PRESENT SITUATION AND FUTURE PROSPECTS FOR GRASSLAND FARMING IN JAPAN

Sukeo Kawanabe*

ABSTRACT

Although research into and practice of grassland farming in Japan have a comparatively short history of only 30 years, the results obtained have been significant and the establishment of pastures in mountainous regions and cultivation of forage crops in arable land have been implemented actively in these years. The increase in the area devoted to pastures and to the cultivation of forage crops was associated with the increase in the number of dairy cattle, the decrease of the area of natural pastures and the number of horses. Research results which contributed to pasture development include the no-tillage method of establishment of pastures, the extension of the grazing period, etc. The present level of pasture productivity is still low and improvement of daily gain through the promotion of intensive production and efficient utilization of herbage is being considered. Cropping systems adopted by progressive farmers changed from an extensive, complicated laborious system to an intensive, simple, labor-saving system, and feeding practice shifted from soiling to year-round silage feeding. The increase of productivity obtained through these changes was remarkable. For future development the need for designing effective farming systems is emphasized and a new strategy of research is presented.

Introduction

This is a brief report on Japanese grassland farming research and practices in the past, present and future, with emphasis placed on practical aspects. Before the 1940s, horses and cattle primarily for draft purposes used to graze on natural and forest pastures, and hay was made for winter feed.

After World War II (1945), the number of dairy cattle increased with the corresponding increment in milk and meat consumption. This resulted in a considerable increase of feed concentrate importation. With a view to producing as much domestic feed as possible in using Japan's land resources the necessity of promoting farming was recognized. In 1962, the land area for agricultural use accounted for 16% of the total land area with 64% being covered with forests. There was thus a great potential for development of grassland farming (Science and Technology Bureau, 1962).

For this reason grassland research was started and grassland development has been implemented. Although the history of grassland farming involves only 30 years and it can hardly be said that the technology and management developed are adequate, great efforts have been made to further improve these aspects over these years and a number of significant results have been achieved (Anonymous, 1983). The situation is almost the same as that in Korea (Kee Jong Lee, 1983).

Land area devoted to pasture and forage crops

Before the 1950s, the area of pasture and forage crops was limited to about 100,000 hectares, and native plants growing along paddy fields and farm by-products were used as feed. In the 1950s the cultivation of forage crops including corn, Italian ryegrass, and grass-

* Director for Research, Division of Pasture Crops, National Grassland Research Institute, Nishinasuno, Nasu, Tochigi, 329-27 Japan.

legume mixtures, was promoted on arable land. Furthermore pastures were established by improving the existing natural pastures, and by clearing forests in mountainous and hilly areas (Anonymous, 1976). The area developed in this way reached 1,040,000 hectares in 1982 (Fig. 1) with half of it covering arable land and replacing upland crops, such as green manure crops, and rice in paddy fields, while newly developed artificial pastures accounted for the other half. In addition, 123,000 hectares of natural pastures, and 132,000 hectares of forest land are presently used for grazing. In this connection, natural pastures and grazing forests amounted to 1,658,000 hectares in the 1930s, more than 6 times the present area.

The trend of such land use parallels a corresponding increase in the number of beef and dairy cattle (Fig. 2). There were 2,380,000 beef and 2,100,000 dairy cattle in 1982.

In spite of the increase in the total land area the number of animals also increased so that

