	Year	Country
(a) Evaluation of grasses and legumes adaptable to tropical conditions	1972-1977	Thailand
(b) Management of natural grasslands	1977-1984	CIAT (Colombia)
(c) Production and utilization of forage crops for intensive feeding of beef cattle	1979-1985	Paraguay and Brazil
(d) Improvement of natural grasslands by introduction of legumes with seed-coated fertilizer pellets	1984-1991	CIAT (Colombia)
(e) Development of tropical pastures in sandy soils	1987-	Thailand
(f) Evaluation and conservation of natural resources of grasslands in the arid zone	1989-	ICARDA (Syria)

Table 4 Research subjects already completed and currently undertaken in the field of Animal Production

Subject	Year	Country
(a) Performance of local cattle breeds and survey of feeding practices	1972-1977	Sri Lanka
(b) Nutritive value of agricultural by-products	1978-1981	Malaysia
(c) Utilization of local agricultural products and by-products for development of calf starter ration	1981-1983	Malaysia
(d) Digestion characteristics and physiological responses of cattle fed with oil palm by-products	1983-1985	Malaysia
(e) Processing and utilization of oil palm by-products for ruminants	1985-	Malaysia
(f) Digestive function of ruminants in the tropics	1989-	Malaysia
(g) Mineral nutrition of beef cattle raised on tropical pastures with sandy soils	1990-	Thailand
(h) Genetic and physiological characteristics of trypanotolerant cattle in Africa	1991-	

of the disease and led to the development of assays for a vaccine in Thailand. As a result of TARC's contribution to basic research on the disease in Thailand, a center for the manufacture of Foot-and-Mouth disease vaccine operated by JICA, Japan International Cooperation Agency, was established in Bangkok.

Challenges

Research on Theileriosis : During the last decade, the Center has concentrated its research activities on the disease of cattle which causes significant damage in Africa and is observed widely in Southeast Asia. Further basic research will be required for characterizing this tick-borne disease distributed in these areas and for developing a vaccine.

Research on tsetse-borne disease, Trypanosomiasis, arbovirus infections and endoparasitic diseases will also be essential.

2 Evaluation of grasses adaptable to tropical conditions and improvement of natural grasslands

Highlights

Improvement of natural grasslands : In South America, most of the beef cattle are raised in the tropical region, in particular, in vast savanna areas with acid infertile soil and scarce forage. The collaborative activities at CIAT, Colombia, clarified the effect of grazing and burning on vegetation changes for the incorporation of legumes to mixed pastures (1977-1984) and seed-coated fertilizer pellets were developed for improving the grasslands (1984-1991).

Challenges

Improvement of pastures and natural grasslands : The factors which limit the productivity of pastures and grasslands show a site-specific character including changes in the climate, vegetation and soil conditions. Therefore, it is essential to overcome the specified constraints in the land by the improvement of the management of the soil-grass-animal complex and by the introduction of better adapted species of grasses and legumes. As an approach to this research, studies on modeling of nutrient cycles in pastures will be important.

Evaluation and conservation of natural resources : There are many marginal lands, in particular, in West Asia and Africa, where nomadism and pastoralism are the most important land uses. The Center initiated research on the evaluation of natural resources of grasslands in arid areas by applying remote sensing techniques. To conserve natural resources and enhance land productivity, further research will be required for identifying means of improvement and for establishing suitable grazing systems.

3 Evaluation of animal performance and improvement of genetic potential of local breeds

Highlights

Evaluation of performance of local cattle breeds : To increase meat production in Sri Lanka, the collaborative activities (1972-1977) involved the analysis of the liveweight gains and characteristics of the carcasses of various breeds of cattle in comparative studies under various rearing conditions. The survey conducted in the dry zone enabled to clarify technical problems and analyse socio-economical conditions of cattle raising farmers.

Challenges

Improvement of genetic potential of local breeds : Many attempts to introduce exotic breeds with a high potential have been made for improving the potential of local breeds but the outcome has not always been successful due to the limiting conditions prevailing in the tropics. Since in the tropical region, local breeds are generally well-adapted to the local conditions and are disease-resistant, it is important to improve the potential of local breeds by the evaluation of genetic characteristics and the development of crossbreeding systems.

The Center will initiate this year research on the genetic and physiological characteristics of trypanotolerant cattle to enhance ruminant production in tsetse-infected areas of Africa.

Improvement of reproduction rate : It is well recognized that research should be carried out to increase the reproduction rate of cows which is very low in the tropical region due to a wide range of factors such as diseases, low nutrition levels, poor management, etc. Therefore, it is important to identify the constraints in reproduction under tropical conditions. Research will involve the analysis of post-partum changes of reproductive activities and related hormonal levels in order to shorten the number of days to conception.

4 Utilization of local feed resources and improvement of animal nutrition

Highlights

Processing and utilization of oil palm by-products : In Malaysia, the amount of oil palm by-products markedly increased along with the expansion of areas under oil palm during the last few decades. Collaborative studies (1985-1990) have been carried out to develop the by-products of oil palm, i.e. palm press fiber (PPF) and oil palm trunk (OPT), as feeds for ruminants and it was observed that OPT is a promising feed resource. On the other hand, the use of PPF is limited due to its very low digestibility.

Challenges

Development of local feed resources : In tropical regions, the low productivity of ruminants is closely related to the low nutrient status of the animals, which largely depends on the shortage of feeds throughout the year or seasonally. Therefore, it is necessary to develop feed resources as well as to improve grasslands. As shown in Table 1, the area of grassland per unit of large ruminant differs from one region to another. In Africa and West Asia, the area is very large. On the other hand, in East Asia, the area is very small, indicating that the development and utilization of non-conventional feed resources such as crop residues and other agricultural by-products is essential. The research needs are site-specific and it is therefore important to develop a method of feeding best suited to each area or locality by promoting the efficient use of various locally available feed resources. Research on treatment is also required for improving the digestibility of low quality resources.

Due to the seasonal variation in grass production, it is also important to develop methods of storage of grass and fibrous feeds for use in the season when there is a shortage of feeds.

Utilization of feeds for production of milk and meat : Research on the mineral nutrition of beef cattle was initiated in grazing areas characterized by mineral deficiency to identify the deficiencies and develop effective methods of supplementation. Research on digestion physiology and metabolism and manipulation of the rumen ecosystem under critical conditions in the tropical region should be promoted to enhance the nutrient utilization from feeds for efficient production of milk and meat. Recent development of biotechnology has attracted the attention of a large number of organizations in developing countries. It is envisioned that the genetic manipulation of rumen microbial population and/or forage crop components through biotechnical procedures may enhance feed resource utilization in ruminants.

In recent years, issues of sustainability of agricultural production have become increasingly important worldwide. Comprehensive studies will be required for developing sustainable production systems for smallholders in placing emphasis on the preservation of natural resources and the environment.

References

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Discussion

Haryanto, B. (Indonesia) : I do hope that in future research collaboration between TARC and Indonesian organizations will be implemented.

Answer : We do hope to establish closer contacts with your organizations in future.