Outcome of Networking People on Livestock in Crop-based Farming Systems in Asia

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Abstract

Recognizing the importance of animals in smallholder farms, the crop-animal systems research (CASR) in Asia evolved in 1984 out of the IRRI Asian Cropping Systems Network, later renamed Asian Rice Farming Systems Network (ARFSN). Collaborative on-station and on-farm research among 4 countries was initiated on different rice ecosystems primarily to develop appropriate technologies and methodology. By 1994, the number of CASR sites of ARFSN increased from 5 to 72 in 9 countries. In many Asian countries, the crop-animal systems research has been institutionalized in the national research programs and expanded to non-rice crop systems.

The conduct of CASR requires an interdisciplinary team from the biological, social, economic, environmental disciplines immersed in on-farm situation. Differences in research and extension organizational structure, availability of interdisciplinary scientists, and financial support hinders the implementation of systems research involving animals. AFRSN provided a venue for animal scientists to reorient research towards increased animal productivity in small farms, to work closely with crop scientists, sociologists and economists, and to appreciate the farmers' priorities in resource allocation. Towards this end, a working group was organized to link researchers, extension workers and policy makers. Thus, the farming systems research methodology, involving

diagnosis, design, evaluation and technology transfer, was modified by the different national research teams appropriate for a given ecosystem.

Some highlights of CASR project results are presented and discussed. More importantly, the following issues need to be addressed:
1) refinement of the economic and environmental impact assessment of crop-animal technologies;
2) testing the validity of CASR under a large-scale production system, i.e. pilot production program;
3) the ability to anticipate the broad socioeconomic ramifications of fast economic development in Asia and its effects on crop-animal integration in small farms.

KEY WORDS: network, crop livestock integration, research and extension methodology, Asia, rice, smallholder farm, on-farm research, feed, residues, by-product

Introduction

Animal production systems in Asia are generally an integral part of crop production. Farmers' production systems are complex and vary depending on the physical, biological and socio-economic environments. Farmers consistently diversify the use of their resources as there are interactions of various activities, not only within the crop and animal components, but also between them and the other enterprises or activities on the farm and off-farm. Furthermore, Asian farmers own small areas of land from less than 0.5 ha in China to about 5 ha in Thailand and Myanmar. A typical farm in Asia consists of a cropping area, and a homestead with the house, trees, vegetables and animals.

The most economically important animals are cattle, buffalo, goats, sheep, chickens, ducks and pigs. Animal production systems can be classified into three broad categories: smallholder, semi-intensive and intensive. The dominant production system is the smallholder. Most farmers raise combinations of different animals depending on their farm size, available labour, socio-economic conditions, cropping intensity, soil type, rainfall etc.

Cattle and water buffalo are raised mainly for cash, draught, meat, milk, as a source of manure for the crops, fuel, transportation, utilization of crop residues, and other related purposes. Goats and sheep are important components of farming especially in Indonesia, India, Nepal, Philippines and China. They are raised for cash, food, security, prestige and social values, and for the utilization of by-products. In West Java for example, one in every 5 farmers raises sheep and goats which contributes 14% and 17% of the income in the lowlands and uplands, respectively.

While the commercial pig and chicken farms are well developed due to the application of advanced technologies in breeding, nutrition, farm management and disease control, more than 80% of these animals are still raised in the "backyard". Approximately 90% of smallholder farmers raise chickens for food (meat and eggs), cash, utilization of by-products and for manure.

The Need for A Novel Research Approach

To improve animal production in smallholder farming systems, a change in approach was needed to solving the problems of animal production affecting the small farms in Asia. The traditional discipline-oriented research in animal science had resulted in the development of many animal production technologies. However, the impact of these has been more towards increasing productivity in commercial animal systems rather than that of animals in smallholder farms. Apparently, there was a need to reorientate animal research activities in Asia to focus more on the problems and constraints to animal production in small farms. There was a need for animal scientists to work closely not only with crop scientists, but more with farmers who are concerned foremost with crop production. An appreciation by animal scientists of how crop-based farmers allocate their limited resources to either crops or animals and of on-farm constraints to the application of matured technologies was necessary to be able to design and implement on-farm research with systems perspective.

