COLLABORATIVE RESEARCH ON RICE-BASED FARMING/CROPPING SYSTEMS IN ASIA: PROGRESS REPORT 1985

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INTRODUCTION

Asian rice farming are generally involved in various activities in the farm. These are production, consumption, savings and investment activities. Their farm activities are conditioned by their family needs and aspirations and by biological, physical and socioeconomic constraints. Because of the complex activities in the farm and the interactions of farm activities with the environment, cropping/farming systems approach to research appears to have better promise than the commodity approach in increasing farm productivity and welfare of small farmers.

The two major agriculture production enterprises are crop and animal production which constitute about 70-90% of the agricultural enterprises in a small farm. Farmers consciously diversify the use of their resources to produce mix activities to maximize their income. A typical rice farm is generally small with less than 1 ha (Java, Indonesia) to about 5 has (Thailand and Burma). It consists of a cropping area, a homestead with the house, trees, vegetables and livestock. One of the most important crop is rice which is grown during the rainy season and upland crops before or after rice. The common upland crops grown with rice are soybean, mungbean, corn, sesame, sweet potato, wheat, peanut, blackgram, chickpea and mustard. These crops are planted during the dry season on residual moisture or with irrigation when available.

A systems approach to research was started by IRRI on rice-based cropping systems in 1974. A methodology for cropping systems research evolved and was refined by various national programs involved in the Asian Cropping Systems Network. This methodology was further expanded to include not only

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cropping but also animal production, fisheries and forestry. Some national programs have expanded to farming systems research and in 1983 the Network changed its name to Asian Rice Farming Systems.

The methodology used in the Network was formulated as early as 1975. A conceptual framework of cropping systems research and development was formulated after 3 meetings of the Asian Rice Farming Systems Working Group (members are leaders of cropping/farming systems research from national programs). This framework was reently expanded to include animal production systems (Fig. 1). It started from selection and description of target areas; selection of a site (village or villages) representing the target area where research will be conducted; description of the research site; design of cropping/farming systems and component technology experiments; testing of designed experiments with farmers participation; multilocation testing and pilot production program and finally a wide scale production program. It is an interdisciplinary and inter commodity research approach involving biological and social scientists with the participation of the farmers in the research process. A research team composed of agronomist, economist and crop protection specialist is assigned in the site which may be a village or several villages. The methodology is describe in detail in several publications (Zandstra et al. 1981 and Carangal 1985). The methodology provides feedback to commodity and descipline research in experiment stations and make research more relevant.

ASIAN RICE FARMING SYSTEMS NETWORK

Farming/cropping systems is highly environment specific like any other technology. In order to develop relevant technology for major production complexes research has to be conducted in different major environments. This of course can be done through collaborative research between scientists from national programs and the IRRI Rice Farming Systems Program. The mechanism for this collaborative research is the Asian Rice Farming Systems Network. The IRRI program provides the coordination for the Network activities. It is a scheme for IRRI and national scientists to work together to jointly increase food production in Asia through the identification of a more productive rice-based farming systems that are acceptable to small scale farmers. The specific objectives of the network are the following:

a. To develop farming systems technology for the major rice growing regions in Asia.

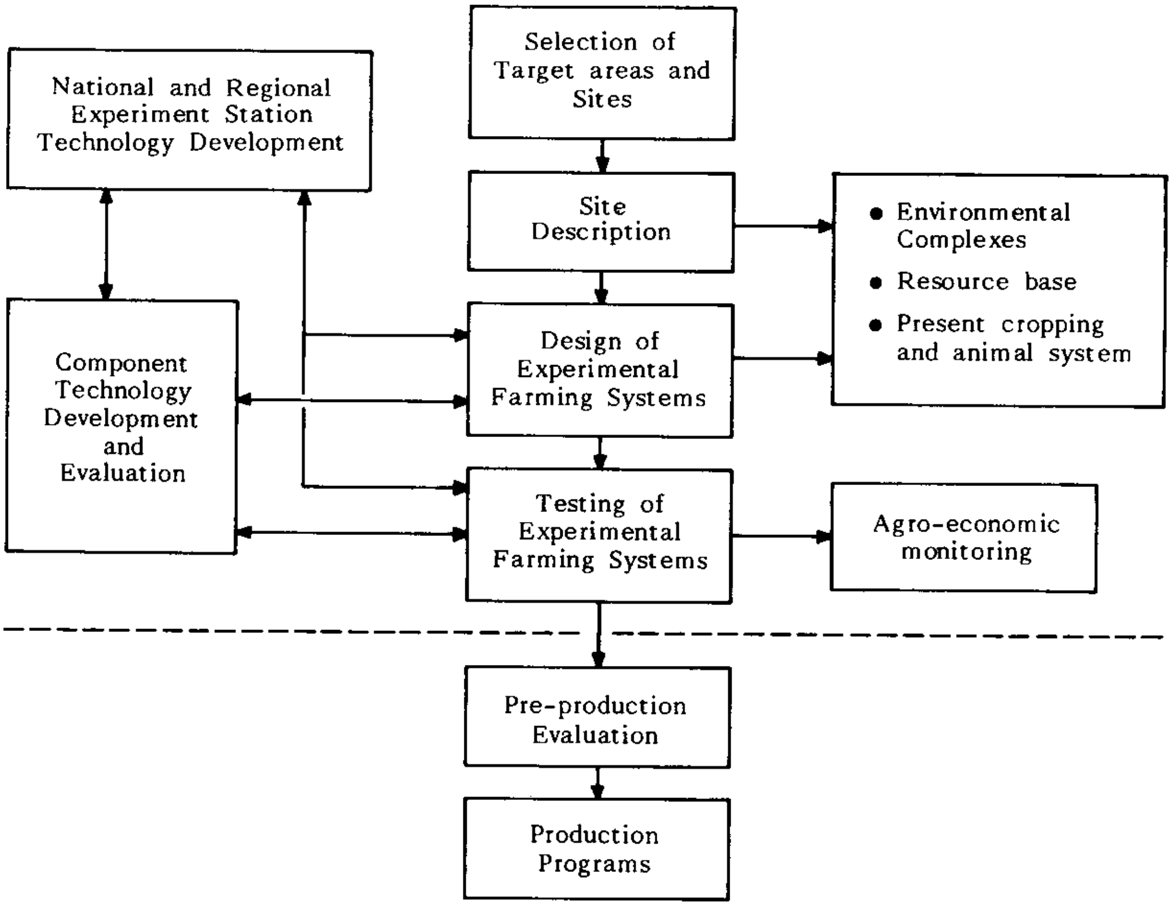

FIGURE 1. Farming System Research and Development.

b. To promote and coordinate collaborative researches on major problems in crop intensification and crop-livestock integration.
c. To enable IRRI to extend relevant technology and methodology into national programs.
d. To establish and develop strong national cropping/farming systems programs.
e. To generate and provide data on performance of crops and animal production technology in a wide range of environmental complexes.
f. To help organize international and regional meetings, conferences and symposium and monitoring tours.