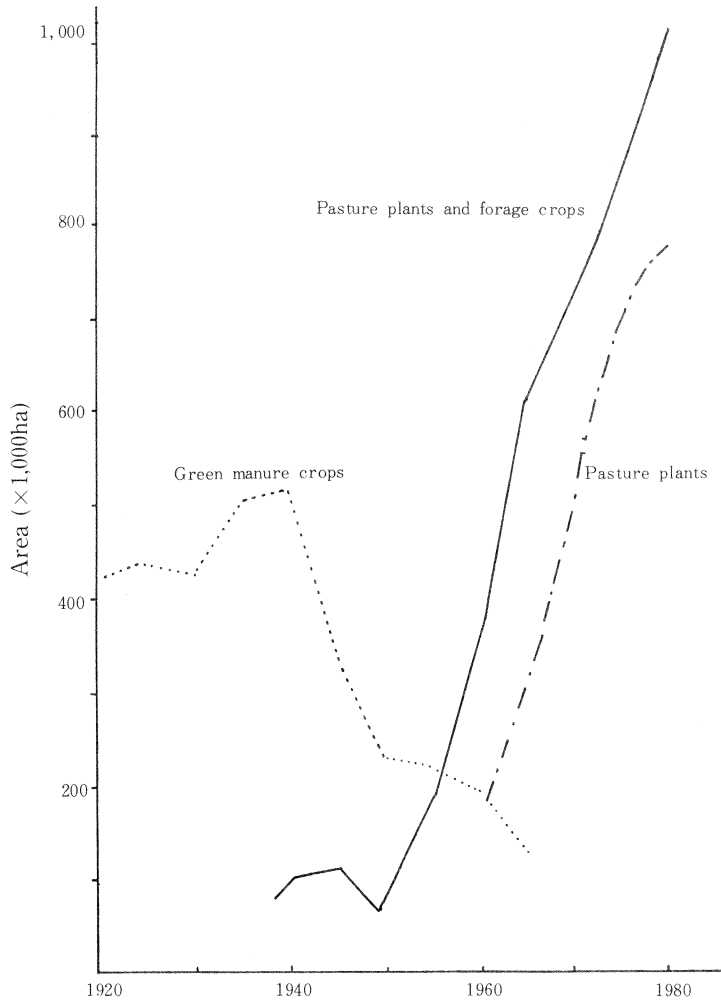

Fig. 1 Acreage of plants, pasture plants and forage crops (total) and green manure crops.

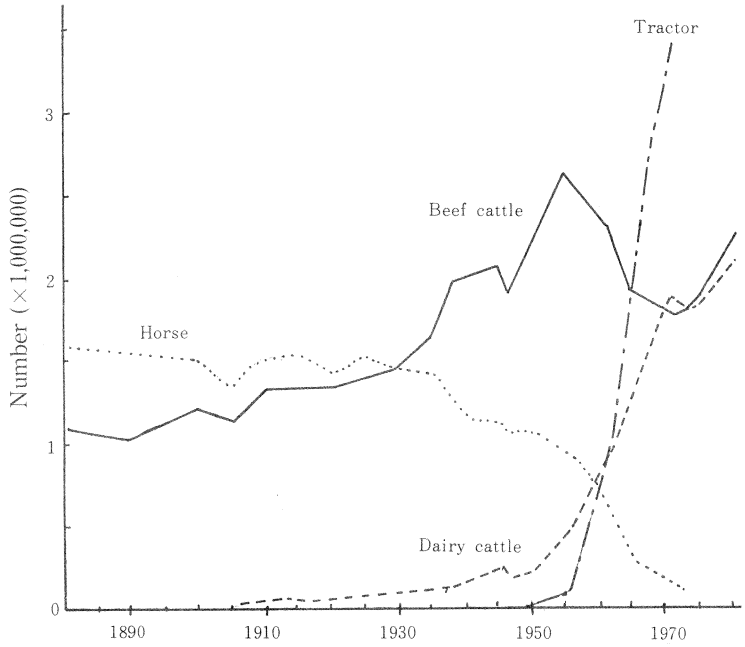

Fig. 2 Number of horses, beef and dairy cattle, and tractors.

the area of pasture and forage crops per head is low, namely, 43 are and 6 are for beef cattle and only 57 are and 10 are for dairy cattle in Hokkaido and other prefectures, respectively. Consequently the rate of self-sufficiency of total digestible nutrients in dairy farming is still very low i. e. 49%, and animal rations depend on large amounts of concentrates.

Organization of research and education

To promote research work, laboratories were established at National Institutes or Experiment Stations after 1947. The capacity of these organizations was gradually filled and the present organization was established in 1970 with the central Institute being the National Grassland Research Institute and local research being carried out in 7 regional stations. Emphasis is placed on the establishment of regional experiment stations located in Hokkaido, Tohoku, and Kyushu where grassland farming is especially important. A number of grassland and forage crop chairs were created in 17 universities and colleges during the 1953-1973 period.

With a view to encouraging research and education, the Japanese Society of Grassland Sciences was established in 1953. Its activities have grown substantially and it will host the XV International Grassland Congress in 1985 in Japan.

Six grassland experts, such as R. O. Whyte, formerly with the FAO and P. D. Sears, formerly Director of Grassland Division, DSIR, New Zealand, visited Japan from 1955 to 1963 under a program of technical assistance sponsored by FAO.

They provided valuable advice (Whyte, 1964) for the establishment of these organizations, research activities and government undertakings in grassland development.

