PN-AAS-619 39698

CROPPING SYSTEMS RESEARCH AND DEVELOPMENT IN INDONESIA

Inu G. Ismail and Suryatna Effendi[1/]

Introduction

One of the objectives of the Indonesian government is to become self sufficient in food stuffs, especially rice, and to generate foreign exchange earnings from the export of agricultural commodities.

Indonesia has 5.8 million hectares of wetland rice of which 4.1 million hectares are irriated and 1.7 million hectares are rainfed. In spite of this large area grown to rice, more than one million tons of rice must be imported each year to meet the needs of the increasing population.

The government plans to increase agricultural production by means of three strategies:

- intensification of productivity on present cropland
- expansion of crop production into non-agricultural areas and
- diversificiation toward more productive and economic crops on existing agricultural land.

With respect to rice based cropping systems, there is still much potential for increasing productivity in the existing rice growing areas and for expanding into new areas. For example, approximately 650,000 hectares of wetland rice can be brought into production by improving irrigation and drainage and another 650,000 hectares by converting upland areas to lowland. A further 210,000 hectares can be brought into wetland rice by impoundment and use of natural bodies of water for irrigation. If drainage and flood control measures could be effected it is estimated there are 6.6 million hectares of tidal and swamp land that could be utilized for rice production. Furthermore, Indonesia has vast areas of non producing, or under producing upland areas which, with the proper technologies, could be used for the production of rice as well as other agricultural commodities.

[1/] Assistant and Coordinator of Cropping Systems Program CRIA, Bogor, Indonesia, respectively.

One of the problems for increasing productivity of agricultural land is that the same technology cannot be used for all agroclimatic environments. Technology such as cropping patterns, crop varieties, kind of crops and management practices are environment specific.

Cropping Systems Research

Central Research Institute for Agriculture (CRIA) has been conducting on-farm rice based cropping systems research in several outreach-sites throughout the country covering different environments of upland, swamp, rainfed and irrigated areas. The research is a coordinated and integrated effort to develop technology which is suitable for increasing farm productivity in the different agro-climatic environments. This technology development can be for improving cropping patterns as well as the management practices needed to support the patterns. The ultimate objective is to formulate a package of practices which is both agronomically and economically acceptable to farmers in their particular environment.

The selection of target areas for cropping systems research is very crucial. The Indonesian cropping systems program emphasizes the following criteria for selection of target areas:

1. Critical areas in terms of food shortages and governmental designation.

2. Large areas having similar agro-climatic condition.

3. Feasibility of intensifying cropping patterns based on prior evidence.

4. Availability of markets and infrastructure.

A diagram for cropping systems research and development program in Indonesia (Diagram 1) shows five distinct phases, associated research activities and approximate time frame that follow after selection of the target area.

The next step after the package of technology had been developed is to verify, and if needed, modify the package of practices over a wider area and in new locations having similar environments to the original sites, and to implement these packages of technology in cooperation and coordination with the extension service and other relevant implementing agencies.

Summary of Results of Cropping Systems Research in Selected Target Areas

Crop intensification in partially irrigated areas

The sites representing this category are in Indramayu and Jambahdadi (1975-78) and in Serang (1979/80). The strategy for cropping systems research includes increasing yields for crop as well as the number of crops per year.

In the area with limited rainfall and irrigation water (5-7 months) the risk of growing two crops of transplanted rice is much higher. To increase the productivity of the land and to make the best use of the irrigation water, a system of growing two rice crops per year was introduced. To minimize the risk the first rice could be grown as gogo rancah (direct seeded rice) and then followed by the second rice crop planted by walik jerami (zero tillage transplanted rice). By this system there is still enough moisture left in the soil to grow the third crop of cowpea. The availability of high yielding early maturing rice varieties has made it possible to harvest two good rice crops as shown in Table 1. (Data from Serang was not completed yet by this report).

Constraints to widespread adoption remain unsolved. Additional power (man, animal or machine) is needed to facilitate land preparation and to shorten initial land preparation and turn around time. Certain organizational arrangements of the irrigation management system must be simplified, coordinated and strengthened in order to have a concentrated production program for the irrigation areas. The irrigation water must start and terminate within a unit area in accordance with water demands for the different production practices (land preparation, planting, harvesting) for each crop in the recommended pattern which all farmers will need to follow. Agricultural extension, irrigation and local government officials must work closely together with the farmers in a specific irrigation and agroclimatic unit of manageable size. Credit and material inputs including seeds must be available on time.

