INDONESIAN CROPPING SYS. WORKING GROUP
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INDONESIA

Network Methodology and Cropping System Research in Indonesia

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Cropping Systems Working Group
Central Research Institute for Agriculture
Jl. Merdeka 99, Bogor, Indonesia
July, 1979

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Indonesian Cropping Systems Working Group Meeting
July 20-21, 1979
Bogor

Friday	Program		Presiding
0800 - 0810	Opening	Dr. Surjatna E.	Dr. Surjatna E.
0810 - 0820		Dr. Rusli Hakim	"
0820 - 0830	C.S. Research and development for selected target areas	Dr. Surjatna E. Dr. J.L. McIntosh	"
0830 - 0845	C.S. Research Program, Madura	Ir. Suwasik	"
0845 - 0900	C.S. Research Program, Kalimantan Selatan	Tairan	"
0900 - 0915	C.S. Research Program, Padang	Dr. Syarifuddin	"
0915 - 0945	Discussion		
0945 - 1000	B r e a k		
1000 - 1045	Physical Description: Soil taxonomy Rainfall-Irrigation	Dr. Sudjadi	
1045 - 1130	Discussion	Dr. Sudjadi	
1130 - 1400	L u n c h		
1400 - 1445	Economics: Agro-Econ. Profile Baseline Survey Farm Record	Dr. R. Bernsten	Dr. Hans Anwarhan
1445 - 1500	B r e a k		
1500 - 1530	Data handling	Dr. J.L. McIntosh Dr. R. Bernsten	"
1530 - 1600	Discussion	Dr. R. Bernsten	"
Saturday			
0800 - 0815	C.S. Research Program, Sukamandi	Ir. Aja	Ir. Suharyadi
0815 - 0830	C.S. Research Program, Sumatera Selatan	Drs. W.Sabe A.	"
0830 - 0900	Discussion		
0900 - 0945	Methodology: Partition of Target Area	Dr. J.L. McIntosh	"
0945 - 1000	B r e a k		

1000 - 1045	Design, Testing of Cropping Pattern	Dr. Surjatna E.	
	Component Technology	Dr. Surjatna E.	
1045 - 1145	Discussion		
1145 - 1230	Pest Management	Dr. Suhardjan	
1230 - 1330	L u n c h		
1330 - 1400	Discussion		
1400 - 1445	C.S. Research Program, Makaleo	Dr. James Hoopper	Dr. Surjatna E.
1445 - 1500	B r e a k		
1500 - 1600	Discussion		

List of Participants

INDONESIAN CROPPING SYSTEM WORKING GROUP MEETING

July 20-21, 1979

No.	N A M E	A D D R E S S	
1.	Drs. Wayan Sabe	Baturaja, Sumsel	Site Coordinator
2.	Ir. Adjah M. Cholish	Sukamandi, Jabar	C. Systems Agronomy
3.	Suprapto B.Sc	Jakenan, Jateng	Station Manager
4.	Ir. Heriyanto	Madura, Jatim	Economics
5.	Ir. Suwasik	" "	C. Systems Agronomy
6.	Rumansyah I. B.Sc	Banjarmasin, Kalsel	Economics
7.	Tairan Sarimin B.Sc	" "	C. Systems Agronomy
8.	Dr. H. Anwarhan	" "	Coordinator, S.Kalimantan
9.	Soebowo	Way Abung, Lampung	Acting Site Coordinator
10.	Dr. James Hoopper	Maros, Sulsel	C. Systems Agronomy
11.	Dr. A. Syarifuddin	Padang, Sumbar	Head, LP3 Padang
12.	Ir. Suharyadi	LP3, Bogor, Jabar	Economics
13.	Ir. Adimesra Djulin	" " "	"
14.	Ir. Johari Sasa	Tulang Bawang, Lampung	Site Coordinator
15.	Dr. M. Suharjan	LP3, Bogor, Jabar	Head, Pest & Disease
16.	Dr. Sudjadi	LPT, Bogor, Jabar	Head, Soil Chemistry
17.	Drs. Fatchurochim M.Sc	LP3, Bogor, Jabar	Physiology
18.	Ir. I. Prasadja	" " "	Entomology
19.	Drs. Rasyid Mardjuki	" " "	Breeding
20.	Ir. Iskandar	" " "	Agronomy
21.	Wargiono Hadi B.Sc	" " "	"
22.	Ir. Aman Djauhari	" " "	Economics
23.	Wayan Sudana B.Sc	" " "	"
24.	Ir. Soeharsono	" " "	C. Systems Agronomy

No.	N A M E	A D D R E S S	
25.	Dr. Suryatna Effendi	LP3, Bogor, Jabar	Coordinator, C. Systems
26.	Dr. J.L. McIntosh	CRIA/IRRI, Bogor, Jabar	C. Systems Agronomy
27.	Ir. Imtiaz B.	LP3, Bogor, Jabar	" " "
28.	Soegiyanto	" " "	" " "
29.	Inu Gandana Ismail B.Sc	" " "	" " "
30.	Ir. Endang Suhartati	" " "	" " "
31.	Ir. Markarmah Badruddin	" " "	Ag. Engineering
32.	Ir. Trip Alamsyah	" " "	" "
33.	Drs. Tantono Subagyo	" " "	Agronomy
34.	Ir. Sukamto	" " "	Research Dissemination and Training
35.	Sadikin Somaatmadja M.Sc.	" " "	Legume Breeding
36.	Dr. Rusli Hakim	" " "	Director
37.	Ir. Paransih Isbagio	" " "	Secretariat
38.	Ir. M. Supartini	LPT, Bogor, Jabar	Soil Fertility
39	Ir. Sri Adiningsih	" " "	" "
	Subagio M.Sc	" " "	Soil Survey
41.	Ir. Soleh Sukmana	" " "	Soil Conservation
42.	Dr. R. Bernsten	CRIA/IRRI, Bogor, Jabar	Economics

Network Methodology and Cropping Systems Research in South and Southeast Asia[1]

Jerry L. McIntosh and Surjatna Effendi[2]

Cropping Systems in South and Southeast Asia

Organized efforts to study Multiple Cropping and Cropping Systems in this region were begun in 1965 at IRRI (Bradfield, R). This research was patterned to a large degree after the intensive systems used by farmers in Taiwan (Cheng, C.P.). Much of the early work at IRRI developed around intensive Multiple Cropping Systems under ideal conditions. Drainage and irrigation systems provided good water control. Land preparation and other management operations were mechanized as much as possible. Soil fertility and pest management practices were maintained at high levels to eliminate them as constraints.

The main value of this research was to focus attention on the need for research based on systems rather than crop commoditions. The high levels of total production and the

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[1]Material presented at Cropping Systems Working Group meeting, Indonesian National program. Bogor, Indonesia. July 20-21, 1979.

[2]Cropping Systems Agronomists, Cooperative CRIA-IRRI Program and the Central Research Institute for Agriculture, respectively.

visual demonstration to IRRI visitors created the right environment for accelerated research activity and support. Training was begun in 1969 for junior scientist from the Philippines and other South and Southeast Asian countries. Interest developed in varying degrees for the development of national programs.

National programs

The first trainees at IRRI in 1969 were from the Philippines. The second group the following year included scientists from several countries. Sufficient interest was created among the trainees to cause them to start research in their countries. Initially much of this research was patterned after their IRRI experiences. But it was soon realized that the national needs were different and that there existed within each country cropping systems that were equally as fascinating and productive as those under study at IRRI. These indigenous systems needed study within the context of the local agro-economic environment. There developed a keen awareness of the ingenuity of farmers in developing cropping patternsand systems to fit their needs. In many instances introduced technology was not appropriate even under experiment station conditions. It became evident that in-depth research was needed to understand the biological basis for the farmers' pattern while research in the farmer's field was needed for agro-economic evaluation. Many of the country programs were not able to effectively do this because

of commodity orientation in the research institutes. In this respect IRRI served a very valuable role by expanding their program to include studies of farmers' cropping patterns commonly used in Southeast Asia and by conducting research outside the research stations in the Philippines (Harwood and Price, 1976).

The Indonesian program will be used as an example in this paper for cropping systems research and methodology in upland and irrigated areas. The IRRI program in the Philippines will be used as an example for the rainfed lowland rice producing areas.

South and Southeast Asian Cropping Systems Network

By 1973 National Multiple Cropping Programs existed in the Philippines, Indonesia and Sri Lanka. The Sri Lankan program had developed to the extent that they were able and willing to accept trainees from other countries. Indonesia sent 16 Extension Specialists to Sri Lanka for training in their program that year.

Indonesia selected two target areas for intensive reserch in 1973. One site was located in Indramayu, West Java and the other in Bandarjaya, Central Lampung. The objective was to identify and remove constraints to more intensive cropping patterns under farmer's condition in these two areas. Poor water control and heavy clay soils characterized the Indramayu location. While low soil fertility and pH and infestation of the land with Imperata cylindrica characterized the Lampung location.

In 1974 IRRI received funding to expand its Multiple Cropping Program. The on-site research in Batangas Province had begun to show the value of site specific research in farmers' fields. Funds were also received to support the National programs in South and Southeast Asia through a Cropping Systems Network. Each national program was represented in the Network by its Program Leader and IRRI provided a Network Coordinator.

Working Group Meetings. Since 1975 the program leaders within the network have met once or twice a year to review each countries' research, develop methodology, and discuss network activities. The locations and major topics for discussion for each meeting are given in Table 1. These meetings have been most beneficial. Each participant was an active and voluntary contributor to the conceptual framework for cropping systems methodology that evolved from the meetings (Table 2). This gradual development enabled each program to adapt the methodology to meet its needs but still follow the basic concepts. Participants from other countries were able to see first hand the problems and possibilities that existed in the host countries.

Plant material introduction. The availability of seed of new varieties and lines of food crops suitable for new cropping patterns was a major constraint to the cropping systems program. This was particularly true for crops other than rice. The Cropping Systems Network Coordinator at IRRI,

Dr. V.R. Carangal, took the leadership in collecting, screening and sending to the country programs new promising materials. The University of the Philippines at Los Banos received special funding to evaluate new material in mono culture and intercrop combinations common to the countties in the Network This kind of cooperation and interaction among the research institutes within the Network has been most useful. IRRI as a rice research institute can provide the nucleus for rice varietal improvement and agronomy. But cropping intensification which is a basic tool for Cropping Systems may include other crops. The testing, identification and distribution of seed materials becomes very important. Table 3 shows the magnitude of this program for 1976-77.

Study tours. The Cropping Systems Working Group meetings provide a limited opportunity for National Program leaders to view the research efforts of their colleagues in neighboring countries. Study tours for site coordinators and other field staff were begun in an effort to familiarize these field scientists with activities in other countries. A typical study group might consist of 6 - 10 persons and come from three different countries. The tour would last about 3 weeks and would visit three other countries within the Working Group.

Short term training. This aspect of the Working Group has probably been IRRI'smost significant contribution. Each year IRRI offers a 4 - 6 months training course for Cropping Systems. This is a highly organized and structured program

which has enabled many of the country programs to quickly develop their staff. The environment and nature of the training has served to stimulate the trainees and develop an "esprit de corps". The common training has done much to establish uniformity in research methodology within the network within stifling initiative.

In addition IRRI scientists have encouraged selected staff from the country programs to participate in on-the-job training for periods of a few weeks to six months. This has permitted specialized training for site coordinators, economists and entomologists within the Cropping Systems programs. Table 4 shows the kinds of training and numbers of trainees from each of the country programs.

Degree training. The cooperation between IRRI and the University of the Philippines at Los Banos has been very beneficial to the Working Group. Table 4 shows the numbers of IRRI scholars in degree programs for Cropping Systems.

Collaborative research. The evaluation of plant materials introduced through the Working Group is a kind of collaborative varietal testing program. Yields and performances of the materials are evaluated in the cooperating countries.

As the methodology and technical expertise develops the feasibility of evaluating not only varieties but also cropping patterns within the Network increases. The success of this research depends upon thorough site description and monitoring of research in the field. Under these conditions research

results can be evaluated over much wider areas and even among countries. New technology and cropping patterns can be more readily transferred.

Research dissemination. The Working Group members have actively shared research results through meetings, workshops and publications. Again the Network coordinator at IRRI has played an important role in pressing for publication and distribution of the data. His office has served as a clearing house not only for Network publications but also for those originating at IRRI and from other sources.

INDONESIAN CROPPING SYSTEMS PROGRAM[1]

Objectives

In a developing country it is difficult for farmers to gradually adopt new technology as it is made available by research scientists. This is why production programs are so common in these countries even for introduction of single component technology like new varieties, insecticides and fertilizer recommendations. But introduction of new cropping patterns may take much longer and be infinitely more complex. This is especially true in irrigated areas where farmers cannot easily modify their cropping patterns without conflicting with their neighbors. For example, in fully irrigated areas we are sure from our Cropping Systems research that farmers could grow two crops of IR36 rice and a soybean crop in one year. To do this the first rice crop must be transplanted as soon as the water arrives or direct seeded before the arrival of the irrigation water. If one farmer plants early or uses an early maturing variety of rice, while his neighbors follow their traditional practices, his rice will almost certainly be destroyed by rats or birds. Later if he tries to plant soybeans after two crops of an early maturing variety of rice his crop would likely be destroyed by flooding. His neighbors would still be growing their second crop of lowland rice. In

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[1] Prepared for the Cropping Systems Working Group meeting, Indonesian National Program by J.L. McIntosh, Bogor, Indonesia. July 20-21, 1979.

this situation even research is difficult to conduct. Consequently, insufficient research and difficulties in implementation impede cropping intensification.

Other examples of under use of lands are numerous. In Indonesia the vast areas of tidal swamps and upland-rainfed lands in Sumatra and Kalimantan have considerable potential for crop production. But now they are mostly covered by forests or Imperata cylindrica. In some places new settlements have been started through the transmigration programs. Considerable research is needed to develop appropriate cropping patterns that are agronomically and economically sound for these areas. The research must be integrated to include all components of the production system and at the same time provide for extension and marketing problems that arise with implementation.

The land use in Indonesia may be intensified and the area of production extended. The easy research problems for crop commodities and related fields have received considerable attention. Now our research must be directed to solve the problems that farmers face in their fields and integrated to include the scope of secondary problems that arise.

The overall objectives of the Cropping Systems Research program may be summarized as follows:

I. To increase food production by increasing total area in crops production per hectare.

A. Development of viable cropping systems for new lands.

B. More intensive use of present cropland including interplanting of food crops in estate crops such as rubber, oil palm, coconut, sugar, etc.

C. Amending and maintaining soil fertility.

II. To increase employment opportunity by increasing the opportunity for labor.

A. "Spreading out" time for planting and harvest.

B. Expansion of total area in production.

C. Concomitant increase in agri business.

III. To improve the small farmers' bargaining position by increasing the frequency of harvests and minimizing the need to borrow (which may include items other than money).

IV. To facilitate institutional interaction and implementation of research findings.

Selection of Target Area

The objectives of cropping systems research cannot be met if the research is not implemented. The research must fit within the framework of the Government and meet policy and developmental needs. If this is not the case implementation will be difficult. Consequently, target areas for research must be carefully selected. Criteria have been developed as guidelines for selecting target areas for cropping systems research. The order of priority of the following will depend upon the extent of Government participation in food production activities.