Research and development of pastures

1 Natural pastures

Studies on natural pastures have been carried out since Oseko (1937) initiated such research and a great deal of information (MAFF, 1971; National Grassland Research Institute, 1982) on pasture type, ecology, productivity and utilization has been accumulated in many fields. The main types of vegetation consist of *Zoysia, Miscanthus, Sasa* and *Pleioblastus* of which the major species and distribution are shown in Fig. 3 and Table 1.

The seasonal growth pattern of *Zoysia* grass is shown in Fig. 4. The *Zoysia* type, one of the most important pasture types in Japan's grazing land, produces much herbage in summer and is suited to combinations with improved temperate grasses and legumes. It has been said that native species are not suitable for dairy cattle and that they should be plowed up and replaced with improved pasture species. However it is now being recognized that native

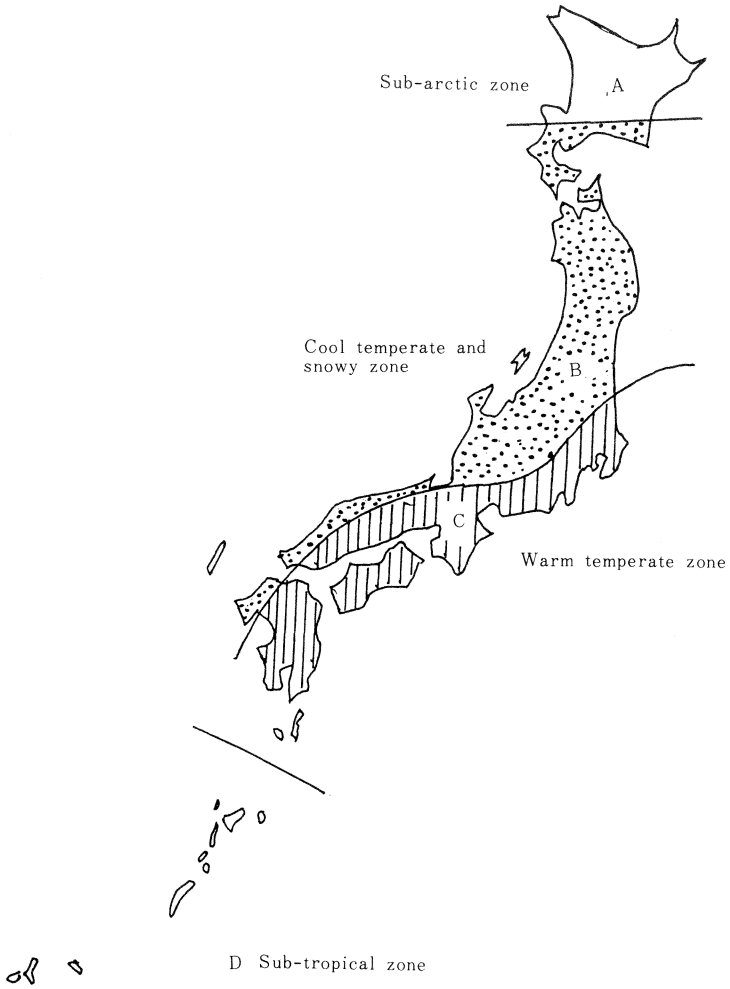

Fig. 3 Climatic zones in relation to vegetation observed in natural pastures in Japan.

Table 1 Major vegetation types observed in natural pastures

	A zone	B zone	C zone	D zone
Meadow	*Sasa* type	*Miscanthus type*	*Miscanthus* type *Miscanthus* type *Miscanthus-Pleioblastus* type *Miscanthus-Arundinaria* type	*Miscanthus* type
Pasture	*Poa* type	*Zoysia Japonica* type	*Zoysia* type *Pleioblastus* type *Zoysia-P.* type *Cynodon* type	*Zoysia tenuifolia* type

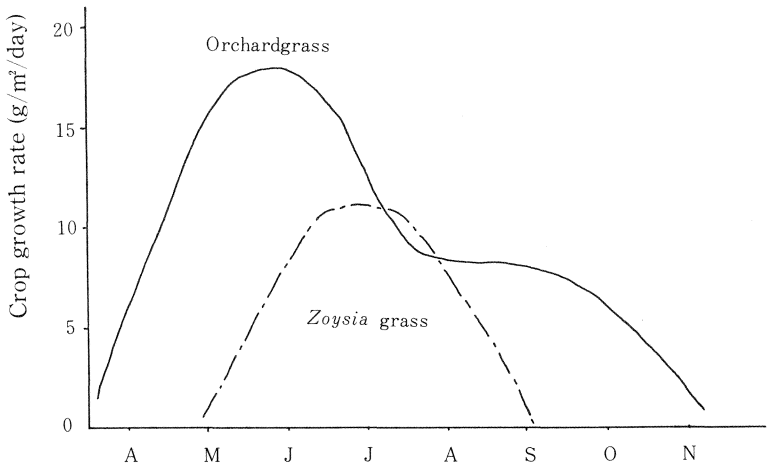

Fig. 4 Comparison of seasonal production of orchardgrass and *Zoysia* grass.