To help the Network accomplish its objective, an Asian Rice Farming Systems Working Group was organized to provide guidance and direction to its collaborative research activities. The group is composed of national cropping farming systems program leaders/coordinators, IRRI Network Coordinator and Economist and 1-3 scientists in the region (invited depending on the topic for discussion. The group meets once a year. The 15th meeting was in Sri Lanka in 1984, the 16th meeting in Nov. 1985 in Bangladesh and 17th meeting will be held in the Philippines in Oct. 1986.

In the first four years, collaborative research is concentrated on cropping pattern testing using the methodology developed by IRRI and the Asian Rice Farming Systems Working Group. Testing is conducted in rainfed wetland, partially irrigated, irrigated, rainfed dryland and deepwater rice. In 1977, collaboration was expanded to other problem areas common in the region. Collaborative research on varietal testing of upland crops that fits the rice farming systems was started in 1977. Other areas of collaboration are rice-wheat production system, farm implement for intensive cropping and long term fertilizer and cropping pattern studies and crop-livestock research. I will try to very briefly discuss each one in this paper.

NATIONAL CROPPING/FARMING SYSTEMS PROGRAM

All the countries collaborating with the Network are now implementing cropping/farming systems research. The research methodology developed by IRRI and the Network scientists is now used by all participating countries with different modifications to suit their organizational set up, available manpower and financial conditions. Other national programs have expanded their work to other systems such as corn-based (Philippines, Thailand, Indonesia), coconutbased (Philippines and Malaysia), cassava-based (Indonesia and Thailand) and sugarcane-based (Philippines and Bangladesh). Some national programs have expanded their cropping systems program to farming systems which includes their cropping systems program to farming systems which includes livestock and fisheries. Philippines, Thailand and Nepal implemented crop-livestock research in collaboration with the Network. Indonesia, Bangladesh and Sri Lanka have initiated plans for crop-livestock research which will be operational in 1985. Thailand implemented an integrated farming with rice, livestock and fish.

The number of rice-based cropping/farming systems research sites in countries collaborating with the Network have increased from 173 in 1983 to 194 in 12 countries in 1984 and to 236 in 14 countries in 1985. The focus of their work is mainly on rainfed with 136 sites and irrigated with 74 sites. There are also sites in partially irrigated (22), upland (45) and deepwater (2) rice. The countries involved are Philippines, Burma, Indonesia, Korea, China, Pakistan, Sri Lanka, Bangladesh, Thailand, Malaysia, Taiwan, Nepal, Bhutan and Malagasy.

The work in the sites was concentrated on the design and testing of cropping patterns. Few component technology research such as varietal testing, fertilizer rates and etc. were conducted. The main focus in each site is to increase production and cropping intensity using early maturing varieties of rice and other crops. In some sites where the intensity is already high, research is focus on increasing productivity of the crops in the cropping pattern. The work on crop-livestock research site includes design and testing of cropping patterns and animal systems.

National programs continued to expand the pre-production (multilocation testing and pilot production) and the production phase of the methodology. Bangladesh, Philippines, Nepal, Sri Lanka, Indonesia and Thailand expanded their multilocation testing and pilot production. In the Philippines, many cropping systems sites in different regions conducted pilot production programs. Bangladesh Rice Research Institute (BRRI) expanded their multilocation testing in rainfed and started multilocation testing in irrigated areas based on data obtained from Salna cropping systems site. Bangladesh Agricultural Research Institute (BARI) started multilocation testing in different regions. BRRI in collaboration with extension have pilot production program in Sylhet and Chittagong districts. In Sri Lanka, preproduction programs were undertaken in Kurenegala, Bandarawela and Paranthan Districts. The most successful was in Kurenegala. Thailand preproduction is implemented in provinces of Chiang Mai, Phayao, Lampun and Phrae using mungbean-rice and direct seeded rice and Nakhon Ratchasima using peanut-rice. In Nepal, they are implementing several preproduction projects using data from 6 cropping systems sites.

Philippines continue to expand their cropping systems production programs in Iloilo and Nepal in several districts in the terai and inner terai. There is large production program of rice-soybean in Aceh, Indonesia.

COLLABORATIVE RESEARCH

CROPPING PATTERN TESTING

This collaboration started at the time the Network started in 1975. It involves testing cropping sequences in different rice environments. Out of 236 cropping/farming systems sites, 45 were involved in cropping pattern testing in 12 countries (Table 1). We monitored the environment, crop and economic performance of different cropping patterns. The sites were selected to represent major rice growing environments in Asia. At least one site is selected for each country. In most cases the focus in each site was to increase production, net income and cropping intensity. In some sites, we increased the production of each crop in the pattern and income of the total system.

The experimental cropping patterns are always compared with farmers' dominant cropping patterns in each site. Table 2 indicates the number of crops in farmers' predominant cropping pattern, number of crops in the experimental pattern and promising cropping patterns. In most cases, the experimental patterns are better in total production and income than farmers' cropping pattern. Promising cropping patterns indicated were better agronomically and economically than farmer's cropping pattern. The patterns with one asterisk indicates that the promising pattern in now tested in several locations within the target area (Multilocation Testing) and with 2 asterisk indicates multi-location testing and/or pilot production are implemented using the technology developed in the research site.

TABLE 1. Number of cropping/farming systems sites involved in cropping pattern testing in the Network.

Country	No.of sites	Rainfed wetland	Partially irrigated	Irrigated	Rainfed dryland
Philippines	12	4	-	4	4
Burma	4	1	3	-	-
Taiwan, China	3	-	-	3	-
China	6	-	-	6	-
Malaysia	1	1	-	-	-
Indonesia	2	1	-	-	1
Sri Lanka	3	1	2	-	-
Bangladesh	1	1	-	-	1
Thailand	4	2	-	2	-
Nepal	3	3	1	1	-
Pakistan	1	-	-	1	-
India	5	-	-	5	-
Total	45	14	7	22	6

TABLE 2. Number of crops in farmer's predominant patterns, number of crops in the experimental pattern and the promising cropping patterns.