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

II. Large areas having similar soils and climate.

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

IV. Availability of markets and infrastructure.

These criteria are simple and straight forward. There are many sources of information that may be useful to administrators and scientists in making decisions to concentrate a research program within a selected target area. The availability of information varies from region to region within Indonesia and from country to country. The outline contained in Appendix I has been helpful in gathering and making use of available information in Indonesia. This outline is not intended to replace institutional land use planning activities but to help Cropping Systems Agronomists make use of information that is usually readily available.

Cropping Systems Research and Development
Selected Target Areas

The objectives of cropping systems research may appear overly idealistic and unattainable. However, the Indonesian Cropping Systems program has gradually evolved a systematic plan of work for this kind of research in selected target areas. The interaction within the South and Southeast Asian Cropping Systems Network has been invaluable in this achievement. The systematic program outlined in Diagram I is based on experience

rather than speculation within the Indonesian context. Other countries may not need to carry out all of the phases indicated and some may need more. Diagram II shows how the Cropping Systems program fits into the CRIA system in Bogor. The program consists of a coordinated working group of scientists from the various disciplines involved in the program. The core staff emantes from the Multiple Cropping Section of the Agronomy Division. Diagram III shows the research sites presently under study and those that have recently been conpleted and those soon to be started.

Site selection and description

These activities are carried out as soon as possible after the target area has been selected. Most of the data can be collected from secondary sources. The survey and data collection teams should be interdisciplinary groups of scientists and extension workers.

Site selection. The Cropping Systems scientist cannot tackle all the conditions and problems that exist in a target area. A brief survey and collection of secondary data from the local government will usually provide sufficient information to enable the research coordination to decide which of the edaphological conditions he wishes to study. Further analysis of the data will permit confirmation or rejection of a certain location as a possible research site. The Research Coordinator must first stress what he hopes to accomplish in the research. Then a logical sequence of steps can be taken to insure that

the right kabupatens, kecamatans, desas and farmers are chosen. Appendix II gives an example of how this may be done.

Site description. Initially secondary data can be collected to provide the physical and economic information needed for site selection. We may need more refined data for research purposes but most of all for transfer of technology to other places having similar agro-economic conditions. The following list of physical and economic factors (determinants) may be broken down in more detail as needed. But we have found there are many problems associated with collecting more data that needed.

A. Physical description

1. Soil Taxonomy - This classification to the family level along with the usual analysis for soil fertility adequately describes the soil properties associated with plant growth in the edaphological conditions explained earlier are taken into account.
2. Rainfall distribution - Monthly rainfall data collected over many years is available for most locations. We need to collect new data for the specific sites chosen. The long term data should be used not only for the average rainfall distribution but also analyzed for possible changes in the patterns and probabilities for starting and ending of the rainy season.
3. Irrigation - Length of time water is available and when it starts and ends.

4. Other climatic data - Solar radiation and temperature data should be collected if not readily available nearby.
5. Location and elevation.

B. Economic description

1. Agro-economic profile - Details for this activity will be further described in Appendix III. We prefer this term rather than base line survey, simply because it describes more accurately what is needed.

Biological feasibility and evaluation

These activities should be started as soon as possible after selection of the target area and research sites and continued as long as needed. Most of the agronomic studies can be conducted in small plots (3 x 5 m^2) by the site coordinator and his assistants. Usually the team in each site consists of a team leader (Agronomist), an assistant coordinator and six field assistants. The assistant coordinator should be selected on the basis of need for a particular expertise in the site. But if this is not possible back-up expertise can be made available from the headquarters. The field assistants should be evenly divided according to biologic and economic research activities.

Sequential testing. These small plot studies should be made at the time of the year and in the sequence they would fit into the cropping patterns to be tested.

1. Varieties - Many times adapted plant materials are not available for new target areas. The Cropping Systems program should not become a breeding program but some testing of new and introduced plant materials is appropriate.
2. Fertilizer response - Response curves for the macro nutrient elements are needed to determine the agronomic and economic thresholds. These should be uniformly carried out so that soil and climatic factors across the country (or region) may be better understood in relation to crop production. The FAO Methodology (Appendix IV) for their regional soil fertility trials is one example that may be used.
3. Crop combinations - Differnt intercrop combinations that are relevant must be evaluated just as for variety trials. Detailed studies concerning light, competition for nutrients, spacing and economics may be more efficiently studied by scientists in the experiment stations.
4. Other component technology - Guides for pest and disease management must be developed. Studies at IRRI by Litsinger show one way this may be done for entomology.

Economic farm recording. Monitoring of the farmer cooperators and surrounding farm families must be started as early as possible. The data collection must be specific, the analyses quick and the information used in design and testing of cropping patterns.

1. Income - For research purposes we need to know the amount and distribution of the farmers' income and the extent to which government intervention is needed for implementation of research results.
2. Labor - The distribution of labor and the amount required for different patterns must be determined.
3. Market prices - The selling and buying prices at the farmers' market level is needed on a weekly basis.

Problem focused survey. Rather than try to collect all data in one large survey it is better to focus on specific issues that may need study.

Design and testing of cropping patterns

Cropping systems research can be complicated and confusing. Scientists must simplify the research approach as much as possible. This can be done by avoiding complex statistical designs that require sophisticated methods of data analysis. The methodology described (use of examples) shows how this can be done but still take into account ecological and socio-economic factors that affect cropping patterns farmers use.

Partition of target area. Even though a target area may fall within a single agro-climatic zone and edaphological class there may be some variations which determine cropping patterns.

1. Water availability - For lowland rice the length of time the soil can be flooded determines when and how many crops can be planted in one year. The classifications such as technical, semi-technical and simple irrigation mean very little to cropping systems research. One target area in Indonesia is located in Indramayu, West Java. The area is characterized by relatively level topography, alluvial clay soils, 3-4 wet months with rainfall greater than 200 mm and a long dry season. There are problems with water control - flooding during the rainy season and only partial irrigation during the dry season. The area was partitioned into four catergories based on present conditions that are mostly dependent on water. These conditions would necessitate modifications or completely different cropping patterns. The bases for partition of the area into categories were:

   Category I - Area with 10 months irrigation water from October 1 to August 1 the following year.

   Category II - Area with 7 months irrigation water from October 15 to May 15.

   Category III - Area with 5 months irrigation water from December 15 to May 15.

   Category IV - Rainfed lowland (added later).

2. Soil capability - Another target area selected was an old transmigration scheme in Central Lampung. The area had been given a high priority for development by the government. The soil in the area is classified under the old system as red-yellow podzolic and similar to the soil of about 46 million hectares or approximately one-fourth of the land area of Indonesia (Peta Tanah Bagan Indonesia, 1972). Furthermore, the rainfall, which exceeds 200 mm for 6 months and falls below 100 mm for only 3 months, is sufficient for year around crop production provided crops like cassava and cowpea are grown during the driest period. Unfortunately the soil is low in inherent fertility and that contained in the organic component is soon lost after cultivation. Fertilizer inputs have not been available. As a result this large agro-climatic zone is underdeveloped for agriculture. It is estimated there are about 20 million hectares suitable for agriculture but presently not used. Traditionally, farmers have used shifting cultivation and an extensive type of agriculture to circumvent the soil fertility problem. The transmigration schemes, however, are committed to a stationary agriculture. Farmers in older transmigration settlements have had difficulties in producing enough food to sustain their families. Our job is to develop cropping patterns and soil management practices that will enable the farmers to

produce food for his family and have some surplus to sell. The original bases for partition of the area into categories was as follows:

Category I - Area with 5 months irrigation.
Category II - Land opened from old Imperata fields.
Category III - Newly opened Imperata fields or secondary forests.

The research in Central Lampung in the upland areas is almost completed (see Appendix VI). Most of the research is now being conducted in new transmigration areas on newly opened land from either forested or Imperata covered lands. Much of the land is rolling to hilly and should not be used for food crops production unless soil conservation practices are used. Based on these conditions and our past experience we now propose to use the following criteria for partitioning of the target area.

Category I - Relatively level land on hill tops.
Category II - Sloping land that must be terraced.
Category III - Land from forest.

3. Market accessibility - This must be considered as a dominating factor influencing cropping patterns suitable for an area. In remote areas far from roads and markets food crops are grown mostly for subsistence. This is especially true for crops like cassava which

are difficult to store and transport. On the other hand, near starch factories and good roads, cassava would likely be the most valuable crop.

Pattern design and testing. We will simply introduce the reasoning that we have used to design cropping patterns for testing in our selected target areas. Obviously, the priorities for different countries will depend upon the social and economic conditions that prevail. Furthermore, we assume sufficient research in the various disciplines (component technology) exists to allow the cropping systems personnel to choose from among a reasonably large selection of crops, techniques, and management practices to meet the needs and objectives of the research in the target areas.

1. Selection of crops to be grown - There are some crops that are not suitable for inclusion in a cropping pattern to be tested in an area even though the crop might be suited agronomically. For example, in Indonesia sorghum grows well during the dry season when planted after lowland rice. But it is difficult to market at the present time and farmers will not eat it if they can get rice or corn.

   a. Agronomic adaptation. This is obviously an important consideration in selecting crops to be grown. The most determining factor is rainfall and its distribution. In Indonesia food crops almost always receive the highest priority. Of these rice is the most highly

valued crop and, consequently, is planted if the rainy season is long and sure enough. Corn would follow in terms of value and length of rainy season. Sweet potatoes would be grown as a main food crop under conditions similar to corn in special areas where the agriculture has not developed. Cassava would be the most stable crop in the drier regions or times of the year. Legumes, the kind depending upon the available water, would be grown as catch crops. Some would be retained for food and seed but most sold.

b. Market and market potential. Most farmers grow crops primarily for food for their families. Consequently if they have enough food (rice) they will not likely grow another crop unless the marketing prospects are good. This is true even for rice in Indonesia as a result of government policy to maintain rice prices low. There is a concomitant effect on the prices of all food crops. Crops which can be exported such as cassava and corn and those which can be processed like soybean, mungbean and peanut offer a wider range of market potential.

2. Arrangement of cropping sequences - The average farm size in Indonesia is less than one hectare. In the outer islands the holdings tend to be larger. Formerly transmigrants received two hectares of land. They usually had enough labor to plant one-half hectare to

food crops per year. The rest lay idle or grew-up in alang-alang (Imperata Cylindrica). Under these conditions there are certain things that the farmer intuitively considers. In a like manner we must be able to interject ourselves into his situation in order to design effective and applicable cropping patterns. We have used the following guidelines in designing new cropping patterns for an area.

a. Maximize stability in production. The concept is especially important in newly opened upland areas where the farmer must be self sufficient. Under these circumstances the farmer many times uses complex mixed cropping combinations with crop species ranging from early maturing legumes to cassava. For example, if there is some doubt about the amount of rainfall for rice, then perhaps early maturing corn should be interplanted with drouth tolerant cassava. After harvest of corn, the cassava may be interplanted with mungbean or cowpea to provide a more stable pattern.

b. Minimize labor. The area that a farmer cultivates depends mostly upon the amount of land he has or upon the amount of labor or power he has for land preparation. Usually a farmer with only hand labor can prepare about 0.5 hectare of land for planting at the beginning of the rainy season. Throughout the cropping season weed control may become a constraint. Minimum

tillage, relay planting and continuous crop cover enables the farmers to plant and manage a larger area for crops with the same amount of labor than for cropping patterns using monoculture and sequential plantings.

c. Distribute labor. The labor distribution inherent in multiple cropping systems is a useful attribute. Strip tillage and planting of intercrop combinations at intervals of 2 to 4 weeks enable a farmer to distribute his labor for land preparation for a given piece of land over a longer period of time. The harvesting time will also be spread out. Even under partially irrigated conditions where direct seeding of rice (gogorancah) on moist aerobic soil is practiced, many times farmers interplant with corn. However, if this practice greatly increases the labor requirement, it may not be practical if the farmer has to hire labor.

d. Distribute capital inputs. Credit is difficult to obtain by a farmer. Without government assistance the farmer has difficulty in buying seeds, fertilizer, and insecticides. This is one of the primary reasons farmers grow many kinds of crops in traditional cropping combinations in upland agriculture in remote areas. They plant what they have available. Again, multiple cropping techniques similar to the farmers' may be used to accrue the benefits of the farmers' systems. But the systems may have to be simplified to minimize the

randomness and diversity that prevent the farmer from planting in rows, using specific fertilizers for higher valued crops and planting another crop soon after the previous crop has been harvested.

e. Distribute harvest income. Frequent harvests means the farmers has money more often and, consequently, is more likely to spend it for things he really needs. It minimizes the need for borrowing money for food inputs. Again the stability inherent in multiple cropping techniques is useful in this respect. But there is a fine line between frequency of harvest and marketing efficiency. If the harvest is too small the farmer may not be able to afford to sell the product.

3. Cropping Pattern Design - Research in the experiment stations contributes to the pool of knowledge necessary to improve agricultural production. Various components of cropping patterns can be studied to understand principles of crop production and interaction among plants. The latter may be described as multiple cropping research to contrast it with traditional research in the various crop commodities. The accumulative reservoir of information may be called component technology for cropping systems.

In developed countries where farmers may be well educated and economically strong the accumulated component technology may be sufficient to meet the needs of

the farmer. No further steps by researchers are needed. The farmer is able to adapt the technology to meet his specific needs. In developing countries, however, where farmers may be undereducated and financially weak the governments have initiated production programs to implement the new technology. These are package programs which include technology, credit and availability of inputs. At first these programs, such as Masagana 99 in the Philippines and BIMAS in Indonesia, were for individual crop commodities. Recently, provisions have been made to include cropping systems programs.

Before these programs for crop commodities and cropping systems reach the stage of implementation, they should be preceded by research that approximates conditions at the farmers' levels of management. Production programs are expensive and must be tailored to fit the conditions that actually exist, if they are to be effective in increasing production. The first step entails research in the farmers' fields under the management of researchers to get some idea of crop performance and production potential. If this looks promising further testing over a larger area is justified.

The final evaluation of cropping patterns should be made through multi-locational trials conducted over the target area under farmers' conditions and management but with and without removal of certain constraints

such as credit, seed, fertilizer, pesticides and markets. Consequently, as an intermediate step between the farmers' pattern and an imposed "improved pattern" we can study the farmer's response to the removal of a set of constraints. Rather than imposing a cropping pattern upon the farmer, we determine the kind he will use if the agronomic inputs, credit and markets are provided. This assumes the farmer is not limited in technical know-how (human technology). On the other hand, if the farmer does not respond to the removal of the constraints but continues to use his present cropping pattern and misuses the agronomic inputs, we may conclude that he would not be able to successfully participate in a production program without a greater infusion of technical assistance by extension or, perhaps, simplified technology.

Three different cropping patterns were designed and tested within each category for Indramayu and Lampung beginning in 1975. Each trial was replicated 3 times but by different farmers. The cropping patterns for each category were not necessarily the same but were selected on the basis of the same criterion. The criteria for selection and rationale for each criterion are as follows:

Criterion A - Farmer's present cropping pattern

Rationale : To establish a base line check for comparison

Criterion B - Farmer's choice of cropping pattern if inputs and market constraints were removed.

Rationale : To evaluate the farmer's level of technical competence and managerial skill and perhaps uncover hidden socio-economic constraints.

Criterion C - Our introduced cropping pattern with inputs and market constraints removed and technical assistance provided.

