PN-AAU-337 43375

INSTITUTIONALIZING FSR/E: THE INDONESIAN EXPERIENCE

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INTRODUCTION

The gradual development of farming systems research in Indonesia started with some multiple cropping experiments conducted during the rainy season, 1970, at the Central Research Institute for Agriculture (CRIA), Bogor. These on-station multiple cropping experiments were similar to those carried out at IRRI. The pioneering research at IRRI by Dr. Bradfield and the ensuing training courses stimulated interest in looking at traditional as well as introduced, intensive multiple crop systems. However, it was soon realized that this on-station research simply served as a demonstration and that more useful information could be obtained from monitoring and studying existing patterns under farmers' conditions in farmers' fields.

In the following years, more research was conducted in several locations in farmers' fields in cooperation with the Directorates of Techniques, Production and Extension, all sister organizations within the Directorate General of Agriculture. Based on this interest and research, USAID and the Government of Indonesia developed a CRIA/IRRI Cooperative Project to provide technical assistance for training, equipment, and supplies and expatriate technical support. It was decided that on-farm research involving intensification of crop production in lowland rice producing areas on Java and evaluation of the production potential and stability of upland rainfed transmigration areas in South Sumatra were the principal goals. The main objectives of these research efforts were to increase crop production in ways that were acceptable to farmers. Consequently, in addition to interdisciplinary biological research (agronomy, breeding, entomology and physiology) economic research was determined to be a necessary component. For example, farmers in Indramayu had previous experiences in growing sorghum after rice. The crop was biologically feasible and produced well, but unfortunately no markets existed. On the other hand, there was little known about the agricultural practices, marketing channels and economics of small mixed farm systems in Lampung.

In 1975 IDRC provided additional support for cropping systems research through IRRI to CRIA. In 1976 the Directorate General of Transmigration became interested in our research and provided funds for cropping systems research in several new transmigration sites. Later, these activities increased further through support of other cooperating agencies and sites were established in Provincial Development Project (PDP) areas in Central Java and Nusa Tenggara Timur (NTT), in the Citanduy Upper River Watershed Project in West Java and in rural development projects in Yogyakarta and Central Java. There have been or presently exist at least 40 cropping/farming systems research sites, just within the Food Crops and Soils Research Center (Figure 1). The research programs vary from one site to the other depending on the respective site

characteristics and needs. Within each site, the research program changes with time as research progress changes the needs.

The initial cropping systems research program has developed several alternative cropping patterns for different agroclimatical and edaphological conditions. In general, it is our feeling that the primary thrust of the cropping systems research has been carried out. There will always be a need for improvement of technology, but much of this can be done through routine commodity and disciplinary research. However, since farmers deal with many components in their farming systems, the interaction of the cropping systems with other components of the farming systems must receive more research emphasis if we are to really help the farmers. Therefore, this research has become pragmatic and oriented more toward farming systems. But it is focused research in that only the most important combinations of components of the farm systems are studied at one time. Consequently, even though animal and perennial crops are identified as parts of this farming systems that need some further research to improve the stability of food crops, production for food subsistence is still a necessity for many small farms.

Cropping/farming systems research in Indonesia has responded to development needs and policy decisions. In the following sections some of the research activities, accomplishments, and objectives are used to illustrate the development processes and support the main purpose of this paper, which is to show how the research was organized and implemented institutionally and to suggest some improvements.

ORGANIZATION

In the early years (1970-1973) the research organization was very simple. There was only a small Multiple Cropping Group within the Corn and Sorghum Agronomy Section of the Central Research Institute for Agriculture (CRIA). CRIA was the research center for food crops under the Directorate General of Agriculture (food crops). During this period joint activities between the Multiple Cropping Group and a group at the Directorate of Techniques (the same level as CRIA, under the Directorate General of Agriculture) carried out cropping systems research in almost all provinces in Indonesia. Early in 1973 the CRIA/IRRI Cooperative Project was started and a cropping systems specialist/agronomist was assigned to work at CRIA.

At the first Indonesian Workshop on Cropping Systems, held in September 1973, it was agreed to strengthen and widen the number of agencies involved to include the Directorate of Extension, Directorate of Economics and the Directorate of Production (all at the same level of CRIA, under the Directorate General of Agriculture). The working group was formalized and a program was established during this workshop. The primary cementing agent for holding together this ad hoc group was provided through short term as well as long term training at IRRI and other places. Consequently, the research started in 1973 was carried out by an interdisciplinary group, with leadership coming from corn agronomists within the CRIA. This research expanded considerably in 1975, when technical assistance was received from IDRC through the

CRIA/IRRI Cooperative Project. The research was further expanded in 1976, when funding was received from the World Bank through a CRIA/Transmigration project. By 1978 there were 25 research sites in Java, Sumatra, Kalimantan and Sulawesi, all within the CRIA research system.

Even though no national coordination was formally established to organize the cropping systems program within CRIA or CRIFC (Central Research Institute for Food Crops, after 1980), a program leader for cropping systems research was informally recognized. His coordination role was channeled through the cropping systems working group which has informally organized annual meetings (there have been 7 workshops) and provided the forum for coordination. During these workshops the previous research, development, and extension activities on cropping systems were evaluated and new programs were discussed. The actual activities were conducted by different institutions and agencies.

Within the past 5 years, scientists from other research institutes working with other agricultural commodities have taken part in the working group. Consequently, the organization changed from a Cropping Systems to a Farming Systems Working Group. Scientists from universities and other ministries are unofficial members of the Working Group and usually participate in the meetings.

These developments have all been in line with organizational changes in the research institutions. By 1978 the Agency for Agricultural Research and Development (AARD) became operational, and the research needs for agricultural development become more diversified. All research in the Ministry of Agriculture came under the administrative direction of AARD. In 1980, CRIA changed to CRIFC (Central Research Institute for Food Crops), and six semi- autonomous research institutes were organized under its framework. Each institute was given a specific research mandate (Table 1). Within each institute, cropping systems research exists as a sub-project of the research and development programs. This kind of decentralization was carried out for all of the Research Centers in AARD. On the other hand, the research administration was centralized. This permits more direct institutional back stopping necessary for Farming Systems Research from all of the research disciplines and agricultural commodities.

Figure 2 illustrates the organization of the Ministry of Agriculture and shows the agencies responsible for research (AARD), extension (AETE), and action programs (Directorate General). Figure 3 shows the organizational framework of AARD. In effect each Center may carry out systems research through its research institutes. The components of the farming systems may be studied and developed as need and opportunity exist. Within CRIFC, a concerted effect has been made for the past 12 years to carry out Cropping Systems Research in the major edaphological land areas of Indonesia. More recently all of the research centers concerned with agricultural commodities (food crops, animal husbandry, fisheries, industrial crops, and forestry) have started similar programs but adapted to meet their special needs. The concept of interdisciplinary research in the various research centers is illustrated by the vertical columns in Figure 4. Together all these components

(represented by centers) make up a farm system that may be studied through Integrated Mixed Farming Systems Research and Development (horizontal arrow, Figure 4). This kind of research is usually carried out in specific target areas. The target areas may be selected by researchers based on scientific reasoning but more likely are selected by policy decisions and development activities.

The farming systems research approach widely used in Indonesia is shown in Figure 5. The general format of this diagram is similar to that of farming systems research diagrams from other countries and parts of the world. The details vary because of need, starting point, government structure and policy. Phases I and II of Figure 5 involve site description and identification of problems for the target area.