Rainfed lowland areas

Two sites of lowland and rainfed rice producing areas were opened on the island of Madura in 1978. The area receives more than 200 mm per month for 3 months and less than 100 mm per month for 5 months of rainfall. The two sites, Jrengek and Kedundung representing the low lying and undulating rainfed lowland rice area, respectively.

In Jrengek Gogorancah (direct seeded) rice produced higher yields and net returns than transplanted rice in farmers or introduced patterns. Introduced patterns, (transplanted rice - corn + peanut); (transplanted

rice - corn + mungbean) and (Gogorancah rice - corn + peanut) produced net returns that were 156, 100 and 85% higher than farmers' pattern of (transplanted rice - corn + peanut).

In the undulating rainfed lowland area of Kedundung, gogorancah rice produced higher yields and net returns compared to those from transplanted rice. Introduced pattern of (gogo rancah rice - corn + peanut) and (transplanted rice - corn + peanut) produced net returns 523 and 213% higher than farmers cropping pattern of (transplanted rice - mungbean). Results from the two sites are presented in Table 2 and 3.

Upland rainfed with red-yellow podzolic soils

The productive capacity of these soils has been seriously questioned by many agricultural scientists. There are constraints to production such as low inherent fertility, low pH and organic matter and susceptibility to erosion. But on the positive side there are several environmental factors which facilitate food crop production in these areas. Rainfall and its distribution are relatively favorable for year-round crop production. Rainfall exceeds 200 mm/month for six months and 100 mm/month for three months. The remaining three months (June, July and August) are drier but only a little less than 100 mm/month. Since the soils are well drained, the heavy rains during the rainy season do not inhibit upland crop production. And even though the soil is acid it does not contain excessive levels of aluminum, since crops planted on these poor soils are highly responsive to fertilizer (especially phosphorus), high yields can be achieved with proper management. Fertilizers and insecticides at amounts comparable to those used on lowland rice fields in Java are absolutely necessary for achieving high crop yields.

The cropping pattern developed for these areas is continuous cropping by using relay intercropping and relay cropping. Five crops per year consisting of upland rice + corn + cassva + peanut - riceban (or cowpea) can be grown in a relay-intercrop arrangement. At the advent of the wet season, corn and upland rice are planted first. The population of corn should not exceed 20,000 plants/ha. The cassava is planted between the corn hills a month later at a population of not more than 5,000 plants/ha. After the corn and rice are harvested, legume crops such as peanuts, soybeans or mungbeans are relay interplanted to the cassava. At the end of the rainy season cowpeas or rice beans (drought tolerant legume crops) are interplanted between the cassava rows that will remain for the rest of the year.

This cropping pattern has shown consistent results over several years of testing in different sites having similar agroclimatic condition (from 1974 up to 1979 Table 4). The total production of this pattern in

terms of calories converted to paddy (unhusked rice) equivalent is comparable to paddy yields from double cropping rice in lowland irrigated fields.

For maintaining stable production, recycling crop residues as mulch is a must to increase soil organic matter, suppress weed growth and reduce surface erosion. For areas with undulating landscape, terracing should be implemented to control erosion.

Tidal swamp areas

One site in South Kalimantan (Barambai) is selected as representative of the tidal swamp areas in 1978/79.

The hydrology of the tidal swamp areas is affected not only by rainfall but also by the tidal action of the sea. This causes almost continous submergence over most of the area. In order to be able to grow upland crops in the paddy fields, the construction of raised beds is necessary. This practice known as sorjan system in Java.

Farmers' present cropping pattern is two crops of corn grown on the raised beds and only one rice crop per year in the furrow beds. The local rice variety usually grown has a long maturity and is photoperiod sensitive. The introduced pattern tested consists of intercropping corn + upland rice + cassava on the raised beds and double cropping rice in the furrow beds. The performance of this pattern is promising. Preliminary testing has shown higher productivity over those from the farmers pattern (Table 5).

Expansion of the Cropping Systems Research Program

The development of new outreach sites had been made possible with the assistance of funds provided by IDRC. The World Bank through the Directorate of Transmigration and cooperation with the BAPPEDA (Regional Bureau of Planning). From the two sites (Indramayu and Lampung) opened in 1975, it increased up to twenty sites in 1980 located in 10 out of the 27 Provinces of Indonesia. Some of these new sites have gone beyond the cropping systems concept to include a "farming systems" approach which includes not only food crops but all farming enterprises which have the potential to maximize the utilization of farmers' resources for profitable gain.