Rationale : To determine production and economic potential and our ability to remove constraints.

A site coordinator, agronomist and economist were stationed in each target area. A field assistant was put in charge of the work in each category and given the additional responsibility to collect all input-output data. A system for collecting daily farm records for all farm buying and selling activities was implemented in cooperation with 36 farmers in each target area to get a larger base for socio-economic evaluation.

The use of these criteria for design of cropping patterns has been very useful. It has allowed us to be objective and kept us from confusing cropping patterns with cropping sequences. We do not get bogged down in evaluating small differnces in results from using different species of legumes or varieties of rice

in crop sequences. These refinements are necessary but are the kinds of research that are never finished. We have, however, been made aware of the severe economic stresses faced by most Indonesian farmers. They simply do not have much money they can use for inputs. If they do they are afraid to use it. This is particularly true for farmers who have seldom worked with the extension service. We feel we must develop low input patterns for new adopters. If the new technology is good and shows evidence of being profitable they will soon learn how to use more inputs. We now use the following criteria for design of cropping patterns.

Criterion A -- Farmer's present cropping pattern (monitor only).

Rationale : To establish a base line check for comparison.

Criterion B - Farmer's cropping pattern with inputs and optimum management.

Rationale : To evaluate the farmer's pattern without input and managerial constraints.

Criterion C - Our introduced pattern with low inputs.

Rationale : To induce the farmer to gradually try the new technology.

Criterion D - Our introduced cropping pattern with input and market constraints removed and technical assistance provided.

Rationale : To determine production and economic potential.

Pre-production testing and implementation

The Cropping System research is problem oriented. Target areas are selected for in depth research. For each target area the activities include identification and quantification of problems or possibilities, evaluation of new technology in the field, pre-production testing (pre BIMAS testing) and transfer of technology to new target areas.

At each step the Extension Service is involved. Usually the research phase lasts for three years and the involvement of the Extension Service and other provincial Services increase each year. In this way the interface between CRIA and Extension is increased and the involvement of the provincial planning Agency (BAPPEDA) facilitated. CRIA's targeted inputs ends with the implementation phase. But of course the routine support continues. Significant results and implications from the research may be summarized as follows:

Indramayu - representative of the irrigated and partially irrigated lowland rice producing areas of Java (including smaller areas of the outer islands).

Presently, there are about 3.94 million hectares of irrigated rice land in Indonesia (Table 5). Generally, two crops of rice per year are planted on this land. From our research in Indramayu it has been shown that except for years with a long wet season the yield of the second rice crop is reduced because of insufficient water in the partially irrigated areas with less than 9 months or irrigation water. This has been

particularly true if the rice varieties used needed more than 120 days to mature. This is illustrated quite well in Tables 6 and 7 and Figures 1 and 2 taken from the 1975-76 data. The second crops of rice in the Farmer's Cropping Patterns (IIA and IIB and IIIA and IIIB) suffered because of termination of irrigation water and lack of rain during the dry months of May, June and July. The second rice crops in the Introduced Cropping Patterns (IIC and IIIC) succeeded. These data show the potential for two good rice crop yields and a legume crop in one year. For these irrigated areas totaling more than 3.94 million hectares enough rice could be produced to meet most of the Indonesian need. Preliminary research results for 1977-78 showed that IR36 produced average yields of 6.8 tons/ha and 5.7 tons/ha within 240 days for the first and second rice crops, respectively. Furthermore, there was sufficient time and water for a soybean crop after either one or two rice crops. Taking into account losses from insects and diseases and the amount of land that is presently double cropped the average yield of rice should exceed 4 tons/ha for 6.6 million hectares of land. This would result in a total rice production of 26.4 million tons of gabah or 17.55 tons of beras. Based on a per capita consumption of 120 kg this is enough rice for 145 million people. The average yield of soybean should be at least 0.7 ton/ha for 3.94 million hectares of land to give a total production of 2.76 million tons. Based on a minimum daily requirement of 55 gm per day this yield of soybean (35% protein) would provide enough protein for approximately 48.1 million people for one year and could supply 0.50 million tons of edible oil. The present cooking

oil shortage could be alleviated and there would be sufficient protein to supplement the starch produced from cassava in the outer islands and Java. These kinds of data and calculations raise two very important questions. First of all, are the basic assumptions true? Secondly, if the assumptions are true, why have the present production programs not produced the same results?

The best data available for land area in irrigation by categories, such as shown in Table 5, indicate that there are approximately 4 million hectares of irrigated land in Indonesia. The exact breakdown of water availability by months is not available. But from our research in Indramayu and other places, we believe that the technology is available to grow two rice crops per year. Furthermore, we believe that in these irrigated and partially irrigated areas where considerable water control exists (for irrigation and drainage) a legume crop such as soybean (preferably soybean) could be grown after two crops of rice.

The second question is more difficult to answer. Until 1977 we did not have a high yielding early maturing rice variety like IR36. Pelita which is a vigorous high yielding variety with high quality takes about 140 days to mature. Consequently, many times the second crop has yielded only about one fourth of that of the first crop because of water stress during the flowering stage. This helps explain the fact that the average yield per hectare for all of Indonesian is about half the potential yield. The rate of failure of the

second crop in the non irrigated and rainfed areas is, of course, much higher. The availability of additional power to facilitate land preparation (to minimize the drudgery associated with rapid and timely land preparation, only) and turn around time must be given some consideration. Presently, there appears to be no need for additional power for planting, weeding and harvesting, but we feel additional power for land preparation is needed and will in the long run increase the need for an acceptable form of labor (for example, harvesting by women, older men and children) for those who need it most by making it easier to grow extra crops.

There are other factors involved which are much more difficult to solve than fitting rice varieties to water availability and providing new sources of power. In order to have a concentrated production program for the irrigated areas certain organizational arrangements must be simplified and strengthened. The irrigation water must start and terminate within a unit area in step with the land preparation, planting and harvesting operations for the crop sequence agreed upon. Agricultural extension, irrigation and local government officials must work closely together with the farmers in a specific irrigation and agro climatic unit of a manageable size. Credit and material inputs (including seed) must be available on time. These conditions are not new and the present BIMAS program covers many of the same points. But new technology and effective leadership within a production complex must be combined with guaranteed markets in order to implement such a program.

Central Lampung - representative of the rainfed upland areas with red-yellow podzolic soils infested with alang-alang and the partially irrigated soils of the same origin.

The productive capacity of these soils has been seriously questioned by many agricultural scientists. In fact they have been described as alang-alang infested waste lands. There are constraints to production such as low inherent soil fertility, excessive drainage and low pH. But on the positive side there are several assets. The rainfall and distribution are very good for year around crop production. Rainfall exceeds 200 mm for 6 months and 100 mm for 3 months. The remaining 3 months are drier but the average rainfall in only a little less than 100 mm. Since the soils are well drained, the heavy rains during the rainy season do not inhibit upland crops production. Run-off problems are minimized by the rapid infiltration of rain water. Consequently, the soils are leached and acid. But fortunately the soils do not contain excessive levels of aluminum. There is sufficient clay and organic matter to hold applied nutrients but fixation of phosphorus is not a problem. Insect problems (seedling maggots etc.) usually associated with upland crops can be eliminated with systemic insecticides. Consequently, these soils can be highly productive if managed properly. Fertilizer and insecticides are absolutely necessary but in amounts comparable to those used on rice on Java on some of the best agricultural land in the world.

Research has been conducted for 4 years in these areas. During this time there have been years with virtually no dry season and years in which there was practically no rain in May, June and July. In a sequence of ULR + C / Cv / PNT - RB we have had no trouble growing upland rice plus corn intercropped with cassava. The peanuts interplanted in the cassava grew well even in the driest years but sometimes were severely damaged by pod borers. There was difficulty in establishing a stand of cowpea or ricebean after the peanuts. The results for five different locations are shown in Table 8-12. These tables show the total yields in terms of calories and protein produced on a hectare basis and net returns. The bottom line in each table gives the yields in terms of gabah rice equivalent.

Table 8 shows the response to fertilizer on land that had been opened and cultivated for the past 22 years. There appears to have been no irreversible damage from cropping at a low level of management. It is remarkable that the yield results from all locations (Tables 8-12) are comparable if some consideration is given to yield differences due to disease and insect problems. For example, the yield of rice from Baturaja (Table 12) was low because of late planting and blast disease.

From these results and our field observations we feel that sustained crop production on these soils is feasible. Judicious use of fertilizers and crop sequences including legumes and rice can actually increase the fertility of these soils.

The crop arrangements and relative proportions of individual crops within a cropping pattern should depend upon available markets and the farmers preference. For example, in the Bandarjaya area of Central Lampung there are several starch factories. The proportion of cassava in cropping patterns within this area should be higher than in areas farther away. But it is also important to note the highly profitable nature of cassava in the patterns (Tables 9-12). This was due to the low cost of production as well as to the high productivity of cassava. Rice also can be very profitable. But at present we still have problems with rice blast. The loss in Baturaja for the corn + upland rice combination was due to low yield of rice caused by blast.

Limited power and markets are presently the major constraints to agricultural development in these areas. Animals seem to be the most logical power source for several reasons. They not only provide power for more land cultivation but also provide a means of utilizing the land in a productive but conservative manner. A forage grass - legume mixture for pasture would provide a balanced animal diet, protect the soil and ultimately provide the manure needed for the land to be used for food crop production. Also, animals offer an alternative to the traditional dependence upon food crops as the principle source of food and income. They represent a higher valued form of agricultural production and hopefully promote a higher standard of living.

Table 1. Cropping systems working group meeting/workshop/symposium records.

No. of meeting	Institute/organization & country sponsored	No. of Participants	No. of Observer	Copies of proceedings printed	Copies of proceedings circulated	Major discussion topics
1. First Working Group together with Workshop of Cropping Systems March 18-22, 1975	IRRI	55	27	500	490	- National Multiple Cropping conditions, research and prospect. - National multiple cropping program. - Experiences with intensive cropping systems - Network need and program.
2. Second Working Group: Indonesia Nov. 3-8, 1975	CRIA, Dept. of Agr., Indonesia/ IRRI	18	-	300	295	- Cropping Systems research methodologies - Economic research methodology - Varietal testing - Training method and needs - Plans for symposium & meeting
3. Third working group, Thailand	Dept. of Agric. Thailand/IRRI	24	12	300	295	- Design and testing cropping system - Economic analysis of cropping system - Cropping Systems Information delivery system - Weed control research methodology - Varietal testing - Approach to production - Plan for symposium

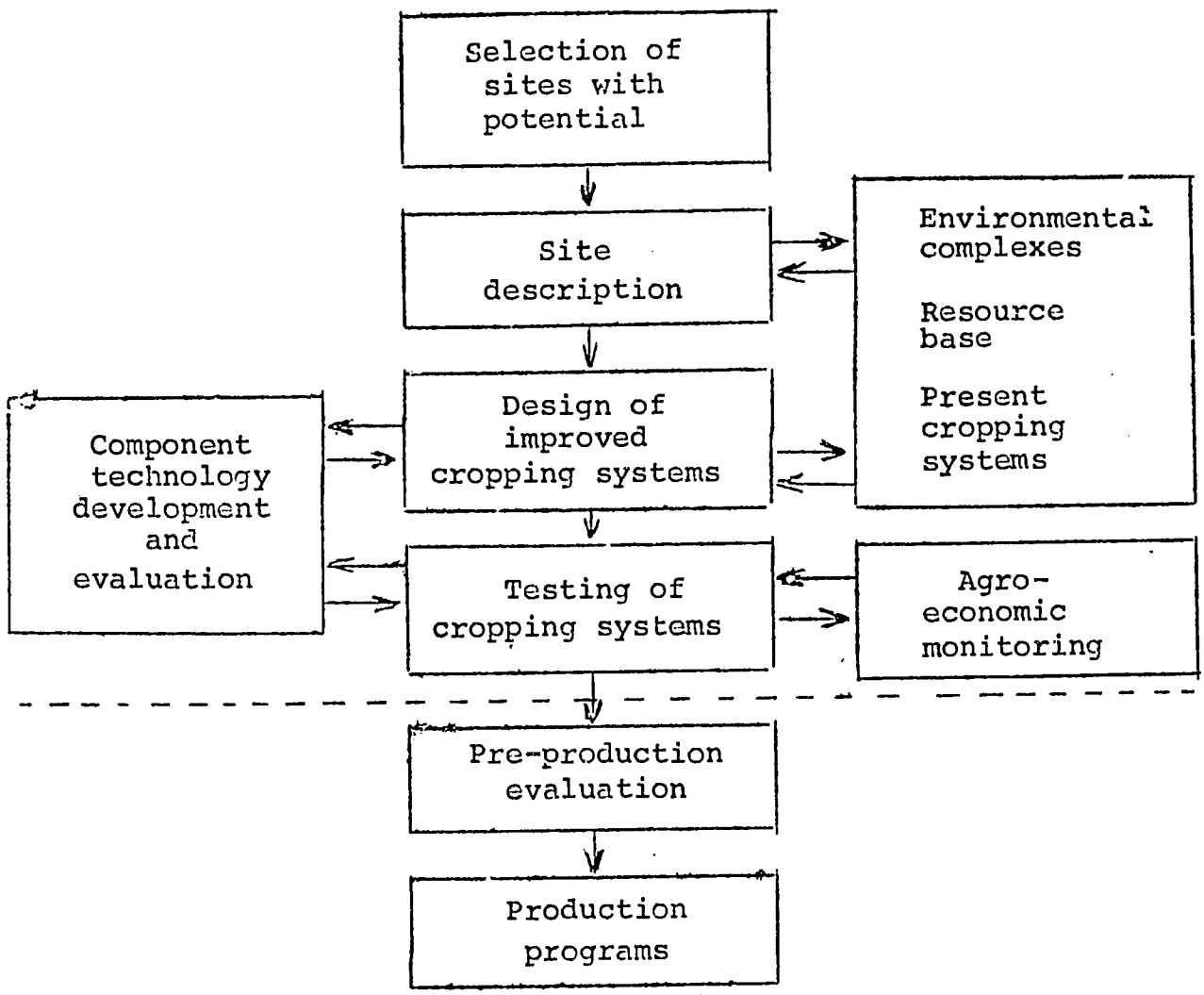
Table 1. (Con't)

No. of	Institute/organization & country sponsored	No. of		Copies of proceedings		Major discussion topics
		Participants	Observer	printed	circulated	
4. Cropping Systems Symposium, Sept. 21-24, 1976	IRRI	66	23	500	450	- Framework for cropping systems research and development for the Asian Farmers. - Physical aspects of cropping pattern design - Economics of cropping systems; description and pattern design. - Testing of cropping patterns - Component technology - Cropping systems approach to adaptive research - Cropping systems approach to production programs.
5. Fourth Working Group Meeting	IRRI	12	18	300	285	- Environmental classification - Farmers participant research approach - Development of in-country training program - Varietal testing - Direct seeding rice - Handbook for economic analysis - Superimposed trials on cropping pattern.