It is assumed that some technology is already available (Technology Transfer In) but is quite limited. It is further assumed that some on-site trials, tests, and studies will be required to help identify priorities for research and systems to be tested. Design and testing of farm systems in a partial or holistic fashion is carried out in Phase III. It should be pointed out that these first three phases may be carried out in chronological order or simultaneously, depending on the situation. In many farming systems programs Phase IV may be carried out by a joint research extension activity or exclusively by the farming systems research project. In Indonesia, however, where the extension services are well developed, particularly in food crops, Phase IV as well as V are carried out by the extension and implementing agencies. It is imperative that formal and informal contacts be made with the local farmers, extension services, and other government agencies to gather ideas, data, and seek support for all phases of the research and finally for implementation. This approach is illustrated in Figure 6. Finally research technology developed in one target area may be transferred wholly or in part to other areas having similar soil, climatic, biologic, and socioeconomic conditions. Figure 7 compared to Figure 5 (Phase IV) shows how as much as two years of time may be saved through this process.

In summary, systems research in agriculture in Indonesia exists with different levels of complexity. Each institute may carry out systems research relevant to its research mandate. These components may be studied together in the context of a project at the center level or holistically at the AARD level, as need and judgment indicate.

Past Cropping/Farming Systems Research

The cropping systems research program that was started in 1973 has developed on-farm research capability and has successfully developed stable and sustainable cropping patterns that are acceptable to farmers for the major land areas in Indonesia. This research effort has been interdisciplinary and integrated with other government agencies through on-site research, workshops, and training activities. Gradual adoption of research findings by farmers has increased year by year. But implementation of the technology in the 1982-83 crop year through BIMAS, INSUS, and OPSUS programs for the major land areas represents a major breakthrough for the wide scale adoption and transfer of new technology (Table 2).

The principal objectives of the cropping systems research have been to develop technologies that will permit use of marginal or under utilized lands and more intensive cropping patterns for existing and productive agricultural areas. These technologies must be economical and acceptable to farmers. Methodology for the research include assessing within selected target areas the existing socioeconomic situation and potential for agricultural production; designing and testing of improved cropping patterns; evaluating and monitoring of on farm trials; transferring of technology to appropriate government agencies for multi-locational trials and pilot production according to methodology outlined in Figures 5 and 7. Research has been conducted in the major lands areas in Indonesia.

Lowland Rice Areas

The greatest potential for immediate increases in food crops production exists in lowland areas which have enough infrastructural development to support intensified agricultural production efforts. Consequently, under these circumstances, where considerable irrigation and drainage efforts have been made, cropping systems research has been able to develop technologies to further intensify crop production. In a similar fashion, but to a lesser degree, we have developed more intensive systems for rainfed areas. The strategies used have included introduction of early maturing and improved crop varieties, direct seeding of rice, reduction in turn around time between successive crops, and improved crop management techniques. To facilitate research in the fie'd and direct research to more specific research issues, these land ar .s were usually partitioned according to water availability into the following:

Categories for study

- Irrigated lowland
  - Full - 10 months or more
  - Partial - 7-9 months or 5-7 months
- Rainfed lowland
  - Humid areas
  - Drought prone

On-site research was carried out in six sites in West Java, Lampung, .st Java (Madura) and South Sulawesi. The initial and most mprehensive research was in the Rentang and Jatiluhur irrigation stems in Indramayu. Inspection of the area indicated that usually only ɔ rice crops were grown in the 7-9 months and fully irrigated areas. ıally only one rice crop was successfully grown in the areas with less 'igation. If a second crop was planted, water shortages drastically uced yields. On the other hand, the practice of direct seeding of e, on aerobic soil and then allowing the field to flood as the rains reased (gogo rancah) was being developed by the extension service on nfed areas in Indramayu. This practice permitted some intensification ı without irrigation (Tables 3 and 4).

Cropping systems research successfully showed how these systems could be further intensified through use of earlier maturing crop varieties, use of gogo rancah in partially irrigated and rainfed areas, and reduction in turn around time. Component research developed more appropriate fertilizer rates and methods of application, insect control measures, and weed management.

The rotation pattern of "lowland rice - lowland rice - legume" was successfully and profitably grown in 7-9 months irrigation categories. A combination of gogo rancah rice and lowland rice in the pattern "gogo rancah - lowland rice - cowpea" permitted the production of three crops in one year where previously only one crop was grown in the other areas which received only 5 months or no irrigation.

The adoption of this technology was slow from 1973-1977. The longer maturing Pelita varieties, which were vigorous and high yielding varieties of good quality, were widely accepted by farmers. But because of late maturity only one good crop could be grown per year in the partially irrigated and rainfed areas. Farmers were reluctant to change to earlier maturing varieties until they were forced to change during the brown plant hopper epidemic in 1977. The introduction and use of IR36, which has a field duration on only 90 days when transplanted, removed much of the risk for intensifying cropping patterns. Consequently, after adoption of earlier maturing varieties, rice production has drastically increased, because two crops can be grown with little risk in irrigated and partially irrigated areas. One good crop can be grown in the rainfed areas. Programs for production of legume crops after rice are being implemented. These include soybeans in the irrigated areas, mungbean in partially irrigated areas and cowpeas in the rainfed areas. The major constraint to widespread and rapid adoption is availability of sufficient quantities of viable and vigorous seed of adapted varieties.

Upland Rainfed Areas

The second major target area for cropping systems research was the rainfed uplands that were being used for transmigration project development in Sumatra, Kalimantan, and Sulawesi. Generally these areas receive enough rainfall, adequately distributed for year around crop production, but management constraints have prevented stable and sustainable food crops production. There have been soil management, pest and disease, and socioeconomic problems that transmigrant farmers could not easily overcome by themselves.

The initial research showed that the existing cropping patterns could be simplified and made more productive by growing crops in rows, use of moderate rates of fertilizers, and returning crop residues to the soil directly or as manure. The technology developed in Central Lampung has been found to be applicable with some modifications for the humid areas of Western Indonesia where the rainfall is greater than 2000 mm per year and where there is no distinct dry season. The basic pattern of corn plus upland rice interplanted with cassava (corn + upland rice + cassava), however, is applicable and can be used throughout Indonesia. In the more humid areas the cassava is planted in rows placed two to four meters apart (depending on the market for cassava). One or two legume

(such as peanut or peanut followed by cowpea) may be planted n rows of cassava after the harvest of the rice. In the drought areas of Eastern Indonesia, where there is a prolonged dry season, ssava may be planted at random and interplanted with a drought nt crop such as cowpea.

his technology has been widely accepted by farmers and is now orated within the BIMAS production programs. Justification for sion of transmigration programs in the rainfed upland areas was to a large extent upon the initial data from cropping systems ch in Central Lampung and the successful transfer of technology gh on-site cropping systems research to other areas of South a, South Kalimantan and Southeast Sulawesi (Tables 5 and 6).

Swamp Areas

arambai, South Kalimantan was selected as the initial target area opping systems research in the tidal swamps. The tidal swamp gy varies considerably from place to place. The degree of structural development also varies. Barambai was chosen as an al target area because some stability has been imposed by drainage, clearing, and settlement activities through the transmigration am. It was felt that new technology could be directly transferred er land areas with similar descriptions and which were being used ansmigration.