References

Cropping Systems Working Group. 1973-79. Laporan Kemajuan Penelitian, Seri Pola Bertanam (Progress Reports, Cropping Systems) Nos. 4, 5, 6, 7 and 8. Lembaga Pusat Penelitian Pertanian, Bagian Agronomi. Bogor, Indonesia.

Ismail, Inu Gandana. 1978. Cropping Systems Research in Transmigration Areas - Southern Sumatera. (1976-77). Cooperation work between the Directorate General of Transmigration and Central Research Institute for Agriculture. Bogor, Indonesia. 114 p.

Ismail, Inu Gandana and others. 1978. Cropping Sytems Research in Transmigration Areas - Southern Sumatera (1977-78). Cooperation work between the Directorate General of Transmigration and Central Research Institute for Agriculture. Bogor, Indonesia. 112 p.

McIntosh, J.L., Suryatna Effendi and A. Syarifuddin Karama. 1977. Testing Cropping Patterns for Upland Conditions. In: Proceedings, Symposium on Cropping Systems Research and Development for the Asian Rice Farmer, 21-24 September 1976. The International Rice Research Institute, Los Banos, Philippines, pp. 201-220.

McIntosh, J.L. and Suryatna Effendi. 1978. Soil Fertility Implications of Cropping Patterns and Practices for Cassava. In: Proceedings, IDRC Workshop for Intercropping with Cassava. Trivandrum, India, November 27 to December 1, 1978. 29 p.

McIntosh, J.L. 1980. Cropping systems and soil classification for Agrotechnology Development and Transfer. Paper presented at the Agrotechnology Transfer Workshop, Bogor, Indonesia. July 7-12, 1980.

Table 1. Summary of results of cropping systems research in the partially irrigated lowland areas. Indramayu and Central Lampung (Nambahdadi), 1975-78.

Cropping Pattern	Indramayu	Nambahdadi
	--------- yield ton/ha ---------	
Introduced		
Gogo rancah rice -	5.06 (IR-26)	5.60 (IR-36)
Rice (walik jerami) -	5.12 (IR-30)	2.90 (IR-36)
Cowpea	0.62	0.70
Farmers' pattern		
Rice (transplanted) -	2.26 (Pelita 1/1)	3.70
Rice (walik jerami)	3.75 (C4-63)	-*)

*) Farmers planting only one rice crop/year.

Table 2. Yields, gross return, labor cost, material cost, total cost and net return in year-round cropping system studies. Jrengek (lowlying rainfed lowland) Madura 1978-79.

Cropping Pattern	Yield (kg/ha)	Gross return (Rp/ha)	Labor cost (Rp/ha)	Material cost (Rp/ha)	Total cost (Rp/ha)	Net return Rp/ha)
Farmers						
Lowland rice	1,541	146,395	113,300	8,030	121,330	25,065
Peanut +	369	175,275)				
Corn	-	-)	51,150	26,363	77,513	97,762
		321,670	164,450	34,393	198,843	122,827
Introduced						
1. Lowland rice	2,153	204,535	147,400	20,730	168,130	36,405
Corn +	210	22,050)				
Peanut	657	312,075)	46,200	22,315	68,515	265,610
		538,660	193,600	43,045	236,645	302,015
2. Lowland rice	2,153	204,535	147,400	20,700	168,130	36,405
Corn +	410	43,050)				
Mungbean	512	230,400)	46,750	17,807	64,557	208,893
		477,985	194,150	38,537	232,687	245,298
3. Gogo rancah rice	3,387	321,765	174,900	42,480	217,380	104,385
Corn +	271	28,455)				
Peanut	433	205,675)	59,950	47,465	107,415	126,715
		555,895	234,850	89,945	324,795	231,100

Table 3. Yields, gross return, labor costs, material costs, total costs and net return in year round cropping system studies, Kedundung (undulating rainfed lowland), Madura, 1978-79.