Thus, the Asian Rice Farming Systems Network (ARFSN) conducted a series of meetings among scientists working on different commodities and disciplines, and research managers from national agricultural research stations (NARS) to develop a methodology for systems research. Initially, the methodology was for rice-based farms, but this was expanded to other crops by the collaborating countries according to their dominant agro-ecosystem. Eventually, a crop-animal systems research methodology was developed. The research methodology continuously underwent refinement depending on the needs and resources in a given environment.

Crop-animal Farming Systems Research in Asia

The evolution of the crop-animal systems research in Asia can be traced back from 1974 with the establishment of the Asian Cropping Systems Network at the International Rice Research Institute (IRRI). The network was established to facilitate collaborative research between IRRI and the national research system in selected Asian countries with the aim of increasing productivity and income from rice and non-rice crops in different rice environments. The research teams then were mainly composed of agronomists, soil scientists and economists doing on-farm, researcher-managed experiments with minimal farmer-participation.

In the early 1980's, research objective shifted to maximizing farm income particularly in the rainfed rice environment, where the farmers are involved in a more complex farming system which includes non-rice crops, animals and trees. The interdependence of rice with the other economic commodities in terms of resource allocation resulted in the expansion of the activities of the network. Towards the late 1980's, the issue of family welfare of Asian farmers was likewise recognized. Thus, the pool of researchers in the network was expanded to include animal scientists, veterinarians, sociologists and anthropologists. The network was later renamed Asian Rice Farming Systems Network to cater for all the research needs of the whole farm.

Due to the strong interaction among the physical, biological and economic environment, a systems approach to research was taken into consideration in the development of technologies that are likewise consistent with the farmers' goals and needs. Farmers' experience, indigenous knowledge and current practices were considered in the design of on-farm experiments and backed up by on-station research.

The early 1990's was ushered in with the need to sustain the natural resource base. This necessitated better complementarity between crops and animals to enhance family welfare, address equity issues and the like. Towards this end, on-farm crop-animal research was conducted with strong farmer participation based on a farming systems perspective. Four key research sites in four countries were established for the understanding of crop-animal systems and for the development of a research methodology.

The Research Methodology

Although modified by different countries, the basic components of the research methodology for crop-animal systems were the same. The steps followed were:

(1) selection of target area and research site;
(2) diagnostic/site description;
(3) design of component and system technologies
(4) testing in farmer's fields with the participation by farmers;
(5) extension of promising technologies in collaboration with extension workers.

The following are the key features of the approach: involvement of farmers in the research process; multi- disciplinary and inter-commodity research cum extension; environmentally-oriented; consideration of farmers' resources in the design of experiments; decentralized research; focused on increasing production and profitability; and a feedback mechanism between field and discipline researchers to make on-station research more relevant to farmer needs.

The description/diagnosis of the research site consists of a survey to identify the existing systems, the physical, biological and socio-economic characteristics, crop-animal interactions, and production constraints. The rapid rural appraisal method was adopted by most national programs. While the data gathered were more qualitative, it served the purpose of understanding the production systems practised by farmers, identifying the constraints and exposing scientists to real farm conditions. However, where extrapolation of research results to other areas was needed, more quantitative data were gathered.

Based on the problems and the environmental characteristics of the site and in consultation with the farmers, experiments were drawn by a multi-disciplinary team. In many cases, technologies developed on research stations were used as an intervention to existing farmers' practice, with or without modifications based on consultation with the farmer- cooperators. Due to constant monitoring of the experiments by both the researchers and the farmers, refinement of the research protocol was made possible even in the middle of the study.

Simultaneously with the development and refinement of the on-farm research methodology on crop-animal systems, several training programs, workshops and meetings for farming systems practitioners were conducted from 1987 to 1995, with ARFSN either as sponsor or as collaborator. Since 1972, more than 500 researchers took FSR and FSR-related courses at IRRI. This was augmented by similar national training programs in different countries. Most of the participants were crop scientists and very few were animal and social scientists.