In the initial surveys it was observed that indigenous farmers grew and other food crops, but that they invariably built raised beds and duced perennial crops such as coconut, clove, coffee, and citrus. ice varieties used were many times photoperiod sensitive, required al transplantings and took 7-9 months to mature. Introduction of er maturing rice varieties, improved fertilizer practices, and acid ant secondary crops permitted more intensive and productive crop ction in the lower bed. Longer term studies are needed to strate techniques for production of perennial crops and development e raised beds. But from field observations and theory, it was luded that gradual development of the raised beds by adding soil to sides of the beds each year would not only reduce the labor straints faced by farmers but would also permit gradual leaching of ulfurous compound from the soil added to the beds. This research ology has been included in pilot production programs jointly carried by the food crops research and extension agencies in South mantan. The prospects for transfer and widescale use of this ology are very good (Figure 8).

ENT FARMING SYSTEMS RESEARCH

The cropping systems research program has developed methodology and re of personnel that can design and carry out on-farm research. The ages with other commodity research groups and government agencies been developed. Gradually farming systems research capability that olistic has developed. In order to conduct research efficiently and ctively, it is still appropriate to identify and conduct research on

specific research issues that involve only two or three commodity groups or research components. For example, in the upland rainfed areas, food crops agriculture is necessary but usually limited to only a part of the land area owned by a farmer. The farmer finds difficulty to use more than 0.75 hectare of land for food crops production if only family labor is available. Extra power is needed if more land is to be cultivated for these crops. Usually production of food crops in excess of family consumption needs is not the most suitable use of the land. Labor shortages, risk from drought, pests and diseases, erosion, and marketing problems limit the attractiveness of food crops production. Yet most farmers own more than two hectares of land. How should this land be used? These are valid research issues, especially since the basic cropping systems for subsistence have been developed.

Crop/Livestock Research

Much technology has been developed for perennial crops. Present farming systems research strategy encourages the introduction of perennial crops into the farm systems gradually, as planting materials become available and as the farmers identify locations on their land where these crops fit. The major research thrust, however, involves the crop/livestock combination. Suitable on-farm research will be carried out to develop more stable and nutritious animal feed supplies. Animal health problems will be studied and controlled. Some research has been carried out in Lampung and South Sumatra in transmigration areas. However, longer term research is being planned that requires longer duration than can be carried out in the farmer's field.

Upper River Watersheds

Throughout Indonesia, settlements have flourished in the intra-mountain regions. The climates within these areas are moderated by higher elevations and proximity to the high mountains. These settlements have been stable and have flourished. Populations have increased and settlements have gradually moved onto lands that are too steep for stable and sustainable agriculture. Many of the lands are suitable only for forests and sources of water for rivers. Loss of the forests has exacerbated problems with flooding, erosion, and siltation during the rainy season and drought during the dry season.

AARD has collaborated with watershed projects in the Citanduy and Solo river systems and in Yogyakarta. These farming systems studies have also provided methodology and experiences for more comprehensive research. In particular research with cropping systems, bench terraces, and forage management has provided the technological base for expansion programs for soil and water conservation. These initial and limited efforts also provide the background needed for further research.

Basically, the traditional cropping patterns in both areas are similar and consist of a mixed cropping of corn, upland rice, and cassava. However, in Gunung Kidul the farmers also plant peanut after the rice harvest. The productivity of these traditional cropping patterns may be increased with better management and use of improved varieties. Better management includes the use of soil and water

ervation practices by terracing and planting of forage grasses on the ice risers. Brachiaria at Citanduy and setaria in Yogyakarta grow on the risers even during the dry season. Further studies are ed to determine the most effective management practices for use of forage grasses either for large or small ruminants.

Pests and diseases were found to be the major limiting factor for th and yield of crops in the upper watershed areas studied. Crop eties may also react differently to varying degrees of slope and ation. Consequently, further studies are needed to develop crop d stability in these upper river areas.

CTION AND STRATEGY FOR FUTURE RESEARCH

ping Systems Research

The main thrust for cropping systems research in Indonesia has been . Methodology has been developed, staff have been trained roximately 150 research and extension workers have been sent to IRRI other places for training, workshops, and monitoring tours in ping systems alone over the past 10 years) and systems research ied out in all the major ecological areas of Indonesia. These rts have been well executed and have received wide acclaim. However, research has identified many specific component studies that need ention, and there are problems for maintaining support and dination as administrative and personnel changes take place.

Coordination. Cropping systems research is basically the onsibility of the research institutes for food crops. These six onal institutes have their own research mandates and develop their research programs.

Consequently, with time each institute will develop its own cropping ems program designed to meet the individual research mandates. The itutes and their mandates are given in Table 1.

For the most part these mandates are based on an edaphological akdown of land areas in Indonesia. Each institute can and should lop cropping systems research suitable to their area and mandate. e is no need to use such terms as "rice based" or "palawija crop ed" cropping systems research, but to simply carry out relevant pping systems research. If the research is done well, the focus will ight also. To make this research as efficient and effective as sible, it would be useful to strengthen the National Cropping Systems ing Group that has functioned over the last 10 years and formalize periodic Working Group Meetings. The intent is to provide a nical advisory group to give direction to the coordinated research. organizational structure could be as shown in Figure 9.

Specific component studies. As has been pointed out, the basic pping systems research has been completed for the major edaphological l areas in Indonesia. The objective of the research has been mainly food self sufficiency. Unless there is a major production

breakthrough or change in the economics of food crops production and marketing, this objective will not likely change. But even with this limited objective there are constraints. There are problems with yield stability from one crop season to the next and sustainability of production over time. That is a problem particularly for the upland rainfed areas and the tidal swamps. In general, however, the major problem is to increase the cash income of the farmers. This will involve better use of land and development of alternative farm enterprises, as will be discussed in the next section on farming systems research. Some urgent research needs are suggested as follows:

A. Varietal improvements
- All crops
  - More tolerance to acid soils (Al)
  - Earlier maturity
- Upland rice
  - Blast resistance
  - Brown plant hopper resistance
  - Fast early growth, droopy leaves
  - Integrated Pest Management (IPM)

B. Soil conservation
- Upland, humid areas
  - Continuous land cover
  - Terracing - evaluation of different approaches
  - Waterways and impoundments
- Upland, drought prone areas
  - Continuous land cover
  - Alley cropping and terracing

C. Soil fertility and management - long term
- All upland areas
  - Soil characteristics related to crop performances
  - Lime x phosphorus studies
  - Organic matter management
- Tidal swamp areas
  - Soil characteristics related to crop performances
  - Evaluate systematically the raised bed-furrow bed system

D. Pest management
- All areas
  - Weeds, broadleaf (borreria)
  - Pod borers
  - Integrated pest management for blast and hoppers

E. Farm implements
- All upland areas
  - Seeders
  - Cultivators
  - Weeders

Uniform systems trials. We do not know the long term effects of intensive cropping nor the relationship between soil fertility and soil analyses and crop responses, particularly on soils in upland areas. We need to establish a transect of sites across Indonesia in the upland red-yellow podzolic soil areas to evaluate over a five to ten year period the effects of intensive cropping, soil fertility, and management practices. This kind of research has begun through the Fertilizer Efficiency and Cropping Systems Working Groups within the Centers for Soil and Food Crops Research.