Site	No. of crops in pattern		Promising cropping pattern
	Farmers'	Tested	
RAINFED LOWLAND			
Bacnotan, Philippines	1	2-3	rice-tobacco-corn
Tumauini, Philippines	1-2	2	mungbean-rice rice-rice
Wakema, Burma	1-2	2	jute-rice-soybean rice-sunflower
Kota Bharu, Malaysia	1-2	2	rice-peanut
Siaton, Philippines	1-2	2	rice-mungbean
Katapotha, Sri Lanka*	1-2	2	rice-mungbean rice-cowpea
Bireun Aceh**	1	2	rice-soybean
Ratna Nagar, Nepal**	1-2	2-3	rice-maize
Maasin, Philippines	1-2	2	rice-rice
Phayao*	1	2	mungbean-rice
Srisaket, Thailand	1	2	peanut-rice
Screepur, Bangladesh	1	2	blackgram-rice (local)
RAINFED LOWLAND (WITH COOLER TEMPERATURE)			
Pumdi Bhumdi, Nepal**	2-3	2-3	rice-wheat maize rice-maize
Sukchaina, Nepal**	2	2	rice-chickpea rice-wheat
Screepur, Bangladesh	1-2	2	rice (local) - rice (BR_{11} or BR_{10})
PARTIALLY IRRIGATED			
North Nawin, Burma	1	2	rice-sunflower corn-cotton
Bandarawela, Sri Lanka*	2	2-3	rice-potato-bean rice-tomato-bean
Patheingyi, Burma	1	2	cotton-rice mungbean-rice
Yezin, Burma	1-2	2-3	rice (DSR) - peanut rice-potato

TABLE 2. (Cont'd)

Site	No. of crops in pattern		Promising cropping pattern
	Farmers'	Tested	
RAINFED DRYLAND			
Trece Martirez, Philippines	2-3	2-3	banana + rice-peanut
Batumarta, Indonesia*	2-3	4	rice + corn/cassava/ peanut or soybean
Manito Albay, Philippines	2	2-3	rice-sweet potato- mungbean
Jaimindan, Philippines	1-2	4	rice + corn-corn + peanut
IRRIGATED			
Beijing, China	1-2	2	wheat-rice (DSR)
Mahaweli H, Sri Lanka	2	2-3	rice-onion/chillies rice-soybean
Changsha, China	2-3	2-3	rape-rice-rice vegetables-soybean + corn-rice
Parsa, Nepal**	2-3	3	rice-maize-maize rice-wheat-rice
Shoaxing, China	2-3	2-3	broad bean + corn-rice barley-rice-rice
Ratna Nagar, Nepal**	2	3	rice-wheat-mungbean rice-wheat-maize
Koshiung, China	2-3	2-3	rice-vegetable-corn
Changhwa, China	2-3	3	rice-soybean-wheat rice-rice-wheat
Yunlin, China	2-3	3	rice-mungbean-corn sesame-rice-corn
Daska, Paksitan**	2	2	rice-sunflower
Ubon, Thailand	2	3	rice + firsh-rice
Guimba, Philippines	2	3	rice-rice-mungbean
Dipolog, Philippines	2	2-3	rice-rice-mungbean
Compostela, Philippines	2	2-3	rice-mungbean-rice

* - Used for multilocation testing

** - Used for multilocation and/or pilot production program

VARIETAL TESTING

The most important upland crops grown before and after rice are corn, sorghum, soybean, peanut, mungbean and cowpea. The Institute of Plant Breeding at UPLB received a grant from IDRC to develop varieties of upland crops for rice farming systems. The project includes screening of lines and varieties from the international centers (ICRISAT, IITA and AVRDC) and other national breeding programs; hybridization for selected promising varieties and selection (Fig 2). The breeding program concentrates on soybean, peanut and mungbean. Hybridization, selection and screening are done at UPLB and further screening and evaluation are also done in Santa Maria, Pangasinan. IITA recently assigned a senior scientist at IRRI to identify varieties of cowpea and soybeans that fits the rice farming systems. For corn and sorghum, we are collaborating with IPB, CIMMYT and ICRISAT. The Thailand Field Crops Research Institute (FCRI) and Indonesian Central Research Institute for Food Crops (CRIFC) intensified their work on breeding for rice farming systems and they contribute to the testing.

The most promising entries from IPB, international centers, Thailand FSRI, and Indonesian CRIFC and national programs are submitted to IRRI for seed increase and distribution to countries involved in the Network (Fig. 3). Seven crops are included in varietal testing. These are soybean, peanut, mungbean, cowpea, bush sitao, corn and sorghum. Pigeon pea will be included in 1985. The number of entries varies from 8-10 entries per crop.

In 1985, we received and seed increase 7 corn varieties from Thailand, Indonesia, Vietnam and IPB; 23 mungbean from AVRDC, Pakistan, China, Burma, Thailand, Indonesia and IPB; 5 soybean from Thailand, 10 peanut from IPB and 5 rice bean from Indonesia. We also increased 10 most promising pigeonpea and 10 sorghum varieties from our varietal evaluation in IRRI. These entries will replace the entries in the varietal testing in 1986-87 cropping pattern year.

A total of 165 trials before rice (35 mungbean, 31 cowpea, 23 bush sitao, 10 soybean, 11 peanut, 2 sorghum and 53 corn) and 268 trials after rice (51 mungbean, 34 cowpea, 32 bush sitao, 37 soybean, 39 peanut, 15 sorghum, 48 corn and 12 pigeonpea) were also distributed to different cropping systems sites in Nepal, Burma, Bangladesh, China, Thailand, Vietnam, Indonesia, Sri Lanka and the Philippines. The trials were for the 1985-86 cropping pattern year.