species grow even on poor soil without fertilizer and are sources of valuable low cost herbage when used in combination with improved pasture species (MAFF, 1979).

The productivity of natural pastures varies with the environment so that a productivity of 4 to 11 ton of DM per hectare has been reported for the *Miscanthus* type and 1 to 3 ton DM for the *Zoysia* type. The carrying capacity of the *Zoysia* type pasture may be about 25-100 cow days.

2 Artificial pastures

Pasture plants are new crops introduced to Japan first in Hokkaido, in the 1890s and later in the 1950s in the other prefectures. Government grassland development schemes which were initiated in 1953 on a "trial and error" basis became eventually successful after 1962 and were further promoted. However the area developed decreased after 1974.

It was reported that there are 1,413,000 hectares of potential grassland (Science and Technology Bureau, 1962). However most of these areas are located far from the villages on

steep slopes.

The cost of establishment of livestock farms in the mountainous areas (Ogura, 1983) is high as it involves the establishment of pastures as well as the construction of the infrastructure including roads, electricity and water facilities as well as conservation projects. For instance, the establishment of one livestock farm costs ¥17,000,000 per hectare of pasture. Indeed such a high cost is one of the serious constraints in grassland development and low cost development methods must be considered. Reclamation of mountainous areas near villages, even though the pasture lot may be small, may be one of the solutions.

The key pasture species are timothy and orchardgrass in the subarctic zone, orchardgrass in the cool temperature zone, orchardgrass, tall fescue, Dallis grass and Bahiagrass in the warm temperature zone, and Rhodesgrass and Napier grass in the subtropical zone. Most Japanese pastures are located in the subarctic and cool temperature zones but a few are found in warmer regions. In such warmer regions temperate species suffer serious summer depression and the level of production in summer and autumn is low. Tropical grasses such as greenpanic and Rhodesgrass, are cultivated as summer annuals (Ibaraki, 1979) over small areas.

Dry matter yield of grass and legume mixtures is 5 to 6 ton per hectare in an average farm. However more than twice this yield can be obtained in experimental plots and in yield contests (MAFF, 1972; Simamura *et al.*, 1981). This fact indicates that only half of the potential productivity is achieved in most pastures, because a small amount of fertilizer is applied and most pastures are old.

Research was concentrated on pasture plants after the 1950s, and especially up to 1965 such a large number of studies on pasture plants was carried out (Anonymous, 1976) that criticism arose about the neglect of fodder crops. Although these studies undoubtedly contributed to the increase of the cultivated area and yields of pasture plants, the interest was shifted to fodder crops after 1970.

Because pasture plants were introduced as new crops to the warm regions of Japan, their climatic adaptation to the Japanese environment including phenological types (Niki, 1954) and temperature response (Kawanabe, 1974), was studied in the early stage. A great deal of research was devoted to the technologies to achieve high yields, including yield surveys, combination of species, cutting, regrowth, fertilization, feed quality, growth analysis, conservation, and system analysis, etc.

A great contribution to grassland development was made by a study on the methods of establishment (MAFF, 1972), particularly the no-tillage method (MAFF, 1974) extensively practiced by the farmers. Similarly studies on the management and utilization of grasslands (MAFF, 1971) which enabled the development of technologies aimed at uniform seasonal production, extension of the grazing period (MAFF, 1979), etc. were also important. These achievements stemmed from research projects implemented by MAFF from 1966 to 1971. Presently research areas of great importance involve the renovation of aged pastures (Anonymous, 1983), combined use of natural and artificial pastures, and short grass pastures, etc.

Productivity of public pastures, which number 1,200, is as follows: carrying capacity 2.1 head/ha, grazing period 152 to 200 days, liveweight gain 0.59 kg/day, or 209 kg/ha, and N-fertilizer application 75 kg/ha. While these figures are higher than for pastures in general, they are still lower than the figures obtained experimentally. Although the productivity of most pastures is about 300 cow days, it has been shown that the adoption of improved grazing techniques may enable to double the capacity (Ando, 1980; Ando *et al.*, 1981).