A. Lime x phosphorus studies on intact and scraped (remove top organic layer ±cm) soils
   - Minimum input
   - Medium input
   - High input

B. Residue management studies
   - Remove
   - Return all
   - Supplement

C. High management plots - demonstration and yield potentials
   - High soil fertility
   - Fully terraced
   - Intensively cropped

D. Complete soil and plant analyses as required
   - Develop rationale-common methods
   - Correlation

Transfer of technology. Even though there has been more than ten years of cropping systems research and development, there is still much confusion concerning data, publications, guidelines, and/or recommendations. There are many reasons for this. We must plan the research better and improve the research quality so that it is more convincing to ourselves, colleagues, and clients. Site descriptions and abstracts, as shown in Appendix I, need to be further developed and stored, so that research results may be more easily disseminated. References of all reports, seminar papers, and published documents need to be compiled and computerized to permit quick retrieval (Appendix II).

In order to hasten technology transfer, cropping/farming systems research must improve the quality of research, develop more systematic means for discussions (workshops), and increase and improve research publications.

a. Improve quality of research
   - Coordination as has been stated
   - Improve precision of experiments
   - Improve data collection and characterization

b. Workshops
   - Discussion and concensus among working group members

- Planning and policy
- Where have been and where to go
- Analyze and discuss results of research

c. Research publications
- Complete
- Readable
- Authorized

Farming Systems Research

The usual farming systems in Indonesia are composed of several components. These components may be referred to as sub-systems and may be studied separately, for example, as cropping or animal systems research. On the other hand, the study of the whole farm with all its activities, would be called holistic farming systems research.

The initial work in Indonesia was pragmatic and largely directed by policy and circumstances. But gradually the research that started with intensification of lowland rice and long term soil fertility and management studies in Central Lampung has evolved and some projects that are being conducted by AARD are broad based farming systems research studies. Considerable experience has been gained and approaches developed to carry out effective farming systems research in the various land areas of Indonesia. There is a continual need for more effective coordination and planning.

Coordination. Farming systems research is basically the responsibility of AARD, just as cropping systems research is a responsibility of the various research institutes for food crops. In a similar fashion, we may consider cropping systems to be one component of the farming systems. The same relationship holds for the systems research from the other centers which represent commodities (Figure 4). Forestry, which is now a separate ministry, must also be a part of the farming systems research consortium, together with its soil conservation unit (P3DAS), and must be considered along with the other research groups. It is likely and even necessary that each center or research institute carries out its own systems research as it develops the technology to meet its mandate. But at some point it is useful and very important that all the relevant centers, agencies and universities work together in one project or geographical area. How can this work be administered and technically coordinated effectively?

Figure 10 shows an example of an organization framework for a Farming Systems Research Project. This is a large, long term project that will require a full time project leader and several senior staff from the various research centers. In many instances this kind of administrative and technical organization is necessary for area development projects. On the other hand, for other target areas it might be better to develop smaller research projects that are more narrowly focused. Broad based and holistic farming systems research can be very difficult to manage and may be inefficient. It may be better to build on past cropping systems research, and add complexity one step at a time.

In general, the objectives or goals given in Table 7 are relative for research in new transmigration areas in Indonesia. The degree to which we have accomplished the initial goals for subsistence determines what we do next. If these goals can be easily attained and the farmers desire more income and are not fully using their land and labor resources, another production component (agricultural enterprise) may be added to the system. There are several factors that farmers must consider when adding other agricultural activities to a subsistence (cropping) system. Usually in upland transmigration areas the decision to add depends on the following situations:

- Little opportunity for off-farm labor
- Family labor is not fully and efficiently utilized
- Land available is not fully utilized.

The actual farm enterprise added usually involves livestock or perennial crops or a combination of both. A research proposal for crop/livestock research has been developed to address some of the research issues involved for the Batumarta Transmigration Area. This proposal represents the "limited farming systems approach" that appears to be most efficient for most situations in Indonesia (Figure 11). We usually consider that farm families will, on their own, develop a home garden and gradually add perennial crops to the system. This process can be greatly simplified and assisted by research and development of relevant technology. Government assistance through production programs such as the nucleus estate programs being developed for rubber and oil palm can provide the quantity of production that is necessary many times to overcome processing and marketing constraints. Consequently, coordination is not only a prerequisite for effective research but also for technology transfer and implementation. Furthermore, we must realize that research and development activities are continuous processes and may never be developed to everyone's satisfaction. Policy and economic situations usually determine end points.

Target areas and research issues for FSR&D. The division of assignments among the various research institutes of CRIFC are done according to edaphological land areas (Table 1). This is an effective way of providing for research coverage and efficiency. These target areas may be partitioned further as needed. For example, the tidal affected land areas may be divided into direct, indirect, and drained tidal swamps. Each has characteristics that require special attention. For more general farming systems research the same target area divisions may be used but with additions as needed. One addition presently under consideration is the upper river watersheds.

It must be understood that each center is responsible for component and systems studies that relate to its speciality. For example, the cropping systems research and organization that has been described in this paper is or may be one example of a kind of research each should be doing. In an integrated farming systems project all or some of these components must work together. There is no need for one national farming systems project that covers all areas and conditions. There may need to be national coordination, as mentioned in the previous section, but research in each specific target area or division thereof may have its

own project management unit and project leader. Specific administrative and technical responsibility must exist if a project is to be effective. It is assumed that systems research in each center will provide much relevant component technology for target area research. However, this will not preclude further research on site.

Generally the target areas for integrated farming systems research in Indonesia are as follows:

- Tidal Swamp Areas
- Palawija Crops Areas
- Upland Rainfed - Drought Prone Areas
- Upland Rainfed - Humid Areas
- Lowland Rice Areas
- Upper River Watershed Areas

Research approach. The first five broad target areas given in the previous section coincide with the research mandates of five of the research institutes for food crops. The upper river watershed areas fall within each of these five target areas, but it is logical that the major research thrust be carried out by one institute. The upland Agriculture and Conservation Project that is being developed, however, will play a major role in addressing the research needs of these areas and will likely be administered by a project management unit directly responsible to AARD (Figure 10). Each of these target areas may be further partitioned into areas that require special attention or needs -- for example, farming systems and technologies needed for upper river watershed areas that differ according to erodibility of soil, steepness of land, development of infrastructure, and ownership of land will not be the same. Also, a drained tidal swamp area settled with transmigrants is vastly different (ecologically, biologically, sociologically and economically) from an indirect tidal swamp that has been settled for many decades by indigenous people.

Farming systems research should follow the basic format that has been successfully used for several years by cropping systems research in Indonesia and modified for farming systems research (Figures 5, 6 and 7). These diagrams show the basic strategy for farming systems research, including the interfacing with pilot production and implementation programs and the concept and value of technology transfer in saving of research time and effort. Figure 4 shows the interdisciplinary nature of farming systems research and the relationship of integrated mixed farming systems research with usual commodity oriented systems research. Figure 6 illustrates how farming systems research must be integrated (linked) with the other government agencies and farmers (including existing private enterprise) through all the farming systems research and development phases. These linkages are vital, especially for identification of research problems and for subsequent implementation of results.