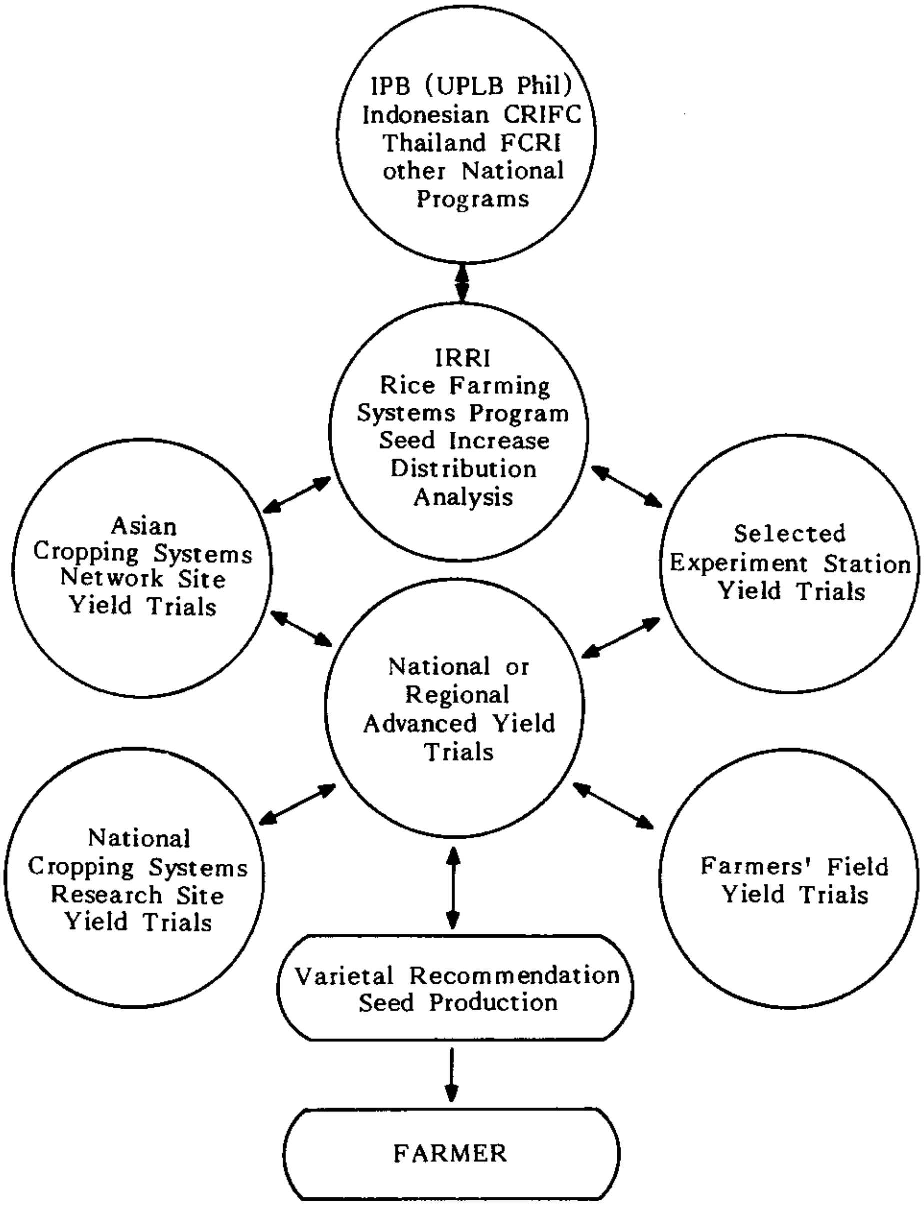

FIGURE 2. Scheme for varietal evaluation of upland crops for rice-based cropping systems.

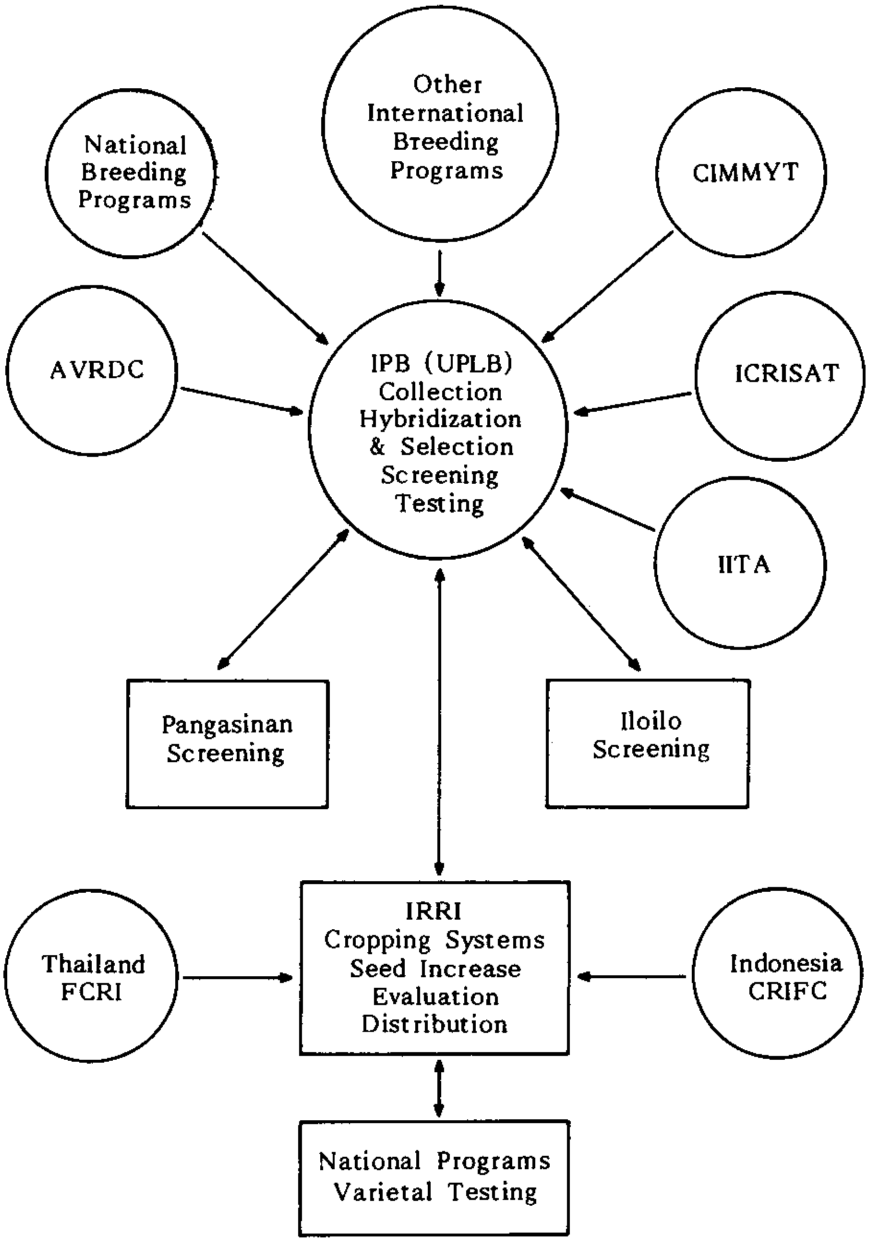

FIGURE 3. Breeding scheme of upland crops rice-based cropping systems.

Varietal trials after and before rice were conducted in 8 countries in 1984-85 cropping pattern years. Data was received from Philippines, Thailand, Burma, Vietnam, Indonesia and China. Several promising varieties were identified. The most promising varieties better than the check and/or the highest yielding cultivars in these locations are presented in tables 3 nnd 4.