Table 1. (Con't)

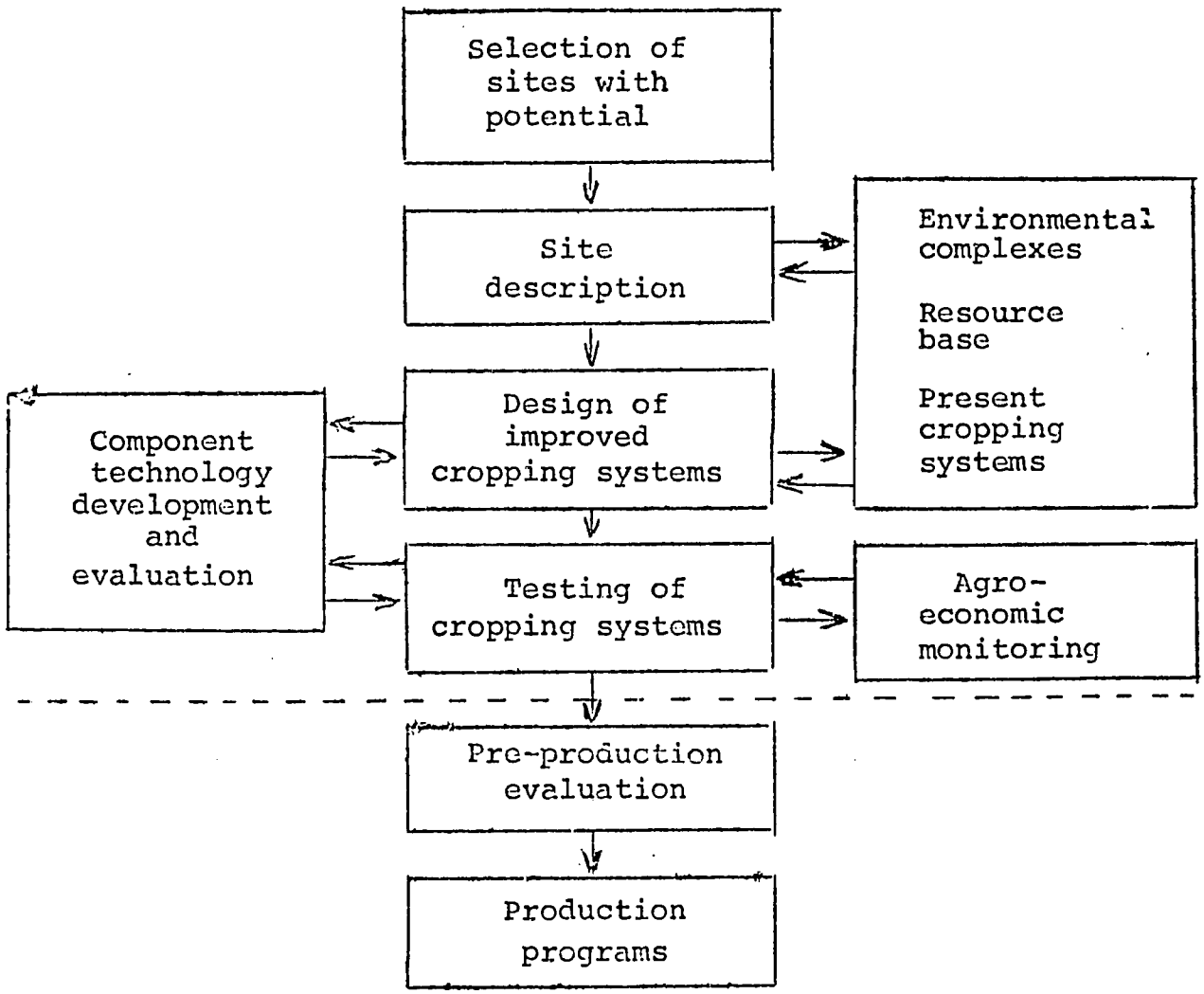
No. of meeting	Institute/Organization & country sponsored	No. of Participants	No. of Observer	Copies of proceedings printed	Copies of proceedings circulated	Major discussion topics
6. Fifth working group meeting Bangladesh Feb. 15-22 1977	BRRI, Bangladesh/ IRRI	11	17	200	235	- Environmental classification - Varietal screening - Time required to stay in each site - Coordination between research and extension in cropping systems research & development - Task of the network - Utilization of research outcome across the network - Pest control in cropping systems - Country progress report
7. Sixth working group meeting Sri Lanka Dec. 13-17, 1977	Dept. of Agric./ Sri Lanka	12	18	200	220	- Cropping pattern monitoring - Varietal testing - Economics handbook - Country report (15)

Table 2. Components and flow chart for Cropping Systems Research and Development.



Source: South and Southeast Asian Cropping Systems Working Group.

Table 2. Components and flow chart for Cropping Systems Research and Development.



Source: South and Southeast Asian Cropping Systems Working Group.

Table 3. Seed materials sent from IRRI to the national program (1976-77)

Crop	NUMBER OF TRIALS										Total
	Thailand	Indonesia	Sri Lanka	Burma	Malaysia	Bangladesh	India	Nepal	Taiwan	Phil.	
Corn	3 (12)	2 (10)	2 (11)	2 (15)	-	2 (14)	2 (10)	-	1 (17)	8 (15)	22
Sorghum	4 (15)	2 (15)	1 (15)	1 (15)	-	2 (17)	-	-	1 (16)	8 (15)	19
Soybeans	6 (8)	3 (7)	2 (4)	2 (15)	1 (8)	2 (8)	-	1 (10)	-	6 (10)	23
Mungbeans	6 (15)	3 (9)	2 (5)	1 (15)	2 (14)	2 (14)	1 (9)	1 (15)	1 (15)	1 (15)	26
Peanut	2 (11)	1 (10)	2 (13)	2 (10)	1 (7)	2 (11)	-	1 (9)	1 (10)	6 (15)	17
Cowpea	2 (15)	2 (10)	2 (5)	1 (13)	1 (9)	2 (14)	1 (9)	2 (11)	1 (14)	8 (15)	22
Sweet potato 1/	1 (12)	-	-	-	-	-	-	1 (11)	-	4 (10)	6

( ) Number inclosed indicates number of entries sent not including their own local check.

1/ Except in the Philippines all materials sent were for multiplication, and observation.

Table 4. Cropping systems training/study tour/observational tour records at IRRI since 1974.

Country	No. of trainees completed short course (4-6 months) at IRRI*	No. of graduate students		No. of officials observed IRRI cropping systems program			Total/ country
		MS	Ph.D	High level	Medium level	Junior level	
Finish already		5	4				
Thailand	21 + 5	7		2	8		52
Indonesia	42 + 20	5	2	3	4		76
Bangladesh	8 + 9	4		1			22
Nepal	4 + 3			1			8
Philippines	30 + 3	3		3			39
Sri Lanka	7			2	5		14
Burma	6	1		1	1		9
South Korea	3						3
India	2			2			4
Malaysia	5 + 3			1	3		12
Japan	1						1

* + means undergoing training now.

Table 5. Present classification and area of rice land in Indonesia.[1]

Classification		Area	Rice crops/ year	Crop area
English	Indonesian			
		ha	No.	ha/yr
A. Upland	Padi gogo	1,168.364	1	1,168,364
B. Irrigated Lowland:	Pengairan Padi sawah:			
Guaranteed	Teratur	1,070,779	2	2,141,558
Partial	Setengah teratur	889,842	1-2	1,557,224[2]
Simple	Sederhana	1,981,525	1-2	2,972,288[3]
C. Rainfed Lowland	Tadah hujan	1,772,465	1-2	2,215,581[4]
D. Swamp	Labak	253,869	1-2	317,336[4]
E. Tidal	Pasang surut	557,823	1-2	697,279[4]
F. Polder	Polder	9,636	1-2	12,045[4]
	Total land area	7,704,303	Total crop area/ yr	9,913,311

[1]Compiled from various sources by Drs. Haeruddin Taslim.
[2]Assumed 75% double cropping.
[3]Assumed 50% double cropping.
[4]Assumed 25% double cropping.

Table 6. Cropping pattern, yield and analysis of costs and returns for each cropping pattern in 7 month irrigation area (Category II). Indramayu, 1975-76.

Cropping Pattern	Average Yield	Gross Return	Labor Cost	Material Cost	Crop Net return	Pattern Net return
	kg/ha	Rp/ha	Rp/ha	Rp/ha	Rp/ha	Rp/ha
IIA						
LLR -	5,818	363,646	132,254	38,119	193,273	
WJR -	1,577	107,214	59,672	23,570	23,972	
Fallow	-	-				217,245
IIB						
LLR -	6,892	430,833	145,355	36,122	249,356	
WJR -	2,393	162,746	73,944	32,548	56,254	
Cowpea	-					305,610
IIC						
LLR -	5,422	338,875	126,427	34,060	178,388	
WJR -	[illegible],837	328,893	105,473	38,830	184,590	
Cowpea	916	229,075	122,061	20,000	87,014	
						449,992

Table 7. Cropping pattern, yield and analysis of costs and returns for each cropping pattern in 5 month irrigation area (Category III). Indramayu, 1975-76.

Cropping Pattern	Average Yield	Gross Return	Labor Cost	Material Cost	Crop Net return	Pattern Net return
	kg/ha	Rp/ha	Rp/ha	Rp/ha	Rp/ha	Rp/ha
IIIA						
LLR -	4,997	312,292	117,649	35,563	159,080	
WJR -	750	51,921	64,921	21,730	-35,651	
Fallow	-	-				123,429
IIIB						
LLR -	5,257	328,542	142,238	34,197	152,107	
WJR -	1,747	118,774	81,321	32,220	5,233	
Cowpea	-	-				157,340
IIIC						
GRR -	4,502	281,375	181,558	39,300	60,517	
WJR -	4,140	281,526	101,690	37,632	142,204	
Cowpea	460	116,000	77,267	20,000	18,733	
						221,454

Table 8. Calories and protein produced per hectare from year around cropping patterns with no and full fertilizer treatments. Cropping Systems Research. Bandarjaya, Central Lampung. 1973-74.

Cropping Pattern	No treatment			Full treatment		
	Yield	Calories	Protein	Yield	Calories	Protein
	kg/ha	K cal/ha	kg/ha	kg/ha	K cal/ha	kg/ha
Corn +	455	1,615	42	1,350	4,792	124
Rice /	769	1,840	52	2,724	6,521	185
Cassava /	14,600	17,520	102	23,200	27,840	162
Peanut -	222	1,003	51	567	2,563	145
Rice bean	93	308	23	627	2,075	157
T o t a l		22,286	276		43,791	773
Gabah[1] equivalent kg/ha/year		9,325	4060		18,323	11371

[1] Gabah x .665 = milled rice

Average value of 6.8% protein used for conversion from protein to gabah.

Table 9. Calories and protein produced per hectare and costs and returns from year around Cropping Patterns. Cropping Systems Research. Bandar Agung, Central Lampung. 1976-77.

Cropping Pattern	Yield	Calories	Protein	Gross Returns	Material Costs	Labor Costs	Net Returns
	kg/ha	K Cal/ha	kg/ha	Rp/ha	Rp/ha	Rp/ha	Rp/ha
Corn +	1,977	7,018	182	88,965	54,375	75,600	77,241
Rice /	1,689	4,043	115	118,251			
Cassava /	21,125	25,350	148	126,749	17,625	6,300[1]	102,824
Corn -	1,739	6,173	160	86,925	22,289	28,500	36,136
Cowpea	328	1,122	75	39,396	11,403	27,600	393
Total		43,706	680				216,594
Gabah equivalent kg/ha/year		18,258	10,003				

[1] Labor costs for cassava would be increased by Rp 11,300/ha if 1/3 of costs for land preparation and weeding for the first 3 crops were charged to cassava.

Table 10. Calories and protein produced per hectare and costs and returns from year around cropping patterns. Cropping Systems Research. Komering Putih, Central Lampung. 1976-77.

Cropping Pattern	Yield	Calories	Protein	Gross Returns	Material Costs	Labor Costs	Net Returns
	kg/ha	K Cal/ha	Kg/ha	Rp/ha	Rp/ha	Rp/ha	Rp/ha
Corn +	2,050	7,384	191	93,600			
Rice /	1,022	2,447	70	71,540	52,350	71,700[1]	41,090
Cassava /	26,110	31,332	183	156,660	17,625	6,600	132,435
Peanut	385	1,740	98	115,410	33,057	54,000	28,353
T o t a l		42,903	542				201,878
Gabah equivalent kg/ha/year		17,951	7,973				

[1] Labor costs for cassava would be increased by Rp 10,300/ha if 1/3 of costs for land preparation and weeding for the first 3 crops were charged to cassava.

Table 11. Calories and protein produced per hectare and costs and returns from year around cropping patterns. Cropping Systems Research. Way Abung, North Lampung. 1976-77.

Cropping Pattern	Yield	Calories	Protein	Gross Returns	Material Costs	Labor Costs	Net Returns
	kg/ha	K Cal/ha	kg/ha	Rp/ha	Rp/ha	Rp/ha	Rp/ha
Corn +	1,169	4,150	108	46,760			
Rice /	1,858	3,448	126	111,480	51,993	91,400	14,847
Cassava /	22,200	26,640	155	133,200	20,722	14,700[1]	97,778
Peanut -	567	2,563	145	141,625	51,610	46,200	43,815
Rice bean	228	1,031	57	51,300	27,922	31,850	- 8,472
Total		37,832	591				147,968
Gabah equivalent kg/ha/year		15,829	8,694				

[1]Labor costs for cassava would be increased by Rp 13,383/ha if 1/3 of costs for land preparation and weeding for the first 3 crops were charged to cassava.

Table 12. Calories and protein produced per hectare and costs and returns from year around cropping patterns. Cropping Systems Research. Baturaja, South Sumatra. 1976-77.

Cropping Pattern	Yield	Calories	Protein	Gross Returns	Material Costs	Labor Costs	Net Returns
	kg/ha	K Cal/ha	kg/ha	Rp/ha	Rp/ha	Rp/ha	Rp/ha
Corn +	1,877	6,663	173	112,620	52,000	155,700	-27,940
Rice /	746	1,786	51	67,140			
Cassava /	16,649	19,979	117	166,490	20,700	36,000	109,790
Peanut -	499	2,255	127	144,710	51,600	92,900	210
Rice bean	531	2,400	133	119,475	27,900	59,200	32,375
T o t a l		33,083	601				114,435
Gabah equivalent kg/ha/year		13,842	8,841				

[1] Labor costs for cassava would be increased by Rp 21,000/ha if 1/3 of costs for land preparation and weeding for the first 3 crops were charged to cassava.