These are general descriptions of activities and intentions of farming systems research. For Indonesian conditions, there are some specific research activities and approaches that need emphasis because of

the natural conditions, stage of development, and the availability of technology for the specific target areas.

a. Ex ante analysis. After target area and site selection and as part of the site description process, a complete ex ante analysis of existing and predicted farming systems should be completed. Through this analytical process many unviable systems may be rejected and the more robust systems identified for further evaluation. To do this, considerable background information and data are needed. Collecting these data is a logical function of the agro-economic studies team involved in site description. There is a need for the National Farming Systems Working Group to collect these data and reach a consensus among relevant scientists for the accuracy of the data. This background information is needed for the different agricultural enterprises, such as food, vegetable, and perennial crops and for fish, poultry, and animal husbandry. The data should include the following, which specifically relate to food crops but may be easily adapted to include perennial crops and livestock (including fish and poultry).

Suggestions: Data to be collected and verified for general use are:

- Management practices and labor requirements
  - Land preparation (plowing, terracing, and cultivation)
  - Planting (spacing, seeding rates, and varieties)
  - Fertilizer practices (rates, placement, and timing)
  - Pest and disease management
  - Harvesting
  - Post harvest (drying, storage, and transport)

- Costs of production
  - Labor (from above)
  - Inputs (from above)
  - Credit

- Expected yields
  - Individual crops (time as well as yields)
  - In combination (monoculture and intercrop)

- Expected sale prices

- Expected profit or loss from year to year until stable system is developed
  - Crop or agricultural enterprise
  - Whole system

b. Field laboratory. Much of the information needed for the ex ante analysis is available from routine activities and publications of the various research centers of AARD and the Directorate's General of the Ministry of Agriculture. It should be reiterated that farming systems research and development does not replace nor supercede the routine research and development activities of the Ministry of Agriculture. In order to develop more appropriate technology for farm systems for the different edaphological areas of Indonesia, more direct effort and interaction of researchers with farmers and their circumstances is

needed. This has been done through on-site research that is a routine part of cropping systems research. Within Indonesia, where so many different conditions exist (edaphological, sociological, and institutional), the gap between routine commodity and disciplinary research in research centers and on-site research in farming systems may be wide. For cropping systems research (a part of the farming systems), this has not been a problem.

On-site research for farming systems is not likely to be effective if there is insufficient technical and staff support from the research centers. Unfortunately, frequently the support that is available is fragmented according to discipline and commodities.

There is a need to provide a research environment for technology development that closely resembles the farming systems in which the technology will be used, but which permits more experimentation over a longer period of time under the researcher's control than can be managed through on-farm research. The relationship among research centers, on-site research and farming systems field laboratories is shown in Figure 12.

Suggestions:

Support the development of farming systems field Laboratories in which relevant component and systems technology may be developed and evaluated on an interdisciplinary, comprehensive and longer termed basis for the major edaphological areas of Indonesia where existing facilities are not adequate or appropriate. The objectives would be:

- to provide a central location for more efficient collection, evaluation, and transfer of appropriate component technology,

- to provide an opportunity to conduct long term experiments on topics such as, land clearing, perennial crops, soil conservation, water control, fertilizer efficiency, crop residue management, crop/livestock and stability, and sustainability of different farming systems and land management,

- to provide an environment for conducting interdisciplinary farming systems research before technology is transferred to farmers.

c. <u>On-site Farming Systems Research</u>. This kind of research must be on-farm and not as long term and comprehensive as that in the field laboratory. Since the methodology for cropping systems research and basic technology for cropping patterns and management have been developed for many agricultural areas, new studies will in most areas, concentrate on the development of stable and sustainable mixed farming systems. The research will focus on the components which appear most relevant, with the intent of making better use of farmer labor, reducing risk, and improving soil and water conservation practices. Since past research on

cropping systems has developed relevant technology for that component, new projects will in most cases emphasize animal, pasture, and perennial crops research. The order depends on field conditions on-site.

Suggestions:

Except for special circumstances, the farming systems research follows the sequence outlined below:

- Develop subsistence from food crops
  - Develop appropriate cropping systems
  - Produce calories needed
  - Determine minimum labor and land requirements

  Rationale:

  Except for lowland rice, food crops tend to have high risks for production and marketing and tend to have high labor peaks and seasonal demand for inputs.

- Develop cash income and minimize risk through diversification
  - Off-farm labor
  - Crop/livestock
  - Crop/livestock/perennial crops
  - Speciality crops

  Rationale:

  Diversification permits better use of land and labor resources and provides more market opportunities. Sequence of agricultural enterprises to study and eventually include in a farming system depends on the situation. Neither researchers nor farmers are able to cope with adjustments in all components at one time. Most likely sequence would be as shown above.

Linkages. Developing countries (in many instances) do not have a strong private sector. It is important that public institutions in these countries make greater efforts to see that the mechanisms for flow of technology and feedback are more highly developed and institutionalized. In this way, the problem of communication between institutions can be solved. However, there is still a problem of communicating with the farmers and learning their needs. In many instances this requires on-site research. One of the reasons for cropping/farming systems research is to solve these research and research dissemination problems.

Figures 5 and 7 illustrate the phases of a cropping systems research project in a selected target area. Linkages are established among farmers, research, extension, and other government agencies as each carries out their responsibilities within the project activities. The relative proportions of the work load distribution between research (FSWG) and the other responsible groups is illustrated in Figure 6. The important point, with respect to linkages that needs to be emphasized, is that closer and more constant contacts are necessary if farmers' needs are to be communicated to researchers and other government institutions and technology is to be effectively transferred from researchers through extension to farmers. Informal contacts and cooperation at the field

research and extension levels can be established easily, particularly if the staff are experienced and mature. The problem is how to insure these contacts if these staff are young and inexperienced. How can we be certain that the linkages are established in the research phases I, II and III and in the transfer and implementation of phases IV and V?

a. Linkages in research phases. The cropping/farming systems research strategy (in Indonesia) has emphasized the importance of maintaining close contacts with the extension services. This has been done informally in each target area simply because more formal approaches were too difficult to negotiate because there was no felt need nor precedent. Experienced cropping systems staff have been very effective in maintaining contacts. Where funds have been available through projects, special training sessions may be carried out for local field extension staff. Since these contacts are made at the field level and because of the organizational structure of extension, the transfer of technology to higher echelons and other areas does not always take place effectively.

Within the Asian Cropping Systems Network, some collaborating countries have used more formal approaches. For example, in the Philippines linkages between research and extension and other implementing agencies are sometimes formalized by a Memorandum of Agreement (Denning, 1981). This approach serves at least two purposes: 1)provide a systematic procedure for identifying and involving the relevant institutions needed for research and implementation; and 2)to encourage commitment and follow through by these institutions.

b. Linkages in the transfer phase. The input of research in this phase of research and development varies from country to country. In Indonesia the Directorate of Food Crops Production has the responsibility to plan and execute field trials and pilot production programs. In other countries in Southeast Asia much of this activity is carried out by the research organizations. The effectiveness of the linkages and mechanisms for strengthening the transfer process in Indonesia, again, depends upon mutual understanding of institutional objectives and activities. Seminars, workshops, and program reviews in which staff from the different agencies and institutions can interact serve this purpose. The Cropping Systems Working Group has made considerable effort to include staff from the Extension Services, Directorate of Production and Research in in-country, and foreign training programs. The existing transfer agencies have been able to carry out their roles, but there appears to be a need for more formal arrangements.