LONG TERM CROPPING PATTERN AND FERTILIZER STUDIES

One major objectives in cropping systems is to sustain the productivity of the soils. As we grow more crops it will result to rapid loss of fertility resulting to lower production. Studies on long term were started in the Network in 1984. The main objectives of the studies are to determine the effects of continous cropping using different crop rotations on the soil and crop performance and to determine residual effects of fertilization and other soil amendments on cropping pattern performance. Studies are not uniform but data collection is uniform. Collaborators designed their experiments depending on their environment. Cropping patterns and fertilizer treatment varies from location to location. Collaborating countries are Bangladesh, Indonesia, Burma, India, Taiwan, Nepal and China. Bangladesh Rice Research Institute is studying 4 cropping patterns with irrigation in Comilla and Joydebpur and 3 cropping patterns in rainfed lowland in Joydebpur and Rajshahi. Fertilizer treatment is the same and the interdisciplinary team monitors the diseases, weeds and insect population in different cropping patterns. Nepal conducted 4 cropping patterns with 3 fertilizer rates in Khumaltar. There is also an on-going rice-rice-wheat cropping pattern with different fertilizer levels in Parwanipur. In Indonesia, there were four experiments established in lowland and upland conditions. There are: (1) effectiveness of partially icidulated phosphate rock in year round cropping pattern in 4 research sites, (2) crop and soil response to time and phosphorus treatment in cropping pattern in 4 research sites, (3) controlled release nitrogen fertilizers in upland cropping in 5 research sites and (4) evaluation of effects of crop residue management on soil and production of rice and soybean in year round cropping patterns in 3 experimental stations. Some experiments conducted in farmer's field were discontinued.

Most of the cropping pattern trials in China are long term at least 3-6 years with rotation of different cropping patterns. Experiments are conducted by the Institute of Soil and Fertilizer of Hunan Academy of Agriculture in 4 locations and China National Rice Research Institute in Shaoxing cropping

TABLE 3. Upland crops varieties better than the check or highest yielding across locations when planted before wetland rice, 1984-85 cropping pattern year.

Location	Mungbean		Cowpea		
	Grain	Fodder	Fresh Pods	Grain	Fodder
Philippines	IPB M79-13-60	IPB M79-22-62	TVx 136-16D2	TVx 136-16D2	TVx 4577-02D
	Pag-asa 1	IPB M79-17-79	EG #2	TVx 4677-08E	TVx 1850-01E
	IPB M79-9-82	IPB M79-13-60	All Season	TVx 4573-02D	TVx 3629
	Pag-asa 3				
Nepal	IPB M79-22-62	-	TVx 1850-01E	EG #2	-
	Pag-asa		EG #2	TVx 1850-01E	
			TVx 136-16D2	TVx 136-16D2	
Indonesia	IPB M79-9-94	IPB M79-22-62	-	-	-
	IPB M79-22-62	IPM M79-9-94			
	IPB M79-9-82	IPB M79-9-82			
China	-	-	-	-	-

TABLE 3. (Cont'd.)

Locations	Bush sitao			Soybean	Peanut	Maize	
	Fresh Pods	Fodder	Grain	Grain	Grain	Green Ears	Fodder
Philippines	BS_1(6-14RxAS)	BS_1(6-14RxAS)	-	-	-	Phil. DMR Glut. Comp. Popn 41C	Phil. DMR Glut. Comp. Popn 41C
	BS_3(6-14RxAS)	BS_3(6-14RxAS)				Los Banos Lagkitan	Los Banos Lagkitan
Nepal	BS_1(6-14RxAS)	BS_3(6-14RxAS)	-	Guntur	UPL PN 4	-	-
	BS_3(6-14RxAS)	BS_1(6-14RxAS)		7207-1	UPL PN 2		
	LBBS #1	LBBS #1			CES 2-25		
Indonesia	-	-	Arjuna	7207-1	-	-	-
			XC #1	7521-26-2			
			Early DMR Comp 2	Guntur			
China	-	-	-	-	-	Phil. Super-sweet #9 Dan Ju #6	Sweet Comp. #1 Hawaii Super-sweet #9

TABLE 4. Upland crops varieties better than the check or highest yielding across locations when planted after wetland rice, 1984-85 cropping pattern year.

Location	Mungbean		Cowpea			Bush witao	
	Grain	Fodder	Fresh Pods	Grain	Fodder	Fresh Pods	Fodder
Philippines	Pag-asa 3	CES 1T-2	TVx 289-4G	TVx 3410-02J	TVx 1948-01E	BS_1(6-14RxAS)	BS_1(6-14RxAS)
	IPB M79-13-29	IPB M79-13-29	TVx 4661-07D	TVx 2724-01F	TVx 4659-03E	EG BS_2	BS_7
	IPB M79-13-45	Pag-asa 3	TVx 1948-01E	TVx 1948-01E	TVx 2724-01F	BS_7	-
Thailand	IPB M79-9-82	-	-	TVx 4661-07D	TVx 289-4G	-	-
	Pag-asa 1	-	-	TVx 3671-14G-01D	TVx 4661-07D	-	-
	IPB M79-13-45	-	-	TVx 2724-01F	-	-	-
Vietnam	IPB M79-9-82	IPB M79-9-82	-	-	-	-	-
	IPB M79-13-29	Pag-asa 2	-	-	-	-	-
	IPB M79-13-45	IPB M79-13-29	-	-	-	-	-
	Pag-asa 3	-	-	-	-	-	-
Burma	-	-	TVx 3381-02F	TVx 2724-01F	TVx 4678-03E	-	-
	-	-	Vita 7	Vita 7	Vita 7		
	-	-	TVx 4678-03E	TVx 3381-02F	TVx 3381-02F		
	-	-	TVx 2724-01F				
Indonesia	-	-	TVx 1948-01E	-	-	BS_1(6-14RxAS)	BS_1(6-14RxAS)
	-	-	TVx 289-4G	-	-	BS_3(6-14RxAS)	EG BS_2
	-	-	TVx 3381-02F	-	-	EG BS_2	BS_3(6-14RxAS)

TABLE 4. (Cont'd)