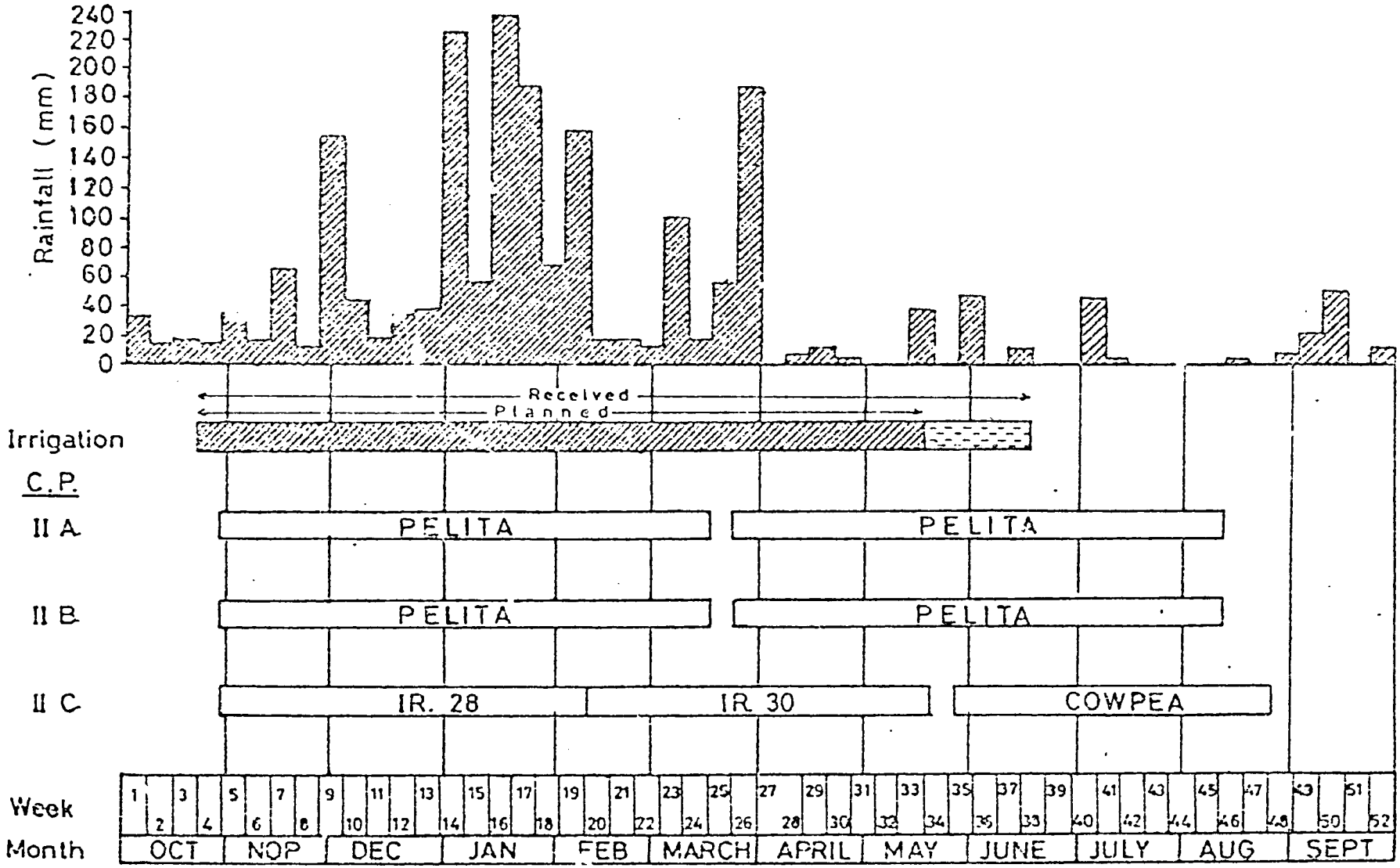


Figure 1. Weekly rainfall distribution, length of water supply from irrigation and cropping patterns in 7 month irrigation area Indramayu, 1975-76.

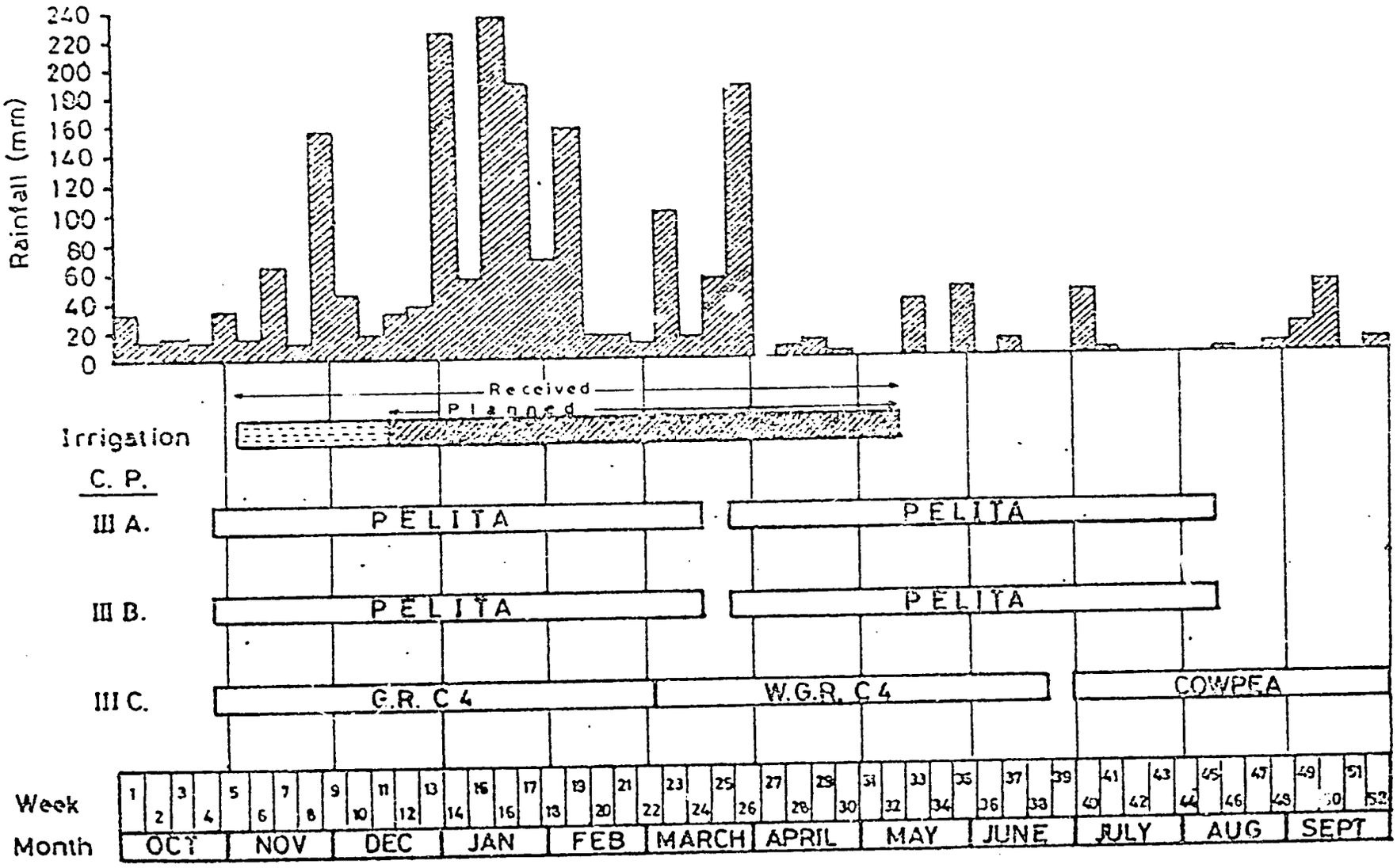


Figure 2. Weekly rainfall distribution, length of water suply from irrigation and cropping patterns in 5 month irrigation area. Indramayu, 1975 _ 76.

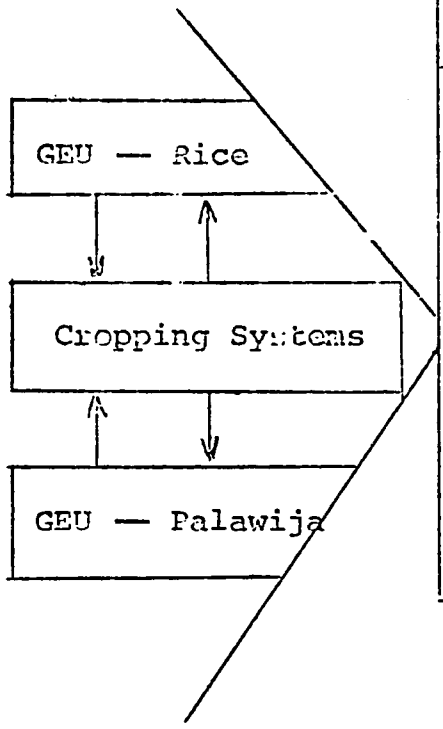
Diagram I. Cropping Systems Research and Development for Selected Target Areas. CRIA, Bogor, Indonesia. July, 1979

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 hectares 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 C. ICP - low levels of input D. ICP - ~~optimum~~ - high levels of inputs	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 coordinated by the BAPPEDA.

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

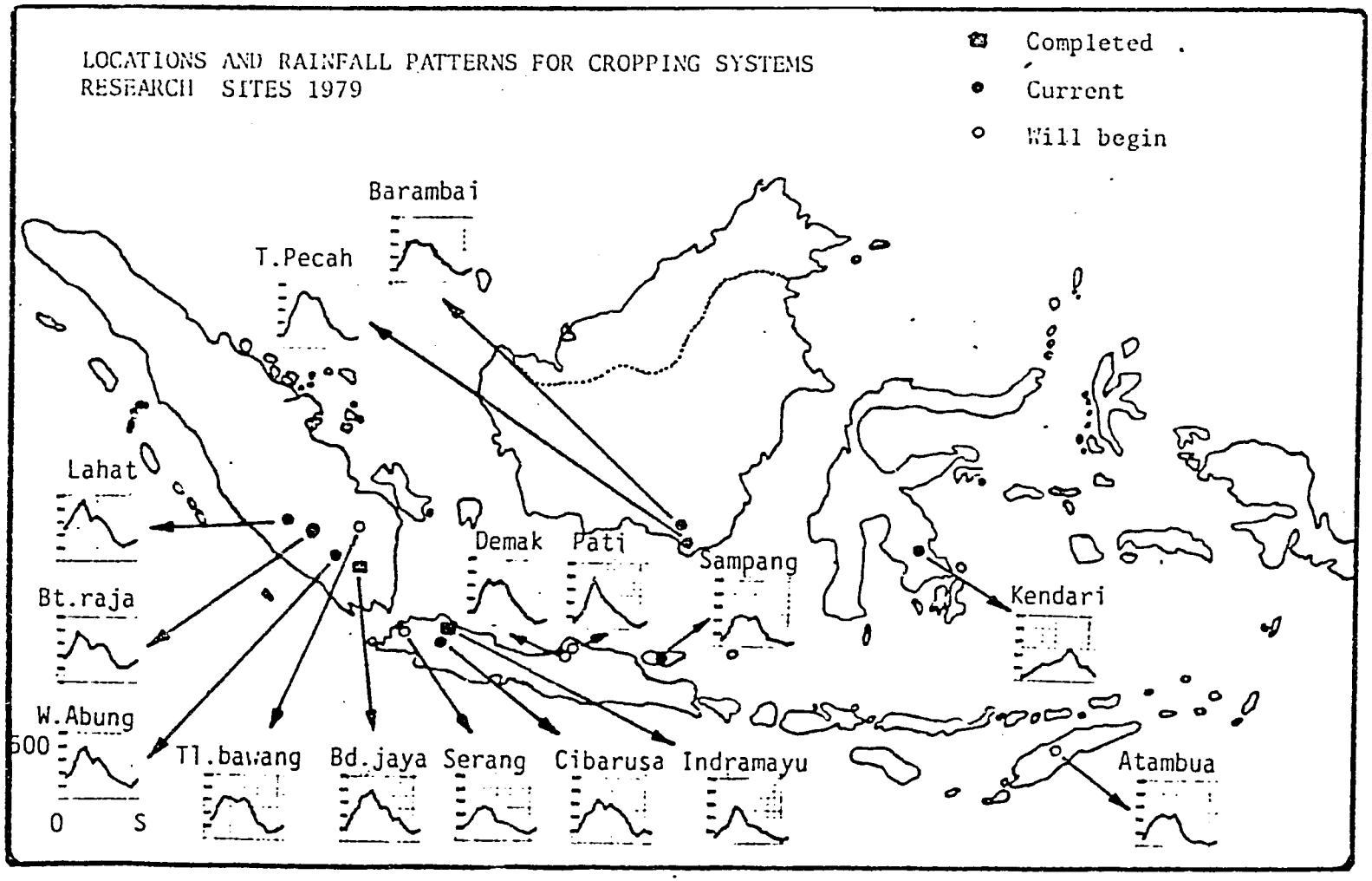
Diagram II. CRIA functional framework



DISCIPLINES

Breeding	Agronomy	Pests and Diseases	Physiology	Socio-economics	Research Dissemination & Manpower development
Rice	Crop Agronomy	Rice	Nutrition	Production	Publications
Corn	Weeds	Corn	Ecology	Marketing	Library
Legumes	Seed Pro-	Legumes	a. Light	Social	Manpower Development
Root crops	Multiple Cropping	Root crops	b. climate		Coordination (CRIA-Ext.)
Sorghum	Soil Fertility and Plant	Sorghum			Technical Team
Quality		Multiple Cropping			
Seed Technology	Nutrition				

Diagram III.


LOCATIONS AND RAINFALL PATTERNS FOR CROPPING SYSTEMS
RESEARCH SITES 1979
Completed
Current
Will begin
Barambai
T.Pecah
Lahat
Bt.raja
W.Abung
500
0
S
Demak
Pati
Sampang
Kendari
Tl.bawang
Bd.jaya
Serang
Cibarusa
Indramayu
Atambua

RATIONALE FOR INSTITUTIONAL RESEARCH PRIORITIES AND CROPPING SYSTEMS RESEARCH

Agricultural scientists with less pragmatic inclination and more research orientation might disregard the development needs and put more emphasis on personal or scientific interests. Furthermore, the objective of the research might be more devoted to in-depth study of small differences or anomalies within an otherwise homogenous target area. Fascination with details which do not not preclude uniformity of recommendations and cultural practices should not become objectives in themselves. They should not be forgotten but kept within perspective.

Indonesian agricultural scientists must provide the technology and ideas for future agricultural development activities. They must do research before they are requested to provide answers. The stimulus for agricultural development should come from researchers rather than the stimulus for research coming from development. In this way agricultural scientists will be able to serve the country better, bring credit to themselves and gain support for their research organization.

Inventory of Resources

In addition to the traditional food crops research activities and cropping systems research in target areas we need to develop a systematic way of arriving at priorities for adaptive agricultural research for all

disciplines within CRIA. The subsequent research would precede development projects and even provide the initiative for such projects. The first thing needed is an inventory of natural resources and the present agricultural situation. The final stage in this approach is usually the development of a "land use capability map". Such maps have been developed for Indonesia. They are useful. But for researchers the logical sequence of information that is needed for development of such maps may be more valuable to the scientist than the final land use capability map. A series of maps presented in a sequence from the edaphological classification of land, through the physical determinants and finally to the individual food crops, would be more useful. It would help us see where we are and what research might have more relevance in all disciplines.

Edaphological classification of land. In this classification we attempt to delineate distinct land areas that differ based on the chemical and physical characteristics of the soil and water environment without reference to climate and other overlapping factors such as slope or land form. As a first approximation, based on experience and data available, the following classifications are suggested for one map of Indonesia. In each case land area for each classification should be included, if possible, on an island basis.

A. Upland areas

B. Lowland rice areas (padi sawah)

1. Irrigated - The following subgroups maybe put together for a national map.

a. Fully ($>$ 10 months)

b. Partially (7-9 months)

c. Partially (5-7 months)

2. Rainfed lowland

C. Swampy areas (lebak)

D. Tidal areas (pasang surut)

E. Mangrove areas.

Environmental determinants. In this section some of the most important environmental factors which determine the suitability of land for crop production are given. The effects of environmental factors on land use capability vary depending upon the edaphological character of the land. These environmental factors may be looked upon as modifiers when used in combination with the edaphological map.