Forage production on arable land

1 Development of cropping systems

In the early stage of forage crop production, before 1955, most forage crops were inter-cropped with cereals or mulberry trees. In the paddy fields they were grown during the winter fallow period. In the second stage, many forage crops including corn, grasses and legumes, Italian ryegrass and sorghum were cultivated within complicated cropping systems. The increase in the area cultivated with Italian ryegrass has been outstanding (Fig. 5).

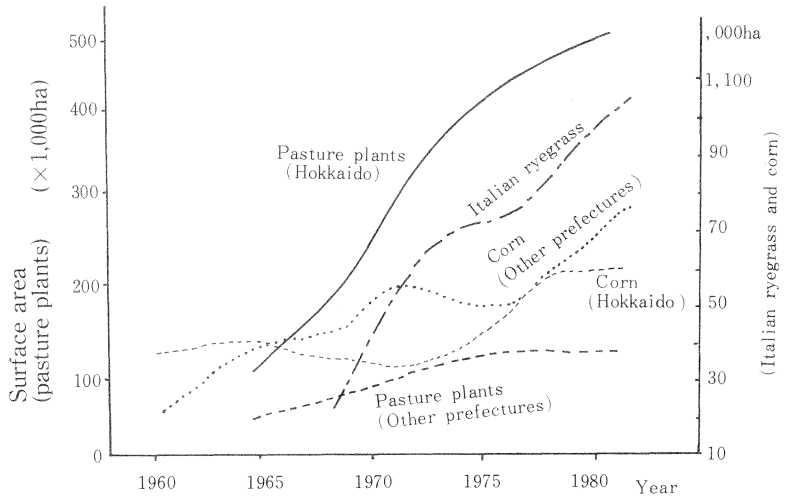

Fig. 5 Acreage of pasture plants and corn in Hokkaido and other prefectures and of Italian ryegrass.

After 1975, F1 corn varieties were introduced and they began to replace pasture plants and other forage crops. Since F1 corn varieties are very productive, resistant to lodging, and since high quality silage (whole crop silage) can be made readily, their cultivation spread rapidly. The adoption of corn for whole crop silage was a breakthrough in the history of cropping systems. Although trials were performed on many species over 30 years, species which were productive in terms of land and labor and of good quality were eventually selected. Many species of tropical grasses have been tested (Ibaraki, 1979) but their status remains only marginal.

Trends in the cropping systems in the dairy farms of the northern part of the Kanto district are significant examples (Anonymous, 1981; National Grassland Research Institute, 1981) (Fig. 6). Corn-turnip type (A) system was predominant before 1971. In accordance with the increase in the number of dairy cattle, it (A) replaced grass and legume mixtures and Italian ryegrass (B). Cropping system B decreased after 1975 and changed gradually to a corn-Italian ryegrass double cropping system.

During the A system period, soiling practice was adopted, using small tractors or tillers. During the B and C cropping system periods, year-round silage feeding was practiced using large tractors, in the cooperatives formed by farmers groups. With the C cropping system more efficient machinery was introduced, and the F1 corn variety was cultivated. With the substitution of the cropping system A for B labor productivity increased, but the land productivity remained unchanged. Substitution of B for C, raised the productivity

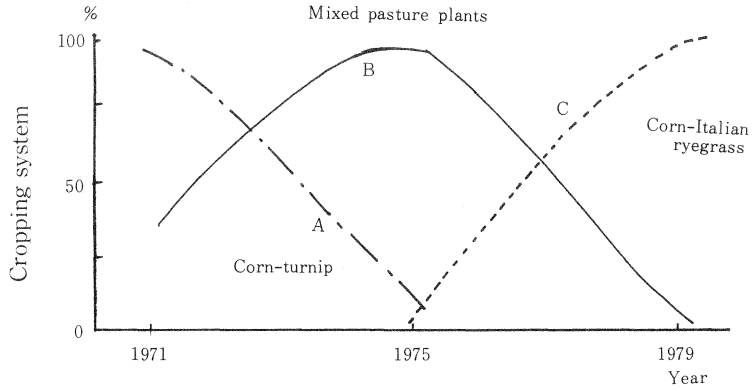

Fig. 6 Development of cropping systems in 33 dairy farms in the North-Kanto district. Iida, 1981.

considerably, i. e. 10 times for labor, and 2 times for land.