The Cropping/Farming Systems Working Group has seen the problems associated with informal research/extension linkages and the routine transfer processes. Technology transfer for single crop commodities (such as rice), pest control, or fertilizer management is much easier than for cropping systems. Changes or modification of systems many times involves not only biological sciences but also, economics, sociology and marketing. Consequently, all of the relevant government agencies that are related to these components of the system must play some role in the transfer process. How each is involved and their specific role in transfer and implementation is a legitimate research issue. In some

instances, particularly where there has been little experience, it may be argued that pilot production projects, in which all of the relevant agencies are involved, should be carried out. The Upland Agriculture and Conservation Project that is being implemented in Indonesia (Figure 10) will have a complementary expansion (implementation) program to test and transfer new technology.

c. Linkages in implementation. The production programs in Indonesia and the Philippines have been effective. Once the technology has been developed and transferred, these programs have proceeded to implement production programs. The colleageual contacts and routine meetings of program and research experts have provided much of the scientific backstopping needed. Are more formal arrangements needed?

At this stage in the research and development processes, precipitous changes in directions, recommendations, and instructions should be avoided. To provide for continuous flow of technical information, a system whereby extension specialists are administered and officed with research staff would be helpful. Perhaps researchers should be administered and officed with extension.

Technology transfer to similar areas. Field laboratories and on-site research activities are expensive in terms of personnel, funds, and time. It is not feasible nor necessary to carry out detailed farming systems research within all the various land areas in Indonesia.

There are two effective ways to improve efficiency for the development and use of technology.

a. Research coordination. This term has been used many times in this paper and will be used again to emphasize the importance of providing a format by which researchers have some feeling of research priorities but are not constrained by boundaries. Coordination can provide the framework that encourages collaboration but does not prohibit some competition. It discourages repetition of preliminary and shallow research and provides a mechanism for transfer of technology among scientists.

b. Site description and transfer of technology. Systematic socio-economic, soil, and biological descriptions of research sites provide the basis for technology transfer to target areas with similar conditions. Figures 5 and 7 illustrate the mechanism for this kind of technology transfer. It is not necessary to repeat all the research phases of a farming systems project in each target area. It is especially important in a developing country to make efficient use of research funds.

Suggestions:

- Organize a National Farming Systems Working Group similar to that for Cropping Systems (Figure 9) and provide for periodic group meetings and publication of data.

- Develop a systematic procedure for site description

and format for presentation of data so that all members of the Working Group understand each other's work (Appendix I).

Develop linkages for informal technologic transfer.

CONCLUSIONS

- Existing bureaucracy is usually comprehensive
  - Try to work within it.
  - Comprehensive FSR&E project may be competitive.
- Systems research is generally accepted
  - It may appear inadequate but output may be good.
- Institutionalization of FSR&E not always necessary
  - Many times it is better to work on project bases.
- Holistic approach is important for understanding farm systers in target area
  - It may be better to limit experimentation to critical but manageable components of a system.
- The major thrust of cropping systems research has been carried out in many countries
  - Work on research issues identified.
  - It is better to let existing bureaucracy take over if able.
- Make better use of existing data for ex ante analyses
  - Minimize time and expense factors.
- Good site descriptions and rapid publication facilitate technology transfer
  - Simplified research brief may be computerized for reference an use.
  - Internationally accepted terminology would be required.
  - International organization needed.
- Abstracts are needed for research papers that may never get into prestigious journals
  - International organization needed.
- Farming Systems Research is exciting and rewarding
  - But try to maintain professional competence in some discipl

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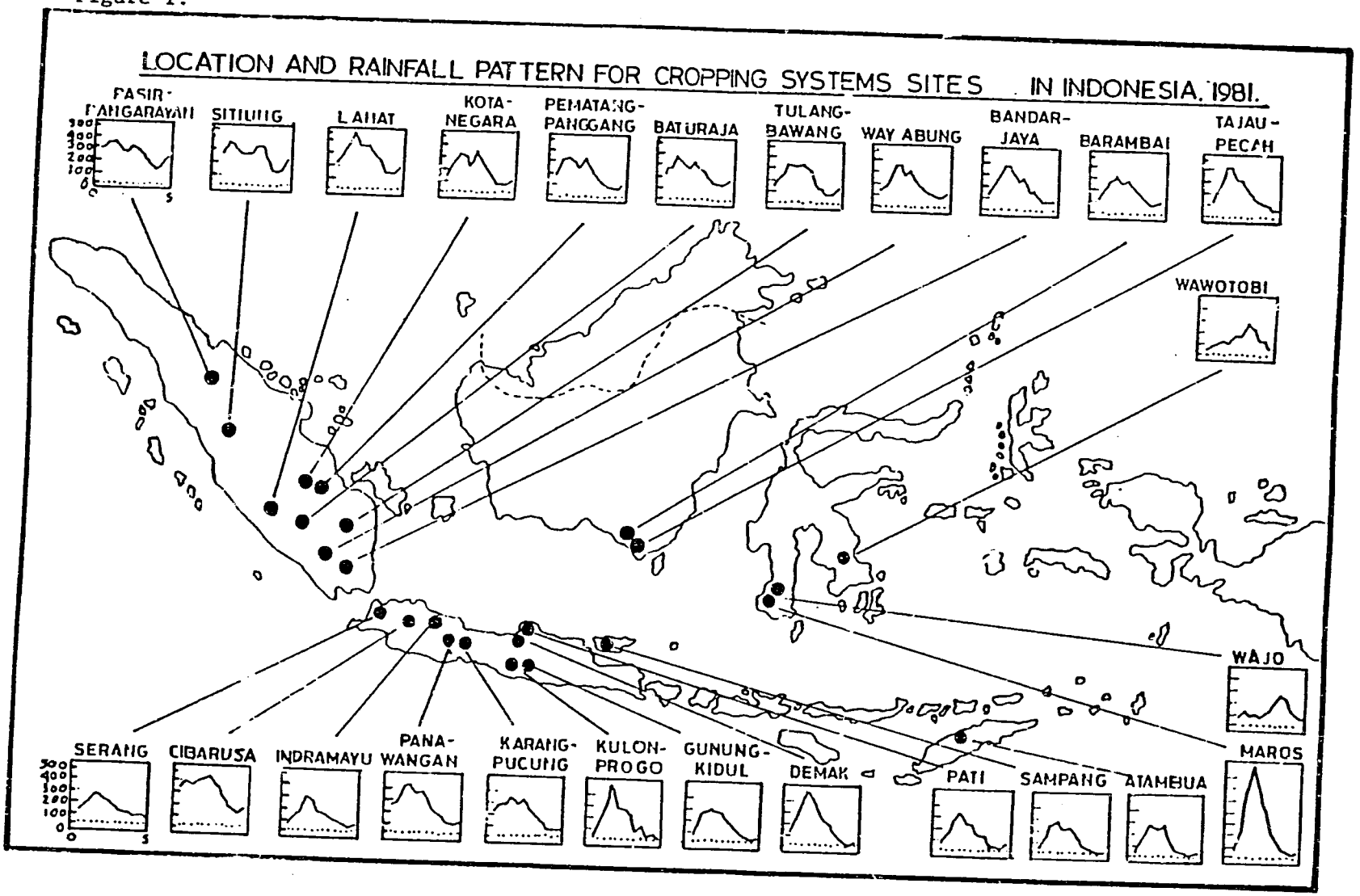
Figure 1.