A. Soils map

On a national scale only the major soil groups can be effectively shown. Soils delineated should be those whose characteristics necessitate different land management practices. For example, differences in inherent nutrient status would not be a reason for delineating between two soils unless one soil required unusual amounts of fertilizer for corrective treatment.

B. Rainfall map

On a national scale the classification described by Oldeman and the IRRI Work Group are sufficient. At the working level (Kabupaten) the bargraphs for rainfall distribution are more useful.

C. Elevation map

A biological classification in which altitudes between 500 M and 1000 M are delineated would be sufficient for a national map. These would correspond to the elevation above which cold tolerant rice varieties are needed ($>$ 500 M) and the altitude above which wheat grows well ($>$ 1000 M). At altitudes higher than 1500 M (another elevation may be more valid) the use of the land for food crops production in limited.

D. Slope map

An average slope above which agricultural activity is limited is difficult to define. A slope of 15% has been considered the cut-off point for food crops production. Obviously, many times land with more than 15% slope has been used for crop production without any extreme problems with erosion. On Java and Bali where terracing is widely practiced for lowland rice much steeper slopes are modified for use. The slope factor becomes almost irrelevant. This is

an example of farmers modifying or removing physical constraints to crop production.

Present land use Map. In development of land or research objectives within an area, the most significant data available are the present land use and information obtained from farmers. What exists cannot be disregarded. On a national scale the following land use classifications may be useful:

A. Upland food crops
B. Lowland rice (Including gogorancah and swamp and pasang surut rice)
C. Mixed alang-alang and brush land
D. Forest (Primary and secondary)
E. Perennial estate crops

The land use information delineated can be valuable in two ways. First of all it is useful to relate land use, by distinctly different crops or vegetation which have different ecological needes, to a physical setting that can be characterized. Further break down by crops or species of plants provide the "standards" for evaluating land capability. They give some bases for modification of present land use or extrapolation of a particular kind of land use into new areas having similar agro-climatic conditions. Secondly, production figures for different food crop commodities from different areas of the country provide a basis of comparison.

If production in areas with similar agro-climatic conditions differ greatly, we are provided with on ideal problem for applied and basic research projects that have relevance. We have rational bases for developing research priorities.

INTERPRETATION AND DECISION MAKING

Use of Resource Maps

Survey Maps. The combination of all the factors that affect crop production into one land use capability map in a useful fashion is difficult. It is not necessary to try. The Soils Research Institute has made these kinds of maps. They are available and are useful for many purposes. For an over view the inventory maps described (Scale of 1: 2,5000,000) are adequate. It may be useful to have more detailed maps of each major island group at a Scale of 1 : 1,000,000.

Working Maps. These maps at a Scale of 1 : 50,000 are needed for provinces or groups of provinces that may be treated as a unit. This would translate to 1 cm of map for each one half kilometer of land. This would provide sufficient detail for most agricultural purposes. Unfortunately data in this detail are not available for much of Indonesia. However, enough data are available in detail to provide thorough agro-climatic descriptions of parts of many of the major agricultural areas. Furthermore,

many surveys funded by the Directorate General of Transmigration and Ministry of Public Works are detailed descriptions of forested and grass covered lands not yet investigated by agricultural researchers. These reports have been prepared by some of the best consulting firms available anywhere. The data in these reports along with the research and experience of CRIA Staff are valuable resources. In combination with the survey maps enough data is available to provide the interpretation and extrapolation needed for establishing national research priorities.

The usefulness of the large scale survey maps and working maps may be enhanced by considering just the relevant combinations. For example, if we consider the categories in the Edaphological Classification of land and the modifier maps the following combinations would be useful:

A. Upland areas - in combination with:

1. Soil map
2. Rainfall map
3. Elevation map
4. Slope map

If we can identify certain upland crops (or cropping patterns) or perennial crops presently growing in one location we might expect to find (or plan to grow) the crop in another location with similar agro-climatic

conditions. The upland crop areas are the most complex.

B. Lowland Rice Areas

1. Irrigated areas - in combination with:
   a. Soil map
   b. Rainfall map (Not so important for irrigated areas)
   c. Elevation map
2. Rainfed lowland areas - in combination with:
   a. Soil map
   b. Rainfall map
   c. Elevation map

The combination of variables are less and the effects of soil and rainfall are minimized by the system, particularly in the irrigated areas. These areas are well know to CRIA Scientists and extrapolation of recommendations for varieties and cropping patterns are relative easy.

C. Lebak Areas - in combination with:

1. Nature of peat (peat domes)
2. Depth of water
3. Acid sulphate

D. Pasang-surut Areas - in combination with:

1. Acid sulphate
2. Depth of water
3. Direct or indirect tides

For the lebak and pasang-surut areas more detail is needed than we have indicated in the survey maps for

Indonesia. In many instances the delineation of factors such as depth and nature of peat and acid sulphate are not clear. Extrapolation of results in one area to another is risky until we have more detailed information. However, our work has been made easier by farmers who have pioneered the development of some of these areas. We should work with the pioneers first and then push into the unsettled areas as we gain more information and experience.

Other data needed

Situation papers for crop commodities. The classification and inventory of physical data is essential for development of research priorities. Unfortunately, many times the constraints to food production in Indonesia are more related to socio-economic than agronomic factors. Many times biological research scientists have been content to emphasize (or point out) this problem but not go further and help find a solution. If an economic constraint exists or is suspected, the scientist could make a significant contribution by documenting the problem and suggesting ways to solve it. Many times it is argued that crops like corn and sorghum are not grown more often because farmers cannot make money growing them. If this is true, the sorghum agronomist would make a significant contribution by helping the economist document the costs of production and give some idea of a fair floor price. Supplement 1 illustrates some of the data that should be collected for each crop commodity or management practice (such as gogorancah or sorjan).

Characteristics of crops needed. The reservoir of germ plasm for different crops throughout the world is extensive and varied. We need to characterize more precisely the kind of plant materials needed for different cropping patterns in agro-climatic regions throughout Indonesia. We can start by collecting this information from scientists in the regions. In this way we can began to systemize the collection of germ plasm from abroad for immediate evaluation and for varietal improvement. Supplement II provide a format for consideration.

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Supplement I

Situation Paper for Food crops[1]

1. Present areas of production

   a. Location - map if possible
   b. Agro climatic situation and water availability
   c. Production per hectare and total

2. Present cultural practices used by farmers

   a. Mono or intercrop
   b. Varieties
   c. Spacing and population
   d. Land preparation
   e. Fertilizer
   f. Insecticide
   g. Weeding
   f. Harvesting

3. Production constraints identified by farmers and extension

   a. Labor)
   b. Time)
   c. Water) examples only
   d. Soil problems)
   e. Storage)
   f. Seed)

4. Costs of production

   a. Credit
   b. Materials

      (1) Seed
      (2) Fertilizer
      (3) Insecticide

   c. Labor

      (1) Land preparation
      (2) Planting
      (3) Fertilizing
      (4) Insecticide management
      (5) Weeding
      (6) Harvesting

---

[1] These crops or practices would include rice, corn, individual legumes, root crops, wheat, sorghum, padi gogo, gogo rancah, walik jerami, cassava and the sorjan system.

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5. Economic situation

   a. Selling price at farm gate per month or per week at harvest time
   b. Buying price
   c. Transportation cost
   d. Profitability
   e. Proposed price floor and expected profit

6. Present market situation

   a. Who uses/for what?)
   b. Who buys/for what?) examples only
   c. Processing)
   d. Export)

7. Recommended practices

   a. Varieties

      (1) Resistances to diseases and insects
      (2) Length to maturity
      (3) Where from
      (4) Production in trials (within & without country)

   b. Cultural practices

      (1) Spacing
      (2) Time to plant
      (3) Fertilization

         (a) How
         (b) Amount

   c. Storage

8. Prospects for increased production

   a. From increased production per hectare
   b. New research
   c. New areas (Agro-climatically suited)

9. Conclusion

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Supplement II

Characteristics of Crops needed for Cropping Systems

1. Crop name:

Indonesian name	English name	Scientific name

2. Days to maturity :

3. Height at harvest :

4. Disease resistance or tolerance needed (most destructive disease first)

Indonesian name	English name	Scientific name
a.		
b.		
c.		
d.		
e.		
f.		

5. Insect resistance or tolerance needed (most destructive insect first)

Indonesian name	English name	Scientific name
a.		
b		
c.		
d.		
e.		
f.		

6. Desired plant geometry:

7. Growth characteristics :

8. Expected management conditions :

9. Expected yield considering management :

10. Other :

11. Relative importance of crop in patterns

    a. Economic

    b. Food source to farmer

APPENDIX II

Site Selection in Target Area

The cropping systems research activities are designed to accelerate agricultural development by increasing both yields and cropping intensity. The program is field oriented, with almost all of the research conducted on farmers' fields.

Four steps are involved in locating farmers' field in which the field trials are to be implemented. First, a target area is identified which is a relatively homogenous agro-climatic area including several districts (kabupatens) and several thousands hectares. The the Cropping Systems Research Coordinator must decide which edophological condition to study such as rainfed, rainfed sawah, irrigated saway (full, 7-9 months or 5 months irrigation), pasang surut, lebak and other conditions. Second, one or several sub-districts (kecamatans) are selected from among these districts that include a large area in the desired research environment. Next, one or more villages (desa) characteristic of each desired environment are selected. Finally, cooperating farmers are chosen in each desa. The decision criteria for proceeding from target area to farmers' fields are discussed below.

Target areas.

The selection of target areas for cropping systems field research is based on four criteria. First, target areas are usually regions identified by the Government as priority agricultural development zones. Second, the area must be representative of a large agro-climatic zone so that the research results will have widespread applicability. Third, the environment must be of a type in which the research staff believes there exists agricultural technology that with slight modifications, it will be possible to increase yields and cropping intensity. Finally, the target area must have some marketing and infrastructural development or is in the process of being developed.

Sub-district selection.

In selecting the sub-districts (kecamatans), the primary consideration is to identify an area which has a large number of hectares of the desired

land use type. The research staff visits each kabupaten extension office and collects secondary data for each kecamatan about the number of hectares in rainfed, technical irrigation, semi-technical irrigation, simple irrigation, annual crop upland, and perennial crop upland. Based on these data, the kecamatan with the largest area of the desired land use type is selected.

Desa selection.

The selection of the desas involves several considerations. The research staff visits each of the chosen kecamatans and collects from the extension office the secondary data listed in Table 1.

Table 1. Data required for systematic selection of Desa sites.

Data	Purpose
Distance from main road (km)	To guarantee that the desa is easily accessable.
Area in each land use class (ha)	To permit the selection of desas with a large hectarage in the desired land use class.
Relative area in each slope class (%)	To avoid desas with atypical topography.
Relative area in each soil texture (%)	To avoid desas with atypical soils
Area planted to each crop, by month (%)	To identify current production level.
Population, by economic activity (number)	To determine importance of agricultural employment.
Rainfall by month for past 10 years (mm)	To determine number of months with 100 mm or more of rain and probability of less than 100 mm at beginning and end of cropping season.
Bimas participants (number)	To determine the availability of credit and level of technology in the desa
Months during which irrigation water is available (% of area with less than 5, 6-7, 8-9, and 10 months or more or irrigation).	To identify areas with the respective irrigation regimes.
Draft animal population (no)	To determine the availability of draft power.
Tractor population (no)	To determine the availability of mechanical power.

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Table 2. Cropping Systems Desa Selection Data Matric

Kabupaten _____

Kecamatan _____

No.	Desa	Distance (km)	Irrigation			Upland		Slope (%)				Soil (%)			Cropping (Pct)						
			Tech & Semi tech.	Simple	Rain-fed	Annual	Peren-nial	Flat	Rol-ling	18%	Mts.	Clay	Silt	Sand	LLR	ULR	C	CV	SB	PT.	LLR
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20
1.																					
2.																					
3.																					
4.																					
5.																					
6.																					
7.																					
8.																					
9.																					
10.																					
11.																					
12.																					
13.																					
14.																					
15.																					
Mean																					

Table 2 Cont.

No.	Desa	Yields (kg)						Population			Gov't Program (%)		Power	
								No.		%	Farmers (%)		Hectares per:	
		ULR	LLR	C	CV	SB	PT	Total	Male Adult	Farmer	Bimas	Inmas	Animal	Tractor
		(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)
1.														
2.														
3.														
4.														
5.														
6.														
7.														
8.														
9.														
10.														
11.														
12.														
13.														
14.														
15.														
Mean														

Once the secondary data is collected, a matrix is prepared for each kecamatan, with the desa forming the rows and the data forming the columns, as shown in Table 2.

After transforming the desa secondary data to the "Data matrix" (Table 2), the mean value for each characteristic is calculated. These mean values taken together may be interpreted as a description of the "typical or representative desa". To identify the desa which is most representative of the population of desas, first the mean value for each characteristic is subtracted from the respective values associated with each desa. This difference is the deviation from the mean for each characteristic. Next for each characteristic the desa with the smallest deviation from the mean is assigned the value of 1, the desa with the second smallest deviation is assigned the value 2, etc., until all desas have been ranked in terms of deviation from the mean. Finally, after ordering all desas for all characteristics each row (representing one desa) is summed. This gives a single index value for each desa. The desa with the smallest index value will be most representative of the population of desas. Unless this desa has some characteristic that precludes the establishment of a site there, it is selected as the research site.

A simple illustration of this procedure is shown in tables 3, 4 and 5. In Table 3, a set of fabricated data is presented. Based on the mean values for each characteristic, the absolute deviations are shown in Table 4. Each desas is then assigned a value of 1 - 5 for each characteristic to indicate its order of magnitude among the population of desas, as shown in Table 5. We see that desa 4 has the lowest numeral value, so it is most representative of the five desas, in terms of the 16 characteristic considered.

In this illustration, all characteristics are given equal weight (i.e. each contributes 1/16 to the "sum" index). Yet, if the researcher believes that a certain characteristics should have a greater impact on desa selection, it is possible to increase the relative contribution of such characteristics on the "sum index" by multiplying those items by any desired value. For example, by multiplying the rank-order value of characteristic 1 (distance), by 5, it weight in the final "sum index" would increase from 1/16 to 5/20.

Table 3. Characteristics of Potential Cropping Systems desa sites.