Cropping Pattern	Yield (kg/ha)	Gross return (Rp/ha)	Labor cost (Rp/ha)	Material cost (Rp/ha)	Total cost (Rp/ha)	Net return (Rp/ha)
Farmers						
Lowland rice	2,137	203,015	178,750	12,510	191,260	11,755
Mungbean	385	115,500	34,100	8,000	42,100	73,400
		318,515	212,850	20,510	233,360	85,155
Introduced						
1. Lowland rice	2,219	210,805	164,450	20,730	185,180	25,625
Corn +	28	2,660)	90,750	35.780	126,530	22,430
Cowpea	418	146,300)				
		359,765	255,200	56,510	311,710	48,055
2. Gogo rancah rice	2,219	210,805	164,450	20,730	185,180	25,625
Corn +	29	2,755)	107,800	33,080	140,880	240,775
Peanut	842	378,900)				
		592,460	272,250	53,810	326,060	266,400
3. Gogo rancah rice	3,293	312,835	184,250	43,095	227,345	85,490
Corn +	110	10,450)	110,000	53,980	168,980	104,720
Peanut	585	263,250)				
		586,535	294,250	102,075	396,325	190,210

Table 4. Summarized results of cropping pattern testing for upland red yellow podzolic soils (corn + upland rice + cassava + peanut - ricebean).

Locations and years of testing	Dry Grain (kg/ha)				Cassava wet root (ton/ha)	Energy equivalent (Kcal/ha)	Paddy equivalent (ton/ha)
	Corn	Upland rice	Peanut	Rice bean			
Bandarjaya[1/]							
1974/75	1350	2724	567	627	23.2	44,640	18.7
1975/76	2436	3222	763	492	20.1	46,141	19.3
1976/77	2213	1820	490	-	36.8	58,580	24.5
1977/78	2261	2146	584	490	22.7	45,250	18.9
1978/79	2360	2155	586	492	25.1	48,521	20.3
Way Abung[2/]							
1976/77	1169	2553	680	228	22.2	39,341	16.4
1977/78	2553	3688	580	280	19.9	45,646	19.1
1978/79	1417	1965	258	309	10.1		
Baturaja[2/]							
1976/77	1877	746	600	531	16.6	31,053	13.0
1977/78	1626	1076	573	544	14.7	31,053	13.0
1978/79	1900	2300	390	600	17.5		
Lahat-Tebing Tinggi[2/]	2440	2822	551	284	14.9	37,032	15.5
Tulang Bawang[2/]							
1978/79	1555	2026	650	430	18.9	37,744	15.8

[1/] Long term experimental plot.

[2/] On farm testing.

Table 5. Yield performance of crops in the cropping systems studies in tidal swamp areas. Barambai, South Kalimantan, 1978-79.

Cropping Pattern	Crops	Yield (kg/ha)
Farmers pattern:		
Furrow beds :	Lowland rice (Local)	1888
Raised beds :	Corn -	6000[1/]
	Corn	7500[1/]
Introduced pattern (with medium input)		
Furrow beds :	Lowland rice (IR-36)-	1969
	Lowland rice (Local)	1473
Raised beds[2/] :	Upland rice +	442
	Corn +	432
	Cassava	3840[3/]
Introduced pattern (with high input)		
Furrow beds :	Lowland rice (IR-36) -	1797
	Lowland rice (Local)	1933
Raised beds[2/] :	Upland rice +	455
	Corn +	428
	Cassava	3908[3/]