The workshops and meetings were convened to provide a forum for the presentation of project progress reports and exchange of information among the members of the Network and other international research institutions.

Research Collaboration on Crop-animal Systems

The most important problems in animal production are the lack of nutritious feeds particularly during the dry season and the consequent low productivity of the animals. Farmers generally feed their animals with residues and by-products of rice, corn, wheat, soya beans, mung bean and groundnuts. To increase the utilization of crop by-products as animal feeds, two major research activities were conducted through the Asian Rice Farming Systems Network. These are on-station research and on-farm research. On-station research focussed on assessing the nutritional quality of forage crops and formulating rations which included home-grown feeds. On- station research identified and recommended forage crops that could increase the daily weight gain of ruminant animals. However, on-farm research had to be conducted to fit the recommended forage crops into farmers' cropping systems.

On-farm research was conducted at key sites representing specific rice ecosystems where farmers traditionally have an integrated crop and animals systems. The following are the outcomes of the on-farm research conducted at some of the key farming systems research sites. These sites have different combinations of crops and animals in specific rice ecosystems.

1. Zhenjiang, Hangsu, China (Irrigated)

Research at this site focussed on improving farmers' cropping patterns to supply quality feeds for swine and introducing improved breeds of swine. In the uplands, wheat or barley followed by soya bean or groundnut are grown, while wheat or barley-rice and rapeseed-rice are the common cropping patterns adopted in the lowlands. Soya bean and rapeseed cakes are used as feeds for pigs. However, the higher rice fields suffer from drought, and thus maize was tested to replace rice. In the lower fields improved varieties and agronomic practices for wheat-rice and rapeseed-rice were introduced. New cropping patterns were evaluated in the upper rice fields consisting of wheat or barley-maize, rapeseed-maize and barley-maize+soya bean. Yield of maize was 10% higher than rice and income from maize stover (sold to the dairy farm as silage) was 50% higher than rice straw. The total net income of rice and maize were the same. With the advantages of maize as animal fodder, farmers increased the area of maize from 0 to 1300 hectares in 1990.

The performance of hybrid pigs (Yorkshire x Taihu) was compared with the local breed, while the traditional system of feeding was compared with improved mixed feeds. Results showed that improved breeds fed with mixed feeds produced a higher net income, more efficient feed conversion and shorter feeding duration. This project was conducted by the Chinese Academy of Agricultural Sciences.

2. Changping, Beijing, China (Partially Irrigated)

Changping county is one of the main dairy production areas in Beijing, contributing one fourth of municipal milk production. Wheat-maize, wheat-maize (silage) and monocrop rice (transplanted and dry-seeded) are the farmers' dominant cropping patterns in irrigated upland and lowland fields. In rainfed, upland, monocrop maize is commonly adopted. Dairying is either managed by the state or cooperatives. The major constraint on dairy production was the short supply of maize and sorghum from irrigated upland fields for silage making. In the paddy fields, 60-70% were still monocrop rice and some farmers grew rice-wheat and barley silage-rice. The yield of barley was low, about 2.25t/ha. Cropping intensity in the uplands was already at a high of 200%, thus there was little potential for increasing silage production in those areas. The only way to increase silage production was to introduce silage crops during the winter- spring period after monocrop rice. In 1986, ARFSN launched a project to introduce triticale for silage production. Yields under irrigation at Yantan Township were very high (50 t/ha), resulting in a net income from the system of US$1,421, which was 114% more that for single-cropped rice and 44% more than for wheat-rice.

Results of a feeding trial conducted in Baifong village showed that there was no significant difference in milk production between cows fed on maize silage and those fed on triticale silage. The nutritive value of triticale even appeared superior, thus increasing crude protein and fat contents in the milk. Lactose percentage remained the same.