Location	Soybean	Peanut		Sorghum		Maize			Sweet potato	
	Grain	Grain	Fodder	Grain	Fodder	Grain	Green Ears	Fodder	Tubbers	Fodder
Philippines	7207-1	UPL PN-2	UPL PN-2	UPL SG-5	CS 182	Early DMR Comp. 1	Los Banos Lagkitan	Glut. Comp. Popn 41C	G 145r-4	G 53r-17b
	Acc 2120	UPL PN-4	UPL PN-4	CS 110	UPL SG 5	XC #1	Glut. Syn 41	XC #1	Tinipay	G 113-2b
	7521-26-2	CES 2-25	PI 118200	CS 137	CS 110	Ranjuna	Phil. Super-sweet #1		G 53r-17b	Tinipay
Thailand	Guntur	UPL PN-4	UPL PN-4	UPL SG 5	-	XC #1	-	-	-	-
	7207-1	CES 102	CES 101	CS 116	-	Pirsabak 7930				
	7521-26-2	CES 103	CES 103	CS 182	-	Arun 2				
		M-10								
Vietnam	-	-	-	-	-	-	-	-	-	-
Burma	Guntur	M-10	M-10	CS 110	CS 110	-	-	-	-	-
	7207-1	UPL PN-2	CES 101	CS 336	UPL SG 5					
	7521-26-2	CES 101	UPL PN-2	UPL SG 5	CS 253					
Indonesia	-	UPL PN-4	CES 102	CS 182	CS 182	-	-	-	-	-
		CES 2-25	UPL PN-4	UPL SG 5	UPL SG 5					
		CES 102	M-10	CS 110	CS 110					

system site. In Pintung, Taiwan the District Agricultural Improvement Station is conducting a long term trial with 3 cropping patterns and 3 fertilizer managements. India participated in the Network in 1985 and cropping pattern trials are conducted in 23 research institutions. Four to 8 cropping patterns are tested on a long term basis.

RICE-WHEAT CROPPING SYSTEMS

One of the major cropping systems in subtropical countries is rice-wheat. In 1983, IRRI and CIMMYT started in collaboration with national programs collaborative research on rice-wheat to identify profitable rice-wheat systems in different rice environments and identify best varieties of wheat and rice that satisfy the crop rotation needs of rice-wheat farmers. Collaboration involves temperate countries (China and Korea), subtropical countries (Philippines, Thailand, Indonesia, Burma, Sri Lanka, Vietnam and Malaysia). The two projects are cropping pattern testing, and international rice-wheat integrated trials.

CROPPING PATTERN TESTING

Cropping pattern testing involving rice, wheat and other crops are conducted in cropping systems sites and experiment stations in Nepal, Bangladesh, Pakistan, China, India and Taiwan. The most promising in terms of returns and yield in Nepal are: rice-wheat-maize and rice-maize in Pumdi Bhumdi; rice-chickpea and rice-wheat in Sukchaina and rice-wheat-rice and rice-maize-maize in Ratna Nager. Bangladesh Agriculture Research Institute reported increase in production and income over existing farmers systems by adding wheat in rainfed site in Rajshahi (rice-wheat) and irrigated site in Rangpur (rice-rice-wheat) and rainfed site in Ishurdi (mungbean-rice-wheat). Substitution of wheat in irrigated site in Hathazari also increased income and production of the farmers existing cropping systems. In Changwa, Taiwan 15 different cropping patterns were tested and the most promising cropping patterns were rice-soybean-wheat, rice-rice-wheat, and rice-sorghum-wheat. Out of the 6 cropping patterns tested in Tongxian cropping site in Beijing, DSR rice-wheat showed the highest yield although the yield of rice in the rice-wheat was lowest, the highest was in green manure-rice-rice. Cropping pattern testing in India started only in 1985 and there are 23 research institutions involved studying 4-8 cropping pattern per site on a long term basis. Most of the sites in northern, north eastern and north western India involves rice-wheat rotation system.

INTERNATIONAL RICE-WHEAT INTEGRATED TRIALS (IRWIT)

The main objectives of this project is to identify better varieties of rice and wheat with multiple resistance to pests and diseases that fit the rice-wheat system. Trials are conducted in the experiment station and promising material tested in the cropping systems sites. Rice entries comes from the IRRI International Rice Testing Program and wheat from CIMMYT Wheat Program. National breeding program contributes 50% of the wheat entries in the trial. In tropical countries with no local checks 5 entries from the Philippine Institute of Plant Breeding and 5 entries from CIMMYT were in each trial.

There are 2 sets of trials for rice and wheat. One set is early maturing and the other early medium maturing for rice. For wheat, one set is early and the other is medium maturing varieties.

In cropping pattern year 1983-84, we distributed 31 sets of rice trials to fifteen countries. Eight early sets were sent to the temperate and high elevation countries (China, Korea, Bhutan, Nepal and Egypt) while 23 sets of early and medium maturing varieties were sent to subtropical and tropical countries (Burma, Philippines, Thailand, Vietnam, Bangladesh, Nepal, Pakistan, Sri Lanka, Indonesia and Malaysia). For wheat, 31 sets of early and medium maturing varieties were sent to the same countries.

On rice, the top grain yielders were IR 42 in Wakema and Yezin and Milyang 54 in Patheingyi, Burma. However, Milyang 54 was outyielded by a local variety, Pelita 1-1. In the Philippines, the outstanding varieties were BR 51-282-8 in Isabela; IR 36 in Los Banos and RP 825-45-1-3 in Nueva Ecija. RP 825-45-1-3 was also the most promising variety in Chiang Rai and Chumpae, Thailand and Bairawaha, Nepal: In two other test sites in Thailand (Chiang Mai and Muang Prae), IR 54 was, however, the highest grain yielder. It also gave the highest yield in Jessore, Bangladesh. In Joydebpur, IR 13540-56-3-2-1 was the top grain yielder.

On wheat, UP 262 was the most promising among the early maturing CIMMYT entries in Joydebpur and Jamalpur, Bangladesh; Muang Prae, Thailand; Milyang, Korea and Isabela, Philippines. It was, however, outyielded by local varieties in Bangladesh and Korea. In other test sites, the outstanding entries were Nacozari 76 in Rupandehi, Nepal and Jessore, Bangladesh; Sonalika in Dokri, Pakistan and Changsa, Hunan, China; Sonka Inia in Khon Kaen, Thailand and C 213-15 in Los Banos, Philippines.

In the medium maturing group, the highest yield levels (4.6 t/ha was obtained in Bangladesh. The most promising varieties were Pavon 76 in Joydebpur, Bangladesh, Dokri, Pakistan and Chiang Rai, Thailand; Chano 79 in Jamalpur, Bangladesh and Kathmandu, Nepal; Glennson 91 in Hunan and Sichuan, China and Wakema, Burma and Tyrant S in Jessore, Bangladesh and Yezin, Burma. Glennson 81 and Tyrant S were, however, outyielded by the local varieties in China and Bangladesh, respectively. C 213, was the highest yielding entry in Los Banos, Philippines.