No.	Desa	Distance (km)	Land Use (Ha)			Soil (%)			Cropping (Pct)			Yield (t/ha)			Farmer population(%)	Bimas(%) members	Power (ha/ animal)
			Irrigated	Rainfed	Upland	Clay	Silt	Sand	LLR	C	CV	LLR	C	CV			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1.	Maritangae	6	600	5,000	700	55	30	15	60	30	10	3.0	0.7	6.7	75	45	10
2.	Panca Rijang	10	4,000	1,000	600	50	20	30	70	20	15	2.8	6.5	5.4	63	33	15
3.	Branti	15	8,000	2,000	1,000	90	5	5	80	15	5	4.1	1.3	10.6	81	58	6
4.	Watang Pulu	7	3,000	100	2,000	75	13	12	68	25	7	3.4	0.8	8.4	68	50	21
5.	Dua Putue	4	600	900	6,000	85	5	10	75	5	20	3.5	1.0	9.0	74	50	9
	Mean	8.4	4,320	1,800	2,060	71	14.6	14.4	70.6	19	11.4	3.36	0.86	8.0	72.2	51.2	12.2

Table 4. Absolute deviation from the mean of each characteristic

Desa No.	Characteristic (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	2.4	3,720	3,200	1,360	16	15.4	0.6	10.6	11	1.4	0.36	0.16	1.3	2.8	6.2	2.2
2.	1.6	320	800	1,460	21	5.4	15.6	0.6	1	3.6	0.55	0.36	2.6	9.2	13.2	2.8
3	6.6	3,680	200	1,060	19	9.6	9.4	9.4	4	6.4	0.74	0.44	2.6	8.8	16.9	6.2
4	1.4	1,320	1,700	60	4	1.6	2.4	2.6	6	4.4	0.04	0.06	0.4	4.2	8.9	8.8
5	4.4	3,720	900	3,940	14	9.6	4.4	5.4	14	8.6	0.14	0.14	1.0	1.8	1.2	3.2

Table 5. Rank-order of Desa Characteristics for all desas in Kecamatan

Desa	No.	Characteristic															Sum index
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1	3	4	5	3	3	4	1	5	4	1	3	3	3	2	2	1	47
2	2	1	2	4	5	2	5	1	1	2	4	4	4	5	5	2	49
3	5	3	1	2	4	3	4	4	2	4	5	5	4	4	4	4	58
4	1	2	4	1	1	1	2	2	3	3	1	1	1	3	3	5	34
5 5	4	4	3	5	2	3	3	3	5	5	2	2	2	1	1	3	48

Appendix III.

Agro-Economic Profile of the selected cropping systems site

Introduction

In order to design cropping patterns appropriate for new target area research sites, a pre-implementation data collection effort is required. First, the data collected should comprehensively describe the selected desa, including the physical, institutional, social, and economic environment. Second, the report should be not only descriptive but designed to also identify constraints to higher yields for specific crops, input intensification, crop intensification, and technologies which are characteristic of the alternative cropping systems strategies that are being considered for target area testing. Third, the agro-economic profile must be completed in a minimum of time not exceeding 2-3 days/site. Fourth, the final report must be short, so it can be completed in a maximum of two weeks after returning from the field. Fifth, the data collection and report must follow a general framework that may be used at each new cropping systems site. This is necessary to reduce the time required for data collection and report preparation. In addition, the use of a general model will permit comparison of new sites to ongoing research areas. This will enable the researcher to evaluate the transfer ability of technologies found to be successful at old sites to the new sites.

The General Research Data Model

Data for developing the agro-economic profile should be collected from the sourse capable of giving the most accurate answer in aminimum of time. The required secondary data is usually available from such sources as the Desa Office, Extension Service, and Bureau of Central Statistics, Irrigation Office, the Bank extending Bimas credit; and input dealers. When the required data is not available from these sources, a key informant may be relied upon. Possible key informants include extension officers, desa officials, village water officers, and a group of approximately ten farmers assembled for the purpose of providing the information sought. This comprehensive set of data required for cropping systems design are listed in Table 1 by subject categories. The same variables are listed in Table 2, according to the source from which the data may be obtained.

For each item, the following outline describes in detail the type of information to be collected, evaluation to be completed with this data, and possible source from where the data may be obtained.

Table 1. Agro-economic profile Data Requirements by subject category.

Subject category	Source
Physical Environment	
Rainfall*	EX-kab
Soil*	EX-kab,RS
Topography*	EX-kab
Land use by type*	EX-kab
Experimental Base	
Variety trial	EX-kab
Fertilizer trial	EX-kab
Pest surveillance	EX-kab
Demonstration plots	EX-kab
Crop Situation	
Hectares in each crop*	EX-kec
Planting and harvesting dates*	EX-kec
Yields*	EX-kec
Current cropping pattern	FGI
Historical cropping pattern	FGI
Institutional	
Land ownership	PPL at Wilud or letter "C" list from DO
Tenure	Rakasabumi (PTD) village officer
Landless labor	FGI
Support services	DO/PPL/DE/ middlemen
Credit	BRI unit Desa (Wilud)
Input sales	DE(Closest to Desa)
Input availability and timeliness	DE/FGI
Irrigation system	IRR/DO(ulu-ulu)

Subject category	Source
Labor	
Employment profile	DO(juru tulis)
Population	DO(-"-)
Off-farm employment	DO/FGI
Migration of agricultural labor	
Farm Practices	
Wages	FGI
Power	DO/EX/FGI
Input use	FGI
Yield constraints	FGI/PPL at Wilud
Varieties	PPL at Wilu /FGI
Planting decision rule	FGI
Inputs level	FGI
Constraints to intensification	FGI/PPL at Wilud
Prices	
Inputs	DE/FGI
Output(crops)	PPK
Subsidies	PPL
Community	
Transportation	DO/PPL
Markets	PPL/FGI

PPL = Extension Officer at Wilud
EX = Extension Office Recording
DE = Dealers
IRR = Irrigation Office
Kab = Kabupaten

PPK = kabupaten statistician
BRI = Bank for Wilud
BPS = Bureau of Central Statistics
FGI = Group Interview of Farmers
DO = Desa Office
RS = Research Station

*These items houdl have already been collected before choosing the desa.

Table 2. Agro-ecnomic profile data requirement, by source

Extension Office - Kabupaten

Rainfall
Soil
Topography
Land use by type
Variety trials
Fertilizer trials
Pest surveillance
Demonstration plots

Extension Office - Kecamatan

Hectares in each crop
Planting and harvesting dates
Yields by crop

PPL at Wilud

Land ownership, Transportation
Support Services, Markets
Power
Yield constraints
Constraints to crop intensification
Input subsidies

Input dealers

Input sales
Input availability
Input prices

Farmer Group Interview

Current cropping pattern
Historical cropping pattern
Landless labor
Input availability
Input Prices
Off-Farm Employment
Migration of agricultural labor
Wages
Power
Input use
Yield constraints
Varieties
Planting decision
Input levels
Constraints to cropping intensification

Middlemen

Support services
Markets

Desa Office

Land ownership
Tenure
Landless labor
Support services
Irrigation system
Employment profile
Population
Transportation

BRI-Unit Desa

Credit

Irrigation Office

Irrigation system

PPK

Output prices

I. PHYSICAL ENVIRONMENT

A. Rainfall

Description - Weekly rainfall data (mm) for the past 20 years is desirable. Alternatively, monthly data may be collected, but is not subjected to further analyses.

Evaluation - 1) Draw a graphic profile of monthly rainfall.
2) Count the number and distribution of months with less than 100 mm of rainfall per year.
3) Estimate the probability of less than 100 mm of rainfall during each month.
4) Estimate the cumulative frequency distribution of the onset and end of rains during the crop year.

Source - Rainfall station located closest to the site (note location and distance from site). This may be obtained from the Kabupaten Extension Office.

B. Soil

Description - Major soil types found in area and hectares in each group. Hectares of land in the area classified in each of the land tax classes. Information on known deficiencies (i.e. aluminum toxicity, high pH, zinc deficiency).

Evaluation - Describe the soil potential and problem with respect to fertility, micro-nutrients, problem soils.

Source - Kabupaten Extension Office; Research Station Lembaga Penelitian Tanah.

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C. Topography

Description - Estimate of the hectares in each type of situation: flat plain, rolling, greater than than 18% slope; and mountains.

Evaluation - Describe the topography of the land.

Source - Kabupaten Extension Office.

D. Land Use By Type

Description - Hectares of land in irrigated (technical, semi-technical, and simple), upland for annual crops, upland for perrenial crops, homelot, unused total agricultural, and urban.

Evaluation - 1) Describe the land use pattern.

2) Determine the potential for crop extensification.

3) Determine the potential for crop intensification.

Source - Kabupaten Extension Office.

II. EXPERIMENTAL BASE

A. Multi-Locational Variety Trials

Description - Nine rice varieties grown in farmers' field experiments.

Evaluation - 1) Describe the yield potential of tested varieties and variability between replication

2) Identify the best variety for the introduced pattern and variety component technology.

Source - Trials organized through Directorates of Plant Protection, implemented through Kabupaten Extension Office.

B. Multi-Locational Fertilizer Trials

Description - Yield response to N and P in farmers' field experiments.

Evaluation - Determine optimum level of fertilizer for introduced pattern.

Source - Trial organized through Directorate of Food Production, implemented by Kabupaten Extension Office.

C. Pest Surveillence/Bio-Type Monitoring

Description - All major rice production areas are evaluated weekly (one worker/10,000 ha) for the presence of economic pests. Also, all major rice production areas are evaluated once per season to determine the BPH bio-type present.

Evaluation - 1) Describe the major pest problems at the site.

2) Use data to determine insect control measures to be used in the introduced pattern.

3) Use data to identify treatments to be used in insect component technology.

Source - Organized through Bureau of Plant Protection, data collected by staff member of BPP located in Kabupaten Extension Office.

D. Demonstration Plots

Description - In many sites, the local extension service conducts trials; including variety, spacing, fertilizer and cropping patterns.

Evaluation - Summarize the existing experimental data to determine the factors that might be included in the introduced patterns and component technology.

Source - Conducted by Kabupaten Extension Office.

III. CROP SITUATION

A. Hectares in Each Crop

Description - Total hectares cropped for each of the past five years, by crop type.

Evaluation - 1) Identify the most important crops growing in the site.

2) Determine changes in the relative importance of these crops over the period.

Source - Kecamatan Extension Service

B. Planting and Harvest Area Data

Description - Hectares of each crop planted and harvested each month.

Evaluation - 1) Determine the month of planting and time distribution of crop establishment.

2) Estimate the percent of cropped area damaged (planted area minus harvested area).

3) Estimate the percent of the area double cropped.

4) Identify the major cropping pattern by observing planting sequences.

Source - Kecamatan Extension Office

C. Yields by Crop

Description - Yield of each crop (by season) for past five years. Yield of rice by production program participation (Bimas, Inmas) for past five years. Crop cut yield as estimated by Bureau of Central Statistics.

Evaluation - Identify the productivity level of each crop and changes in productivity over the past five years as an indication of the existence of yield constraints.

Source - Kecamatan Extension Office

D. Current Cropping Pattern

Description - Typical cropping patterns grown in the areas, by type of land. Also, percent of area allocated to each pattern.

Evaluation - Describe cropping patterns and relative importance of each.

Source - Farmer Group Interview

E. Historical Cropping Pattern

Description - Major changes in cropping patterns that have occurred over the past ten years and causes of these changes.

Evaluation - Identify the dynamic factors that have influenced local cropping patterns.

Source - Farmer Group Interview

IV. INSTITUTIONAL FACTORS

A. Land Ownership Inequality

Description - Hectares of land by type (sawah, upland, home-lot) owned by size of holding class.

Evaluation - 1) Estimate the percent of holdings by size class: 0-0.25, 0.26-0.50, 0.51-0.75, 0.76-1.00, 1.01-1.25, 1.26-1.50, 1.51-2.00, 2.01-2.50, 2.51-3.00, 3.01 or above, to identify degree of social inequality existing in the village.

2) Quantify the degree of inequality of land ownership through graphing a Lorenz curve (i.e. % of land owned by 10%, 20%, 30% etc. of the largest owners) and estimating the Geni ratio of land holding inequality.

Source - PPL at Wilud or letter C list in Desa Office

B. Tenure

Description - Number of farmers who are land owners, lease-holders, and share tenants.

Evaluation - Estimate the percent of cultivators by tenure class to indicate the degree to which farmers are able to independently make input and cropping pattern decisions.

Source - Reksabuni (PTD) in Desa Office

C. Landless Labor

Description - Number of landless laborers (i.e. landless laborer is any farmer who owns less than 0.2 ha of land).

Evaluation - Estimate landless laborers as a percent of farming population to indicate availability of labor and degree of economic inequality.

Source - Desa Official, Farmer Group Interview

D. Support Services

Description - Number of extension officers, input dealers, and output wholesalers by crop.

Evaluation - 1) Estimate the number of extension workers/ha as an indication of the adequacy of extension support.
2) Describe the availability input and output dealers as an indication of input supply marketing and opportunities.

Source - Desa Official, PPL, Dealers, and output meddlemen.

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E. Credit

Description - Number of farmers participating in Bimas during each of past five years. Number of farmers defaulting on government loan during each of past five year. Total amount of institutional credit extended during each of past three years.

Evaluation - 1) Estimate the percent of farmers participating in the government production programs and trends in participation to indicate degree to which modern technology has been introduced.

2) Determine the loan default rate and trends in default to evaluate riskiness of production.

3) Estimate the average loan size per program participant and per hectare in the production program to indicate amount of credit used by the farmers.

Source - BRI unit desa for Wilud

F. Input Sales

Description -Total sale of fertilizer, insecticide, and rat poison for past three years, by type.

Evaluation - Estimate the average level of inputs used/ hectare of cultivated land to indicate intensity of input use.

Source - Input dealer for Wilud

G. Input Timeliness and Availability

Description - Date when inputs were delivered to be input dealers and stock of inputs by month for past two years.

Evaluation - 1) Determine the availability of inputs relative to farmers planting date to indicate timeliness of the input supply.

2) Describe the supply of inputs relative to farmers' demand to determine if a shortage of inputs existed.

Source — Input dealer, for desa, Farmer Group Interview

H. Irrigation Water Availability

Description - Irrigation water schedule over the year and the organizational structure controlling the distribution of water at the village level.

Evaluation - 1) Determine the timing of water distribution to evaluate how this will influence cropping pattern design.

2) Describe farm level water distribution system to identify potential for earlier planting and crop intensification.

Source - Irrigation Office, Desa Office (ulu-ulu)

V. LABOR

A. Employment Profile

Description - Number of persons engaged in the major occupational categories.

Evaluation - Estimate the degree to which the area is agriculturally dependent and size of the local market demand for agricultural products.

Source - Desa Office (Juru Tulis)

B. Population

Description - Population by age group and sex and number of households.

Evaluation - 1) Describe the sex distribution of the adult population (18-60 years) to evaluate the possibility of a out-migration of male worked which would contribute to a shortage of labor for crop production.

2) Calculate the average household size as indicator of availability of labor.

3) Calculate the average household age as an indicator of the family maturity level and availability of family labor for agriculture.

Source - Desa Office. (Juru Tulis)

C. Off-Farm Employment

Description - Employment opportunity by season in major off-farm jobs.

Evaluation - 1) Determine the degree to which agriculture provide off-farm employment to the farmers.

2) Determine when off-farm seasonal labor demand is greatest to guide pattern design with respect to seasonal labor requirements.

Source - Desa Office, Farmer Group Interview

D. Migration of Agricultural Labor

Description - Amount and source of non-resident labor drawn to the site, by farming operation and season. Amount, destination and wage rate received by residents seeking non-farm employment outside the desa.

Evaluation - Identify the existence of labor bottlenecks, associated with specific operations and seasons.

Source - Farmer Group Interview

VI. FARM LEVEL

A. Wages

Description - Wages paid over the past five years for major operation (land preparation, transplanting, weeding, harvesting).

Evaluation - Estimate changes in the real wage rate as an indication of welfare and an existence of a shortage of labor.