In 1988, the results of the feeding trial attracted the attention of the Beijing Municipal Bureau of State Dairy Farming Management, which organized a visit to the research site for dairy farm officials and farmers. The bureau decided to introduce triticale into its many dairy farms throughout the Beijing region. It was not only adopted in a triticale (silage)-rice pattern in the lowlands but also in triticale (silage)-maize (silage) pattern in the uplands. By 1993, the area devoted to triticale was about 2,600 ha or more than 60% of the total area devoted to winter silage crops. Average yields were 32 t/ha, while net incomes were US$207/ha, US$131 higher than from barley. Triticale was introduced and tested in another 15 provinces/municipalities in northwest China, central China and south China. The acreage outside Beijing was about 223.4 ha. The research had led to the reorientation of China's breeding programme of triticale for human food to silage use as well. The Chinese

Academy of Agricultural Sciences (CAAS) has recently released several new varieties for silage production.

3. Batumarta, South Sumatra, Indonesia (Rainfed, Upland)

Several models (combinations of crop and animals) were evaluated with the main objective of increasing farmers income to a minimum income of $1,500/year. The models were:

a) FSA - farmer's system without animal;
b) FSB - farmer's system with livestock;
c) FSC - gradual improvement with livestock;
d) FSD - introduced improvement with livestock.

FSA and FSB were existing farmers' practice; FSC had one cow, 3 goats and 11 chickens and FSD had 2 cattle, 5 goats and 23 chickens. Five farmers from each system were involved and were selected from those who adopted the improved cropping patterns. Farmers adopted the cropping patterns which included maize, upland rice, cassava and legumes such as groundnut and cowpea, grown in a relay intercrop system. After three years of on-farm testing, households adopting the models FSC and FSD achieved the minimum income target of $1500/family/year. With these promising results, FSC was evaluated in six village units involving five farmers in each village, with a total of 30 household cooperators. Farmers were carefully selected from farmer groups organized in each village and were given short training courses on the technology of the crop-animal system with emphasis on the technologies for FSC. Each household cooperator received credit for food production, 3 goats and 11 chickens. All of these households already owned cattle. Credit was provided by the project through the village unit cooperative. The payment of farmer cooperators became a revolving fund and extended to other members of the farmer group who were not involved in this project.

Within 3 years the population of cattle, goats and chickens increased. After six years of testing involving many farmers, the FSC was compared with farmers' existing systems without animals. The net income of FSC was 67% higher compared with the farmers' existing farming systems (without animals).

4. Santa Barbara, Pangasinan, Philippines

The research project was conducted in the rainfed village of Carosucan, Santa Barbara, Pangasinan, where farmers grow only one rice crop a year, leaving the land fallow after harvest. To increase cropping intensity, different cropping patterns were tested for three years. Rice followed by cowpea and mung beans were the most promising cropping patterns. After 2 years, 67% of the farmers planted mung bean and more than 90% in 1993. Net income increased from 80 to 155% more than that of farms with a monocrop of rice. Forage legumes are important components of the diet of ruminants especially for improving the utilization of fibrous residues like rice straw and for green manuring. Hence production of forage legumes in rainfed lowland areas is a strategic approach in the development of a year-round feeding system for ruminants. Scientists and farmers tested three forage crops - siratro, sunn hemp and Desmanthus. Among these forage crops, siratro proved the ideal companion for mungbean. Siratro provided four clippings for feeding to cattle, each with a yield of 3 t/ha, and a further 2.5 to 3.5 tons from the last regrowth, which was used as green manure for the following rice crop. The Bureau of Agricultural Research in Manila is now testing the improved rice-mung bean + siratro system in other provinces. Each province sent two representatives to a 2-week training course held at the Department of Agriculture to introduce the system. The main impediment to more widespread adoption is the shortage of siratro seed.