CROP-LIVESTOCK SYSTEMS RESEARCH

Collaborative research on crop-livestock started in 1984. It consists of on-experiment station research in IRRI and the Philippine Institute of Animal Science (IAS) and an on-farm research in Santa Barbara, Pangasinan, Philippines; Batumarta, South Sumatra, Indonesia; Pumdi Bhumdi, Kaski, Nepal and Ban Phai, Khon Kaen, Thailand. The work in IRRI concentrates on food-forage cropping systems, forage crops management and dual-purpose crops cropping systems. IAS works on feed technology and pesticide residues.

ON-FARM RESEARCH IN CAROSUCAN AND MALANAY

Research the Philippines is conducted in 2 villages of Santa Barbara, Pangasinan. Malanay is an irrigated and Carosucan a rainfed, both lowland rice growing areas. Rainfall starts in May or early June peaks in August and ends in late September thru October with 4-5 wet months and 2-3 dry months 1973-82. Soil is clay loam to sandy loam with pH 6.7 - 7.9.

Carosucan, the rainfed site have about 56% heavy and 44% light soils. Average landholding is 1.6 ha per household. A monocrop rice predominates and depending on rainfall after harvest in November, some farmers may plant mungbean, tomatoes, peanuts, watermelon, etc., most fields being left fallow. IR 42 and other medium maturing rice varieties are grown in heavy soils and IR 36 and early maturing in light soils. Cattle and buffalo holdings average 1.4 per farm, or an stocking rate of 1 mature animal or animal unit (A.U.) per ha. Farmer operators are 48 years old on the average; and a household has 5 members, 3 regular practice of the farmer.

There are 18 cooperators in Carosucan with 4 treatments. These are : (a) 1 animal plus technology intervention with 0.5-1 ha, (b) 2 animals (1 for draft and 1 fattening) plus technology intervention within 1.1-2 ha farm, (c) control of (a), and (d) control of (b). Farm size and animal number are the same for the control and we monitor the regular practice of the farmer.

Interventions or technology package in livestock management included daily feeding with 2 kg leucaena or other legume forages, provision of urea-molasses-mineral blocks, establishment of improved forages in their lots and animal health care. Utilization of fibrous crop residues, especially rice straw, was recorded and related with actual farm grain and residue output.

After 300 days feeding period, liveweight gains of cattle, apparently did not reflect differences due to farm size or intervention. The weight gains for treatment with 1 animal was 0.18 kg/day, treatment with 2 animals was 0.16 kg/day. There was no significant difference because of the following: (a) urea-molasses-mineral blocks was discontinued and farmers do not have enough leucaena to feed 2 kg/day; (b) control farmers also gave the intervention we recommended, and (c) forages grasses and plantings of leucaena were introduced in 1985 and will be used in early 1986. In Dec., 1985, we provided the farmers with 2 kg/day of rice bran to feed the animals for 50 days before marketing.

The livestock cooperators was also the crop cooperators in Carosucan. We continued the cropping pattern and component technology trials to determine the stability of the pattern and further refine the various component of the system. We tested rice-mungbean and rice-cowpea using IR 60 early maturing and conducted fertilizer trials; variety trials of early maturing cowpea, mungbean, and bush sitao in the heavy soils before rice; rice weed control and variety trial of early and medium maturing rice varieties.

Introduction of mungbean and cowpea were adopted by the farmers. In 1985-86 dry season 67% of the farmers in Carosucan planted mungbean and cowpea after rice. Before the project started less than 10% of the farmers planted upland crops.

Field data of the first rice crop using early maturing varieties showed that IR 60 yielded significantly higher compared to IR 36 and IR 62 which the farmers are using with a grain and fodder yield difference of 61; 66 and 17; 40 percent respectively. Differences in return above variable cost further confirm the viability of the improved management with a 26 and 112 percent advantage to that of IR 61 and IR 36, likewise with a higher return to labor, power and material cost.

In the heavier soils IR 42 gave a yield and fodder advantage of at least 4 and 48 percent more than the same variety under the farmer's management. Comparing the improved practice to farmers local rice variety (DIKET) and IR 48 it showed a grain yield advantage of 42 and 16 percent and with 43 and 44 percent fodder yield advantage, respectively. Return above variable cost showed a 10% more gain by just improving the management of IR 43 and an advantage of 64 and 30 percent compared to DIKET and IR 48, with a corresponding higher return to labor, power and material cost.

Variety trial of early maturing legume crop planted before rice were tested to identify varieties for cropping pattern use. For mungbean, IPB M 79-13-60 and IPB M 79-220117 looks promising with a grain and fodder yield advantage of 181, 136 and 26, 6 percent better than the farmers local variety and Pag-asa 1 which is a recommended variety. Green pod yield for cowpea and bush sitao showed that TVx 133-16-1 and Bush Sitao #6 are the most promising cultivars giving pod and fodder yield of 0.36, 6.90 and 0.65 and 1.92 tons per hectare, respectively.

Levels of nitrogen fertilizer to early maturing rice cultivars showed that the presently recommended rate of 40 kg N/ha is still the most economical level while 30 kg N/ha is most appropriate for the medium maturing cultivars compared to the cropping pattern recommendation of 20 kg N/ha.

Weed control trials using early maturing rice variety in the light soils showed that rotaryweeding followed by selective handweeding 21 days after emergence showed to be the most promising treatment compared to the farmers practice and other treatments with herbicide combinations. In the heavy soils using medium maturing variety IR 48, the use of Butachlor 1.5 kg ai/ha 3 days before transplanting plus handweeding 21 days after transplanting was the most economical treatment compared to the farmers practice. However, the use of herbicide to control grasses and sedges will not be adopted by farmers because of the direct input cost (labor is more abundant at the site). In addition weed free fields will deprive the farmers their source of feed for ruminants which become critical during the rice vegetative growth. Accordingly farmers are willing to use chemical weed control methods for broad leaf weeds only.

Variety trial of different early and medium maturing rice cultivars showed that in the early maturing group IR 60 the variety used in cropping pattern testing outyielded the other entries. However in terms of fodder yield IR 19743-25 yielded 12 percent more compared to IR 60 and it is 7 days earlier. Medium maturing cultivars showed that IR 42 the variety use in the cropping pattern trials and popularly adopted by farmers was significantly outyielded by IR 21820-154 in fodder production but 2% higher in grain production. This promising lines also matures 16 days earlier than IR 42.

The irrigated site in Malanay is about 118 ha where 83% is lowland and 17% upland. About 35% of the area is fully irrigated 29% partially high yielding crops are grown in the irrigated areas. Yield are generally about 3-5 t/ha and farmers use the recommended technology. Upland and partially irrigated areas are planted to rice, peanut, corn, cowpea, string beans, tomatoes, etc. Cattle and buffalo holdings average 1.1/household, or 0.92 A.U./ha stocking rate. Farmer cooperators are also 48 years old average; households have 7 members, 4 of whom work on the farm.