LOCATION AND RAINFALL PATTERN FOR CROPPING SYSTEMS SITES IN INDONESIA, 1981.
PASIR-PANGARAYAN
SITIUNG
LAHAT
KOTA-NEGARA
PEMATANG-PANGGANG
BATURAJA
TULANG-BAWANG
WAY ABUNG
BANDAR-JAYA
BARAMBAI
TAJAU-PECAH
WAWOTOBI
WAJO
MAROS
ATAMBUA
SAMPANG
PATI
DEMAK
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KULON-PROGO
KARANG-PUCUNG
PANA-WANGAN
INDRAMAYU
CIBARUSA
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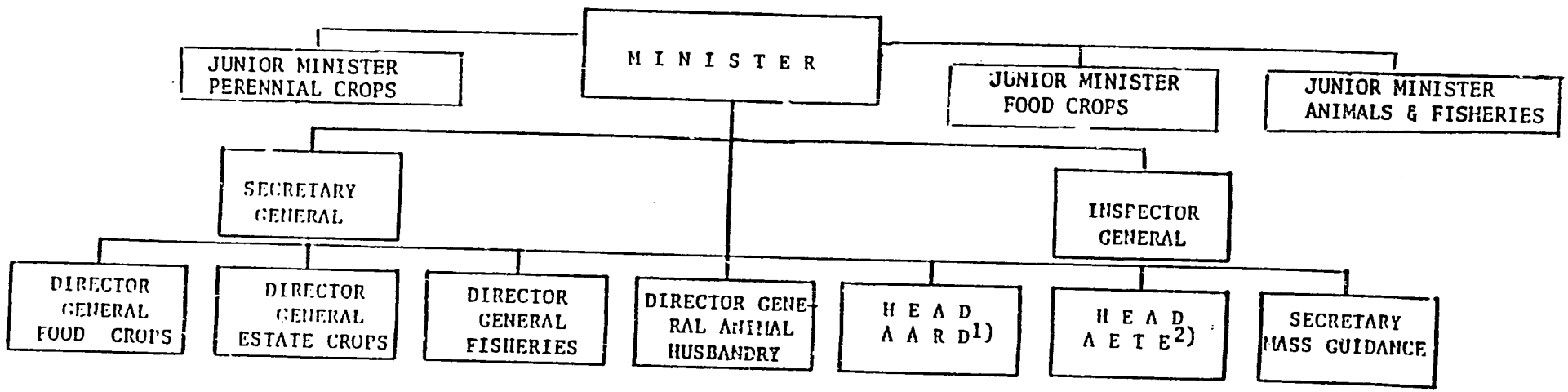


1) Agency for Agricultural Research and Development.
2) Agency for Agricultural Extension, Training and Education

Figure 2. Organizational arrangement of the Ministry of Agriculture

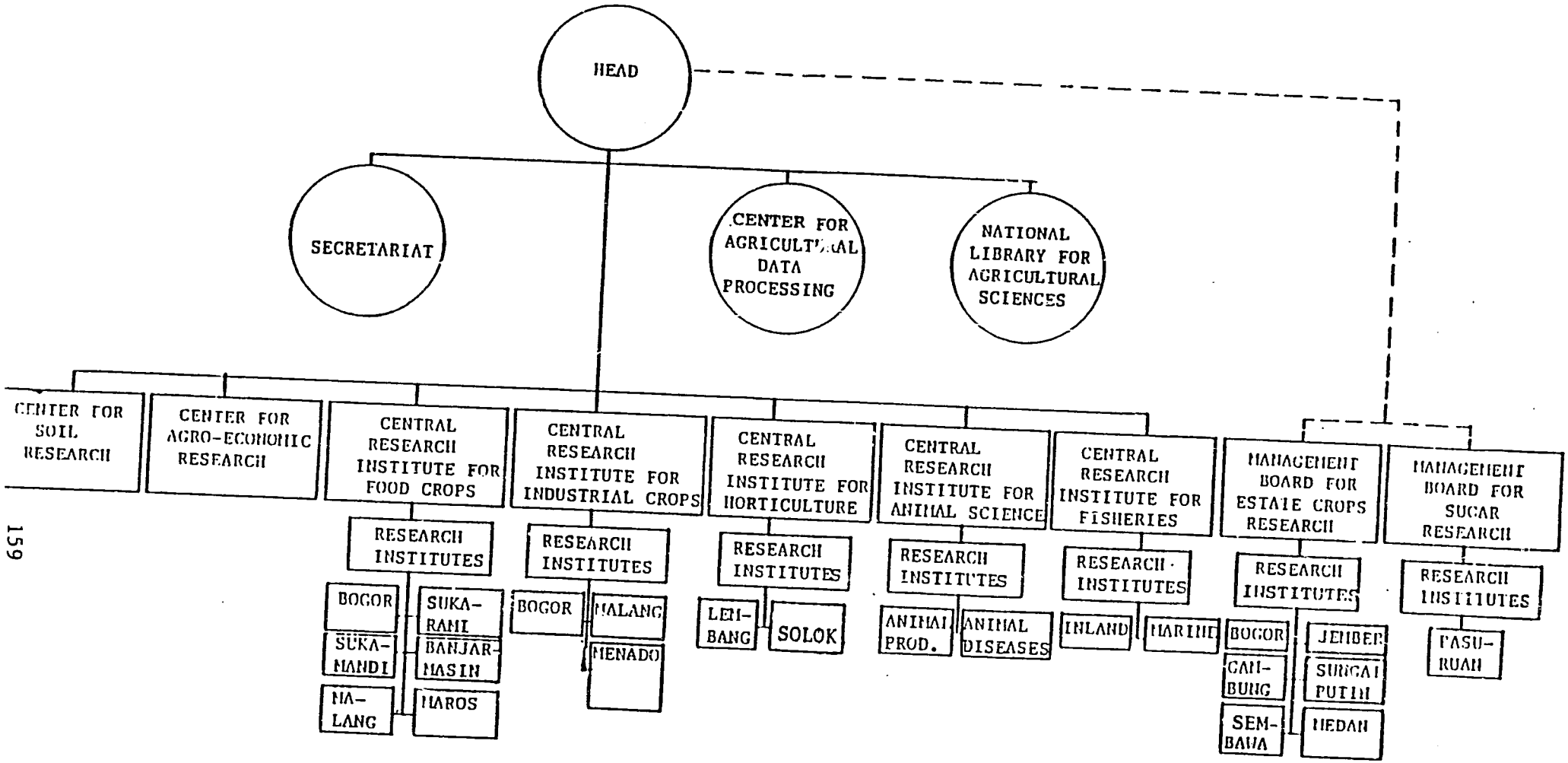
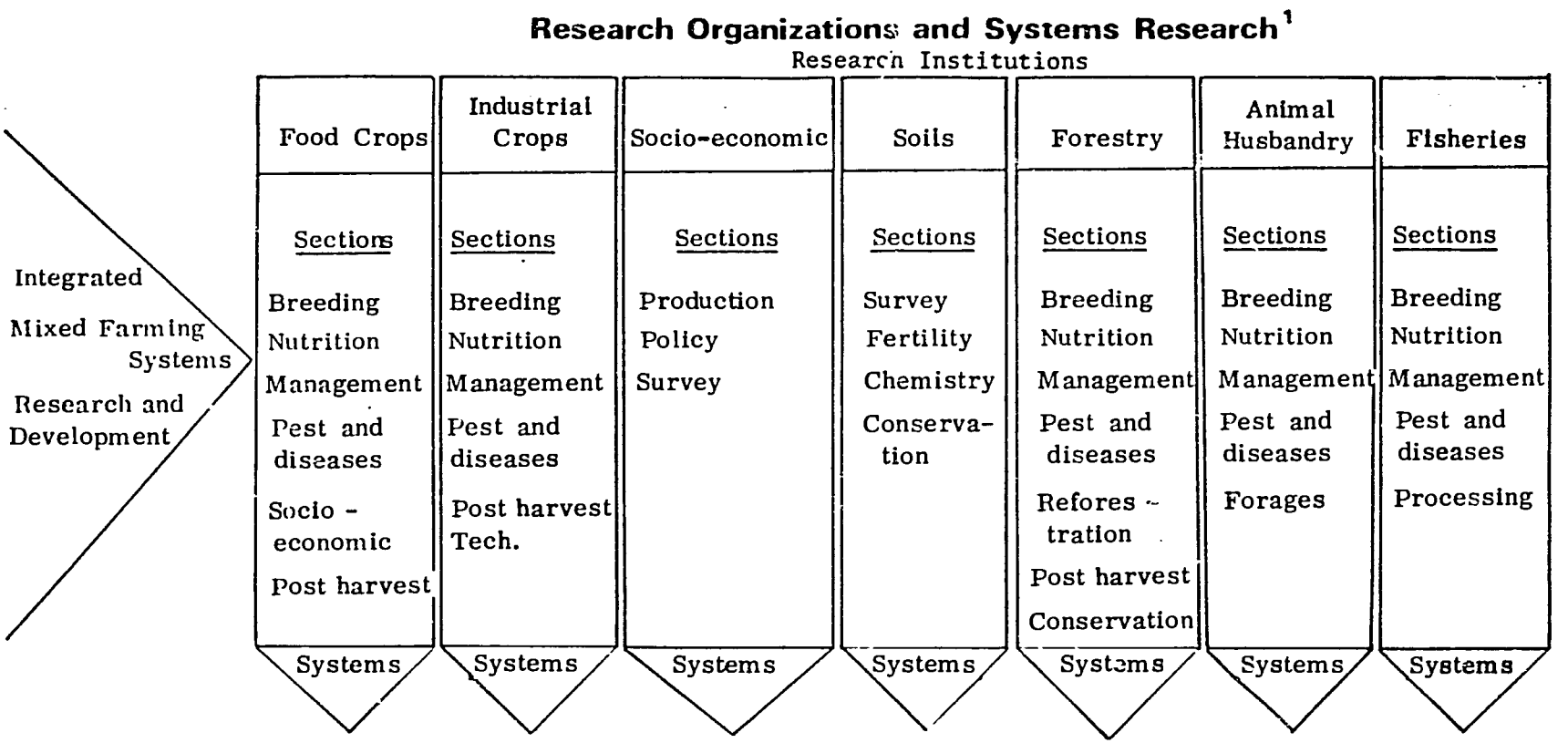