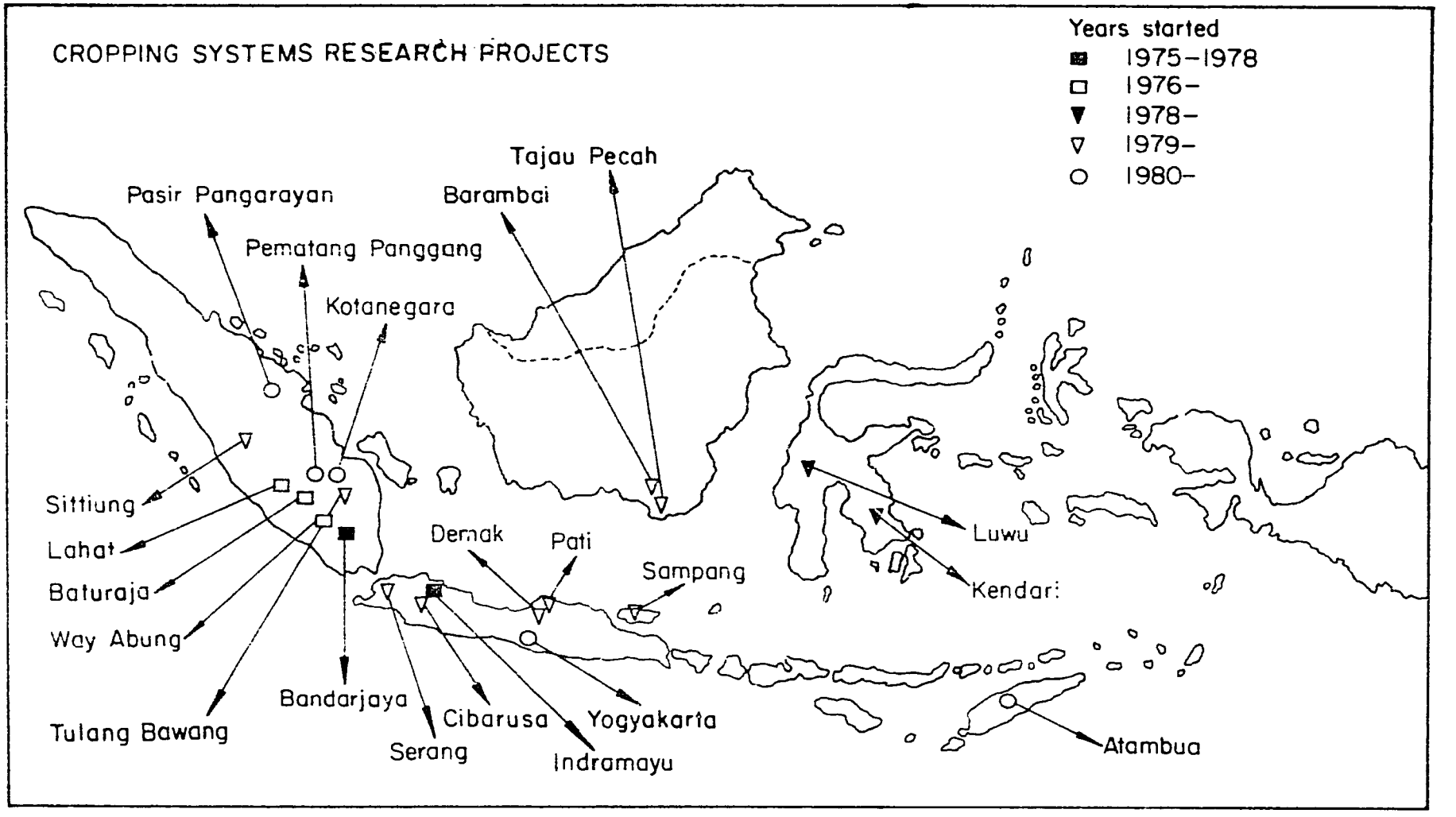
[1/] Number of marketable ears.
[2/] Effective area only 30%.
[3/] Wet root.

Diagram I. Cropping systems research and development for selected target areas. CRIA, Bogor, Indonesia, July, 19

Components	Phase I	Phase II	Phase III[1/]	Phase IV	Phase V
Activity	- Site selection and description	Biological feasibility and evaluation	Design and testing of cropping patterns	Pre-production testing	Implementation
	I. Physical A. Soil Taxonomy B. Rainfall distribution C. Irrigation D. Other climatic data	I. Sequential testing on small plots A. Varieties B. Fertilizer response C. Crop combinations D. Other component technology	I. Partition of target area A. Water availability B. Soil capability C. Market accessibility	I. Research managed plots on 3-4 ha. A. Increase visibility and demonstrate potential	I. BIMAS type program for cropping patterns not commodities
	II. Economic A. Agro-economic profile	II. Economic-farm recording A. Income B. Labor C. Market price	II. Pattern design A. Farmers' - monitor only B. Farmers' - optimum mgt. C. ICP - low input D. ICP - optimum mgt.	II. Desa level A. Identify biological and institutional constraints to large scale production	
		III. Problem focused surveys	III. Testing - 1000 m^2 plots[2/]		
Methodology	- Data collection and survey	Secondary data and small plots	Agro-economic evaluation in farmers' fields	Field level evaluation	Production program
Responsibility	- Research and extension	Research	Research	All relevant agencies	All agencies
Time frame	- Initial	Year 1 - 2	Year 1 - 3	Year 3 - 5	

[1/] In this and succeeding phases all planning must be cooordinated by the BAPPEDA.

[2/] Standardized data collection, data handling, data processing and reporting.


CROPPING SYSTEMS RESEARCH PROJECTS
Years started
1975–1978
1976–
1978–
1979–
1980–
Tajau Pecah
Pasir Pangarayan
Barambai
Pematang Panggang
Kotanegara
Sittiung
Lahat
Baturaja
Way Abung
Tulang Bawang
Bandarjaya
Serang
Cibarusa
Indramayu
Demak
Pati
Sampang
Yogyakarta
Luwu
Kendari
Atambua