There are 20 livestock cooperators in Malanay with four treatments. These are: (a) 2 animals (1 for draft and 1 for fattening) plus technology intervention with 0.5 - 2 ha farms, (b) 2 animals (1 for draft and 2 for fattening) plus technology intervention with 2.1 - 3.5 ha farmers, (c) control of treatment with 2 animals, and (d) control of treatment with 2 animals. In the control treatment, farm size and animal number are the same and we monitored only the regular practice of the farmer. The technology intervention is the same as in Carosucan.

After 300 days feeding the liveweight gains did not reflect differences due to the intervention and farm size. The daily weight gain of treatment with one animal was 0.20, treatment with 2 animals was 0.21, control with 2 animal was 0.22 and control with 2 animals was 0.23. In the months of Aug., Sept., and Oct. the experimental animals recorded daily average weight gain of 0.35 kg compared to the control which was 0.24 kg. In mid Oct. to mid Dec. the weight gain was the same. Loss in weight was recorded in mid Dec. to mid Feb. The animals gain weight in mid Feb.

March and mid April with only 0.19 for experimental and 0.37 kg for the control. In mid April, we provided the experimental animals with supplemental rice bran for 45 days. The animals responded well with gains of 0.55 compared to 0.12 kg/day for the control. This shows that even minimal supplemental feeding could effect better liveweight. The experimental animals were sold and income ranged from ₱ 1,008 to ₱ 1,950 per head.

Although there is no cropping pattern tested in Malanay, component technology trials such as variety trial, fertilizer rates, ratooning potential of the first rice crop and fitting upland crops between the two rice cropping systems were tested. Except for fertilizer rates and variety trial the rest failed due to uncertain time of releasing water during the first crop which eventually flooded the mungbean crop at flowering stage. Potential of ratooning is hindered because of lodging of the main crop caused by flooding. Fertilizer trials during the dry and wet season showed that 80 and 60 kg N/ha are the most economical level, respectively. Varietal trial of promising rice varieties showed that IR 60 gave the highest yields during the dry, although IR 58 showed the highest fodder yield. During the wet season IR 218150-85-3-2 gave the highest yield.

OTHER CROP-LIVESTOCK RESEARCH SITES

A crop-livestock systems research was started in Thailand in June 1984. It is being implemented under the leadership of the Farming Systems Research Institute, Department of Agriculture in collaboration with the Agricultural Economics Research Division of the Office of Agricultural Economics, Animal Nutrition Division, Department of Livestock Development, and the Khon Kaen University.

Ban (Village) Paw Daeng, Amphur (District) Ban Phai in Khon Kaen was selected as the research site. Typical of Northeast Thailand, the site is a rainfed rolling upland with terraced rice fields bounded by uplands. It is comparatively drier than the rest of the country with less than 2000 mm rainfall. A rice monocrop is typical in the lowland and cassava in the uplands with some kenaf. Buffaloes are kept for draft and native cattle for beef.

Twenty three farmer cooperators were selected as follows: (1) Principally livestock farmers. Even farmers owned at least 6 cows in the beginning and had (1.1 ha) 7 rai of backyard forage; (2) Crop-livestock farmers. Eight farmers owned 2-5 cows and had (0.6 - 0.8 ha) 4-5 rai of backyard forage; (3) Practically crop farmers. Eight farmers owned less than 2 cows with 0.4 ha (2.5 rai) of backyard forage.

Improved cropping pattern testing includes peanut + cassava, cowpea + cassava, corn-rice, rice-cowpea, and rice-fodder crops. Urea treated rice straw is to be tested as an improved feed for cattle. Improved forage grass and Leucaena are also planted in the backyard for feeds.

In Nepal, Pumdi Bhumdi Panchayat (village) in Kaski District, western region was chosen as the crop-livestock research site. It represents the hill or middle mountain agro-ecological zone that in turn accounts for 7% of total cultivated land in Nepal. Elevation is from 750 to 1270 m. above sea level. Annual rainfall is about 4000 mm. with over 900 occurring between mid-April to mid-October. Daily mean temperature ranges from 13°C in December to a high 25°C from June thru August. Hail is a serious problem for farmers in March to June and September to November; damaging ripening wheat, corn, and ripening rice.

The cropping systems research in the village has been expanded to accommodate the crop-livestock systems research. Two groups of farmers were identified: Group I (Control) farmers will be monitored as to their agricultural activities. Group II (Intervention) farmers will be involved in dairying.

The site in South Sumatra is located in Batumarta, a transmigration area. The soil is predominantly marginal (Orthoxis Tropudults) with low pH. Rainfall is high with 6 wet and 2 dry months. The area were opened from Imperata and secondary forest about 10 years ago. The most promising cropping systems after 4 years of research is rice + corn intercrop relay cassava on the corn rows followed by soybean of peanut after harvesting rice then followed by cowpea or rice bean. Terracing was introduced and in the edge of the terrace setaria grass is planted to prevent soil erosion and provide feeds for the livestock. Farmers have 5 ha of land, one hectare block is for home lot and food crops. A two 1 ha block is nearby for food crop production; 1 ha is planted to rubber in a plantation, and another ha is reserve. Farmers were given a head of cattle. Now farmers have more than 1 cattle.

The research team extended their cropping systems research to include livestock. Two villages will be involved one village raising Bali cattle and the other Brahman grade cattle. Their study involves the whole farm. Treatments are: (1) farmers' systems without livestock, (2) farmers' systems with livestock, (3) gradual improvement in farmers' systems (with livestock), and (4) introduced farming systems model (with livestock and poultry).

OTHER COLLABORATIVE RESEARCH

There are other collaborative research which were discussed in the Asian Rice Farming Systems Working Group meetings. During the meeting in Sri Lanka in 1984, we agreed to collaborate on green manuring using Sesbania and dual purpose food crops such as cowpea and mungbean. Nepal, Philippines, Sri Lanka, Bangladesh and Burma will participate. IRRI and national programs agreed to include in the Network activities research on women in rice farming. Research will be implemented in the Philippines, Indonesia, India, Bangladesh, Thailand and Nepal. A design workshop was held on April 10-15, 1985 and participants submitted their research proposals. There are discussions with International Center for Living Aquatic Resource Management (ICLARM) to start a project on rice-fish farming systems in 6 countries (Philippines, Indonesia, Thailand, Bangladesh, India and China).

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