Source - Farmer Group Interview

B. Power

Description - Cost of power (animal and tractor), environments where power is used, type and horsepower of power used and number of tractors and draft animals.

Evaluation - 1) Describe the type of power availability for land preparation.

2) Determine the degree of mechanization as measured by ha/carabou and ha/tractor.

3) Compare cost of land preparation by man, carabou and tractor.

Source - PPL at Wilud, Desa Office, Farmer Group Interview

C. Varieties

Description - Hectares in major varieties, farmers' evaluation of each variety and availability of improved seeds.

Evaluation - 1) Determine type of varieties used as an indication of leve of existing technology.

2) Determine acceptability of modern varieties to the farmers.

3) Identify seed shortages.

Source - PPL at Wilud, Farmer Group Interview.

D. Planting Decision Rule

Description - The guidelines farmers use in deciding when to begin land preparation and when to plant each crop.

Evaluation - Identify constraints to earlier crop establishment.

Source - Farmer Group Interview

E. Input Levels

Description - Input levels used by crop, season, environment and other factors that may influence input use such as variety.

Evaluation - Describe type of technology used at the site to assist in designing introduced pattern and component technology.

Source - Farmer Group Interview

F. Constraints to Higher Yields

Description - Major historical (biological, institutional, socio-economic) and recent (last 2 years) constraints to higher yield by crop. Factors believed to be yield reducing at the site.

Evaluation - Describe possible factors to consider in attempting to increase yields.

Source - PPL at Wilud, Farmer Group Interview.

G. Constraints to Increasing Cropping Intensity

Description - Major historical and recent constraints to increasing cropping intensity. Factors believed to make it difficult to grow more crops/year.

Evaluation - Describe possible factors to be considered in attempting to increase cropping intensity.

Source - PPL at Wilud, Farmer Group Interview.

VII. PRICES

A. Inputs

Description - Prices of inputs at the site.

Evaluation - Determine the markup on inputs above official dealer price as an estimate of transportation costs.

Source - Farmer Group Interview, Input dealer closest to desa.

B. Output (crops)

Description - Monthly price of major crops sold in the main market where farmers sell their crop, for past three years.

Evaluation - Estimate the mean yearly price and standard deviation around the mean to determine price level and seasonal variability and potential income gains from early planting.

Source - PPK, (Bureau of Central Statistics field officer).

VIII. COMMUNITY INFRASTRUCTURE

A. Transportation

Description - Type of roads connecting site to nearest main market, number of vehicles passing through site per day, and cost/100 kg of product to transport to nearest major market.

Evaluation - Describe the potential input supply and output marketing constraints.

Source - PPL at Wilud, Desa Office.

B. Markets

Description - Number of times nearest market convenes per week, size of market (number of product sellers or volume of sales by crop), and distance to market.

Evaluation - Determine the availability of marketing opportunities and degree of market development.

Source - PPL at Wilud/Farmer Group Interview

The data listed above will provide on overview of the agronomic and socio-economic characteristics of the site. When the data is collected, evaluated and reported before the agronomic trials are finalized, this data will assist in identifying the type cropping pattern and component technology research that will be most productive.

Appendix IV

Workshop/Seminar on Fertilizer Use

Jakarta, December 1976

SIMPLE DISPERSED TRIALS AND THEIR ECONOMIC ANALYSIS

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Project Manager

FAO/FFHC project for: Fertilizer Use and Crop Yield Improvement in the Upper Solo River Basin.

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SIMPLE DISPERSED TRIALS AND THEIR ECONOMIC ANALYSIS

The FAO Fertilizer Programme in Indonesia has carried out a large number of standard 8 plot dispersed fertilizer trials on farmers' fields in order to determine the fertilizer application which provides the optimum net return for the farmer. From a series of 8 plots (treatments), the comparison of 3 plots (treatments) for which the application rate of 2 nutrients is kept constant allows the determination of the optimum rate of the third nutrient. When the optimum for each nutrient has been calculated separately, the individual optimum rates are added to form a combined grand optimum which is then compared with the control plot.

Trial design:

Control plot	N trials	P trials	K trials
	0-1-1	1-0-1	1-1-0
	(1-1-1)	1-1-1	(1-1-1)
	2-1-1	1-1-1	1-1-1

The digits 0-1-1, 1-1-1, etc. stand for the coded fertilizer rates N P_2O_5 - K_2O. For instance, the central rate 1-1-1 may be 67.5 kg of N 45 kg of P_2O_5 and 30 kg of K_2O. The center treatment 1-1-1 is used for the determination of the response curves of all three nutrients. That is why it appears two times in brackets to indicate that we need to lay it out only once.

Seven treatments give us the munimum 3 points per nutrient required for calculating response curves, the eighth plot, the control plot is necessary for establishing the economics.

In this paper, the following trial results will be used as an example: MAIZE, Kabupaten WONOGIRI, 1973/74.

Trial results

Code	Fertilizer Treatment			
	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)	Yield (kg/ha)
Control				
0-0-0	0	0	0	517
Response to N				
0-1-1	0	30	30	636
1-1-1	67.5	30	30	1,585
2-1-1	135	30	30	1,740
Response to P				
1-0-1	67.5	0	30	1,235
1-1-1	67.5	30	30	1,585
1-2-1	67.6	60	30	1,657
Response to K				
1-1-0	67.5	30	0	1,584
1-1-1	67.6	30	30	1,585
1-1-2	67.6	30	60	1,540

1. Optimum fertilizer rate for "COLWELL'S" yield response curve*

   1.1 Optimum application for one nutrient

   1.2 Optimum application for the 3 nutrients

   1.3 Determination of the parameters of the yield response curve

*Dr. J.D. Colwell (CSIRO), Division of Soils, Canberra, ACT Australia.

[1]Detailed analyses in original paper.

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1.3.1 FAO standard trial design

1.3.2 Generalized formula

1.4 Worked Example

1.4.1 Parameters of the yield Response Curves

1.4.2 Optimum with individual nutrients

1.4.3 Optimum N - P_2O_5 - K_2O rate

1.4.4 Near optimum fertilizer rates

1.4.5 Worked example for 1.4.3 with fertilizer rate

2. Optimum fertilizer rate for "HAUSER'S" yield response curve

The same notation as under section 1 is used here.

2.1 Optimum application for one nutrient

2.2 Optimum fertilizer application for the 3 nutrients

Same as under 1.2.

2.3 Determination of the parameters of the yield response curve

2.3.1 FAO standard trial design

2.3.2 Generalized formula

2.4 Worked example

2.4.1 Parameters of the yield response curves

2.4.2 Optimum by individual nutrients

2.4.3 Optimum N - P_2O_5 - K_2O rate

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CSG - No. 1

Guide for
Rice Based Cropping System In Upland Agriculture
GROWING FIVE CROPS PER YEAR ON UPLAND
RED-YELLOW PODZOLIC SOILS

Abstract

Research in Central Lampung indicates that farmers who follow this cropping system can produce average yields of 2.0 tons of corn, 2.3 tons of rice, 0.6 tons of peanut, 0.6 tons of rice bean (or cowpea) and 24 tons of cassava in one year on one hectare of land. In terms of calories converted to gabah equivalent this amounts to 19 tons/ha of paddy rice.

Cropping Systems Working Group
Central Research Institute for Agriculture
Jl. Merdeka 99
Bogor, Indonesia

June, 1979

Guide for

Rice Based Cropping System in Upland Agriculture

GROWING FIVE CROPS PER YEAR ON UPLAND

RED-YELLOW PODZOLIC SOILS

In order to meet the increasing need for food production, upland farming-with complete dependence on rainfall-will become more important. Upland areas with annual rainfall of over 2,000 mm/year, which are mostly characterized by red-yellow podzolic soils that are acidic and low in natural fertility, could be highly productive if managed properly. It is estimated that there are 15 million hectares of this kind of land in Sumatra, Kalimantan and Sulawesi suitable for food crop production. Corn, upland rice, cassava and two legume crops could be grown in a year-round cropping arrangement that would permit five harvests per year, as shown in Figure 1.

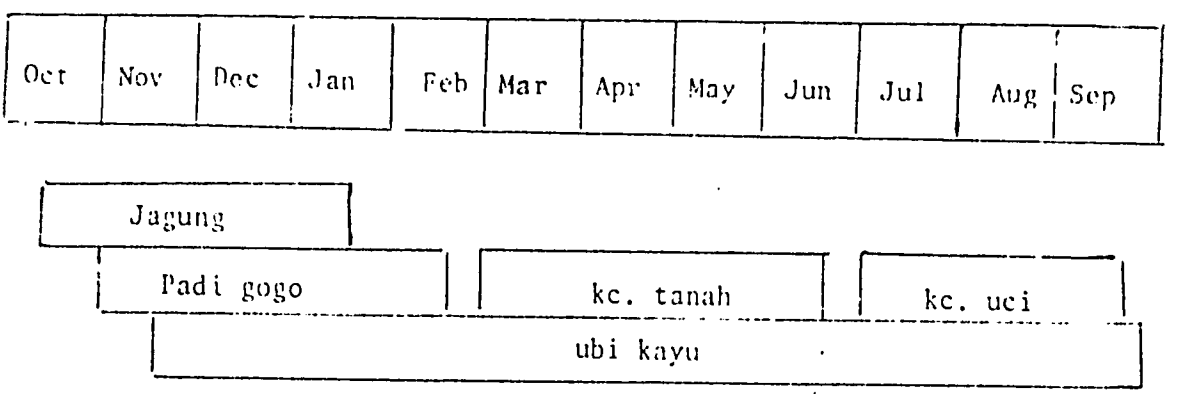

Figure 1. Cropping pattern for rainfed upland areas.

This manual is a guide for upland agricultural production, based on five years of research in Lampung and South Sumatra. We believe the technology described will also be applicable in other areas having similar agro-climatic and socio-economic conditions.

CULTURAL PRACTICES AND CROP MANAGEMENT

Land preparation

For newly opened alang-alang fields the alang-alang must be cut close to the ground and the soil hoed with a cangkul before the start of the rainy season. Then the land is left fallow for at least one month to allow the alang-alang roots to dry and decompose.

When the rains begin to fall, a second hoeing is done in strips spaced two meters apart for planting corn. Land preparation for the rice to be planted between the corn rows is done after the corn germinates. No cultivation is necessary for the cassava. The sticks are just directly slipped into the soil between the corn hills. This tillage system provides a more even demand for labor and quicker land preparation than a monoculture system. This permits the farmers to cultivate more land than would be otherwise possible.

Minimum tillage is recommended for the peanuts to be planted immediately after rice harvest. First, furrows are made along the rice stubble rows. Next, fertilizer and peanut seeds are dibbled into the opening and covered with soil.

After the peanut harvest, one light hoeing is made to control weeds and loosen the soil for planting rice beans or cowpeas — the last crop in the cropping sequence.

Planting

The first corn crop is planted in rows 200 cm apart. Two seeds are dibbled by hand in small holes made by a wooden stick and spaced every 50 cm. The seeds should be of good quality (90% germination). This planting arrangement will give a population of about 20,000 plants/ha.

Two weeks later, rice seed is dibbled every 10 cm within the rows which are spaced 40 cm apart between the corn rows. We try to drop about five seeds per hill. The rice population is not reduced because of the corn. There will be five rows of rice between two rows of corn. Planting rice two weeks after the corn reduces the shading effects of the corn on the rice. By the time the rice plants flower (the most critical stage), the corn is ready for harvest.

One and a half months after planting the corn (one month after rice), cassava sticks are inserted between the corn hills in every other row, giving a cassava spacing of 400 x 50 cm. The population of cassava will be 5000 plants/ha.

After harvesting the rice, the straw is cut close to the ground and pushed aside into the cassava rows. Peanut seed is dibbled beside each hill of rice stubble (one seed/hill) at a spacing of 40 x 10 cm. The rice straw is then spread out on the field surface as mulch. This is very important to suppress weed growth and conserve both soil moisture and organic matter.

After peanut harvest either cowpeas or rice beans may be planted as the last crop in the sequence. The seeds are planted at a spacing of 40 x 20 cm with two seeds/hill.

Fertilizing

We follow the principle that fertilizers should be put as close as possible to the root zone so that the plant roots can easily reach the nutrients and make efficient use of them. For phosphate this can be done by evenly distributing the fertilizer at the bottom of the furrows made for the plant rows of each crop. For nitrogen and potassium the fertilizer should be banded in a row beside and below the seed. The amounts of fertilizer needed for each crop in the pattern and time of application are shown in Table 1.

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Table 1. Kind, amount and timing of fertilizer applications in the cropping pattern

Crop	0 DAP[a]		14 DAP	30 DAP	42 DAP	Total/crop	
	Urea	TSP	Urea	Urea	Urea	Urea	TSP
	kg/ha						
Corn +	25	50	0	50	0	75	50
Upland rice +	0	100	100	0	50	150	100
Cassava /	0	0	0	0	0	0	0
Peanut /	25	50	0	0	0	25	50
Rice bean/cowpea	25	50	0	0	0	25	50
				Total/year		275	250

[a]DAP = Days After Planting

Weeding

Normally one or two weedings are enough. The time for the first weeding depends on the weed situation. But we must make sure that the rice crop is free of weeds during the early vegetative stages. Weeding can be done by hand or with any appropriate tools that are available.

Pest management

During the early growth stages, corn, rice and legumes can be well protected by seed treatment with the granular insecticide, Furadan 3G. For rice, 30 grams of Furadan 3G/kg of rice seed is effective. Mix the insecticide with the seed and add sufficient water to just cover the mixture. Allow the seed (and Furadan) to soak for about 12 hours.

For corn and legumes Furadan 3G may be applied with the seeds at planting at a rate of 7.9 kg/ha. The amount of Furadan 3G that can be easily held between two finger tips is about the right amount per hill. If Furadan is not available we recommend at least two sprayings of Diazinon, Sevin, Surecide or Azodrine at ten day intervals. The first spraying should be made 7-10 days after planting and the second when necessary.

Harvest and crop residue management

This cropping pattern provides five well distributed harvests throughout the year. One important thing to keep in mind is that all crop residues should be returned to the soil after harvest in order to conserve soil fertility.

Corn will be harvested first. The stalks are cut and laid down in the original rows. Next, rice is harvested. The straw is used as mulch for the following peanut crop. In order to avoid disease problems, the peanut straw is usually taken from the field. The straw from the following legume crop (rice beans or cowpeas) should be incorporated into the soil during land preparation for the next season. Cassava is the last crop harvested in this pattern. The leaves should be left in the field, but the stems removed. All diseased plant parts should be burned.

VARIETIES AND CROP ARRANGEMENT

Varieties that may be used for each crop along with the spacing, plants per hill and seed requirements are shown in Table 2.

Table 2. Recommended varieties, spacing and amounts of seed required.

Crop	Variety/Selection	Spacing (cm)	Plants per hill (No.)	Seed required (kg/ha)
Corn +	Harapan Baru/DMR-5/ Bogor DMR-4	200 x 50	2	12
Upland rice +	Gati/C-22/Seratus Malam/ Cartuna/Gamma-61	40 x 10	5	30
Cassava /	No.528/Gading/Local (non branching)	40 x 50	1	5,000 sticks
Peanut /	Gajah/Kidang	40 x 10	1	120
Rice bean	Local	40 x 20	2	20
or				
Cowpea	No.191/No.126/Local	40 x 20	2	20

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