5. Ban Phai, Khon Kaen, Thailand

In Ban Phai, Khon Kaen, Thailand, the traditional cropping system was monocrop rice in the lowlands and cassava in the uplands. To improve the quality of feeds and utilize crop byproducts and residues, several crops such as corn, mung beans, cowpea, groundnuts were evaluated in the uplands and upper paddy areas. Artificial insemination was introduced to produce half-bred cows from American Brahman and Holstein-Friesian for dairying and the male for beef production. Backyard forage production using stylo, napier and ruzi grass were evaluated for night feeding and urea-treated straw was also introduced. Net cash income of the animal-based farmers was 100% more than the crop-animal based and 207% more than the crop-based. In all groups, the income from animal production was higher. Farmers at all experimental sites, including the neighboring villages, adopted the production of ruzi grass in bigger plots close to their homesteads.

Lessons Learned From Crop-animal Collaborative Research

The organization of the crop-animal systems research network was a learning experience. The complexity of different farming systems, diversity of production systems and the socio-economic constraints of rice-based farming households provided challenges to researchers and extension workers. The following were the lessons learned from the research network:

1. Organizational Difficulty

The methodology for crop-animal farming systems research required multi-disciplinary teams of social scientists, animal nutritionists, agronomists, livestock specialists, veterinarian, etc. However, these specialists come from different offices, ministries and departments. Thus, it was difficult for these specialists to coordinate their work and moreover to conduct field visits especially if the research sites are remote. There is generally a lack of social scientists, including economists, who have the interest and time to work with the other disciplines at the farm level. However, there are exceptional cases in Thailand, Indonesia and the Philippines where social scientists from agricultural universities worked together with scientists from farming systems research institutes.

2. Methodological Problems

Since the evaluation of systems and component technologies managed by farmers was replicated across farms, the variability of results was generally high, resulting in statistically insignificant differences. While more replicates are ideal, the conduct of research becomes more difficult and expensive. Occasionally, the farmers assigned to the control group duplicated some of the recommended practices. Similarly, there was tendency for some researchers to dictate to the farmers the experimental interventions rather than involving farmers in all phases of research particularly in getting their feedback.

3. Research Emphasis

There was more emphasis on nutrition and forage research and less on the different aspects of animal production. This is expected since the lack of forage for ruminants and high cost of concentrates for monogastric animals are the dominant problems under Asian conditions. Furthermore, crop by-product utilization by ruminants is the major point of crop-animal integration.

4. Socio-economic Constraints

In spite of the availability of crop-animal technologies developed, tested and evaluated on the research station and at the farm level, the adoption rate is low due to several socio-economic constraints (Paris *et al.*,1995). These are:

a) Farm labour shortage due to the higher off-farm wages and greater opportunity costs of family labour (especially males);

b) Unfavourable government agricultural policies which provide disincentives for small livestock development;

c) Unavailability of required inputs and support services;

d) Risk aversion and perceptions of technology by farmers;

e) Inadequate training and extension for technologies which require knowledge and information;

f) Lack of credit to the poor without collateral. For example, the dairy industry in Thailand prospered due to incentives and support which the Thai government gave at the community and farm level. Farmers were encouraged to specialize in forage seed production. In the Philippines, farmer cooperatives supported by the Land Bank provided credit not only for rice inputs but also for procuring large and small animals.

5. Farmer Participation

While farmer participation was very much emphasized in the methodology of crop-animal on-farm research, very few trials have included women farmers who play crucial roles in large and small animal production. It is now realized that they will play even greater roles in the management of farm animals and in sustaining household food security due to the increasing male migration to the cities. More efforts are now being undertaken to recognize women's roles in crop and animal production and in including them in research and extension activities.

Conclusion

ARFSN, as its major contribution to agricultural research in Asia, has exposed and trained local scientists in the conduct of on-farm animal research. As such, it has instilled into the researchers the need for collaborative research not only among institutions but, more importantly, with the farmers. With the current concern for sustainable agriculture amid dwindling funds for tropical agriculture research, ARFSN has put in place a critical mass of human resource with skills and capabilities to pursue research based on farmers' needs and aspirations. Provided with support by their respective national research programs, this pool of scientists can largely contribute to the improvement of rural life in Asia through appropriate research approach.

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