Double or triple cropping systems involving the whole crop together with year round silage feeding are now spreading to all the regions of Japan and are replacing the pasture plants and the soiling system.

2 Studies on cropping and feeding systems

Many studies have been carried out on cropping and feeding systems. These will be summarized as follows.

1) Multiple cropping with soiling system

With a view to obtaining high yields from small fields intensive cropping systems with fodder crops have been studied by Matsuoka (1951), and later Abe (Matsuoka *et al.*, 1952, 1953, 1955). Although land productivity was fairly high such a system was so complicated and laborious that it became unpractical later when forage fields were enlarged.

2) Survey on cropping-feeding systems in dairy farms

Project teams surveyed dairy farms in the Tohoku (MAFF, 1960) and Kanto (MAFF, 1961) regions. The results indicated the major problems and directions for improvement, including more simplified cropping by introducing pasture plants and consolidation, etc.

3) Year-round silage feeding system

Aimed at obtaining high herbage yields and a constant and even supply of feed to animals, a year-round silage feeding system was developed experimentally by Suzuki and Ando (MAFF, 1973). This system has actually been found to be effective in dairy farms of the northern part of the Kanto district (Fig. 6) by Takano (1982) and Nakamura (National Grassland Research Institute, 1981). Farmers readily accept the introduction of this system, since large amounts of manure are available for spreading on fields, yields of milk increase and women are freed from tedious field work. Since the corn harvester is an indispensable machine for harvesting corn, relatively large field scale and joint use or operation by farmers groups are a prerequisite for successful introduction of this system.

4) Intensive cropping system for year-round silage feeding practice

In conjunction with the spread of this system intensive cropping practices suited to each region have been developed. Table 2 illustrates an example (Anonymous, 1981).

Continuous cropping of corn tends to promote the incidence of diseases and the deterioration of soil fertility in warm humid areas so that the introduction of legumes, sorghum and tropical grasses (annuals), etc. is being considered.

Table 2 Cropping system and productivity in arable land

Region	Typical cropping system	Productivity	
		Target	Present
Sub-arctic and cool temperate	Pasture plants—Root crop—Corn (4-5years) (2years)	17t/ha	8 t/ha
Temperate	Corn—Italian ryegrass Corn—Barley (whole crop)	25	12
Warm temperate	Corn—Sorghum—Barley Rhodes grass—Italian ryegrass-Oats	30 25	13

Strategy of research and development for the future

Grassland farming in Japan has been geared, so far, to the achievement of intensive technology. In the future, however, emphasis must be placed on low cost technology through the effective use of the existing resources. Also the technology must be ecologically sound, and involve the recycling of by-products or wastes within the agro-ecosystem. From this aspect the following two considerations are presented.

1. Integrated farming systems such as livestock/cereals or /vegetables which enable the recycling of farm resources should be promoted. As most Japanese farmers are small holders, recycling of farm products and manure is difficult. Therefore effective farming systems have to be designed for this purpose.

2. New systematic technology which enables grassland farmers to manage successfully under-utilized mountainous lands is required. Although grasslands have been extensively developed, the development accounts for only a small part of the potential and large areas still remain under-or non-utilized. However, for further development of these remote mountainous regions new techniques should be applied. It seems that the present levels of productivity could be raised and expenditures for developing new and present grasslands could be lowered by applying a new systematic technology. Application of some techniques already developed may provide higher productivity with lower costs, i.e. combined use of native plants and improved pasture crops, no-tillage methods for pasture establishment, extension of grazing period, etc. A new strategy for research should emphasize the systematization of individual advanced techniques relevant to grassland farming through the collaboration of scientists in various fields encompassing crop science, animal husbandry, ecology and socio-economics.

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Discussion

Cocks, P. S.(ICARDA): It seems that the forage production systems in Japan depend heavily on the use of nitrogen fertilizers. Could you develop similar intensive systems using legumes?

Answer: Legumes are becoming increasingly important in pasture lands. The use of nitrogen fertilizer is related to the price of the product.

Mendoza, R. C. (The Philippines), **Comment:** It appears that Japan has established a highly sophisticated pasture system. I believe that in future you may encounter problems in terms of efficiency of nutrient cycling, in particular in the lowland areas.

Kawanabe, S. (Japan), **Comment:** Indeed the excess of excreta applied in small land areas creates environmental pollution. We have to devise new farming systems including the integration of crops and livestock or vegetables and livestock.