Figure 3. Organizational structure of AARD.



[1]this diagram illustrates how research in a farming systems program (FSP) interacts with other systems, programs and traditional commodity and discipline-oriented research activities.

Figure 4.
Framework for integrated mixed farming systems research for small farms.

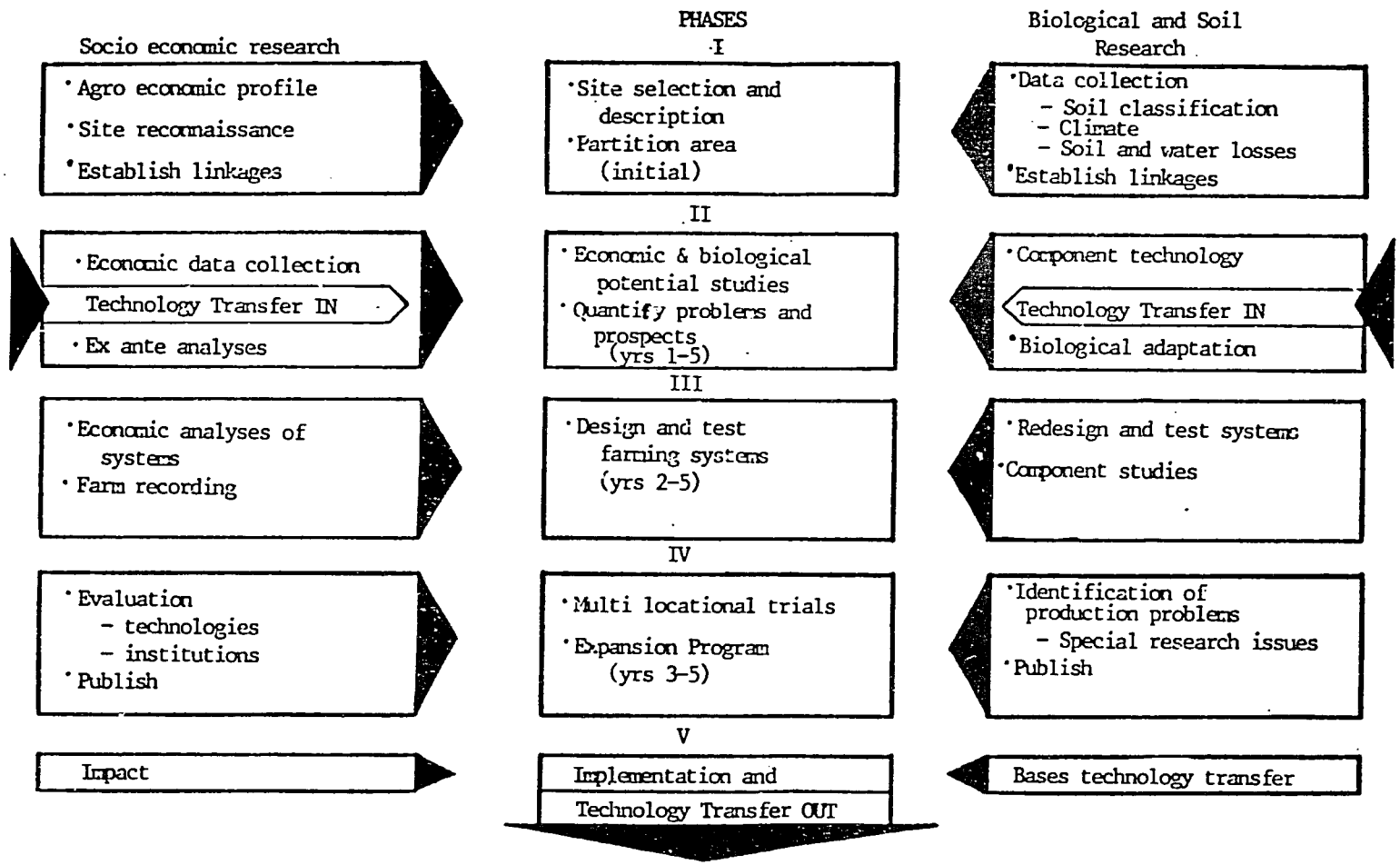


Figure 5. Parallel biological and socio-economic activities required for the five distinct research and implementation phases of a Farming Systems program with little inflow of technology.

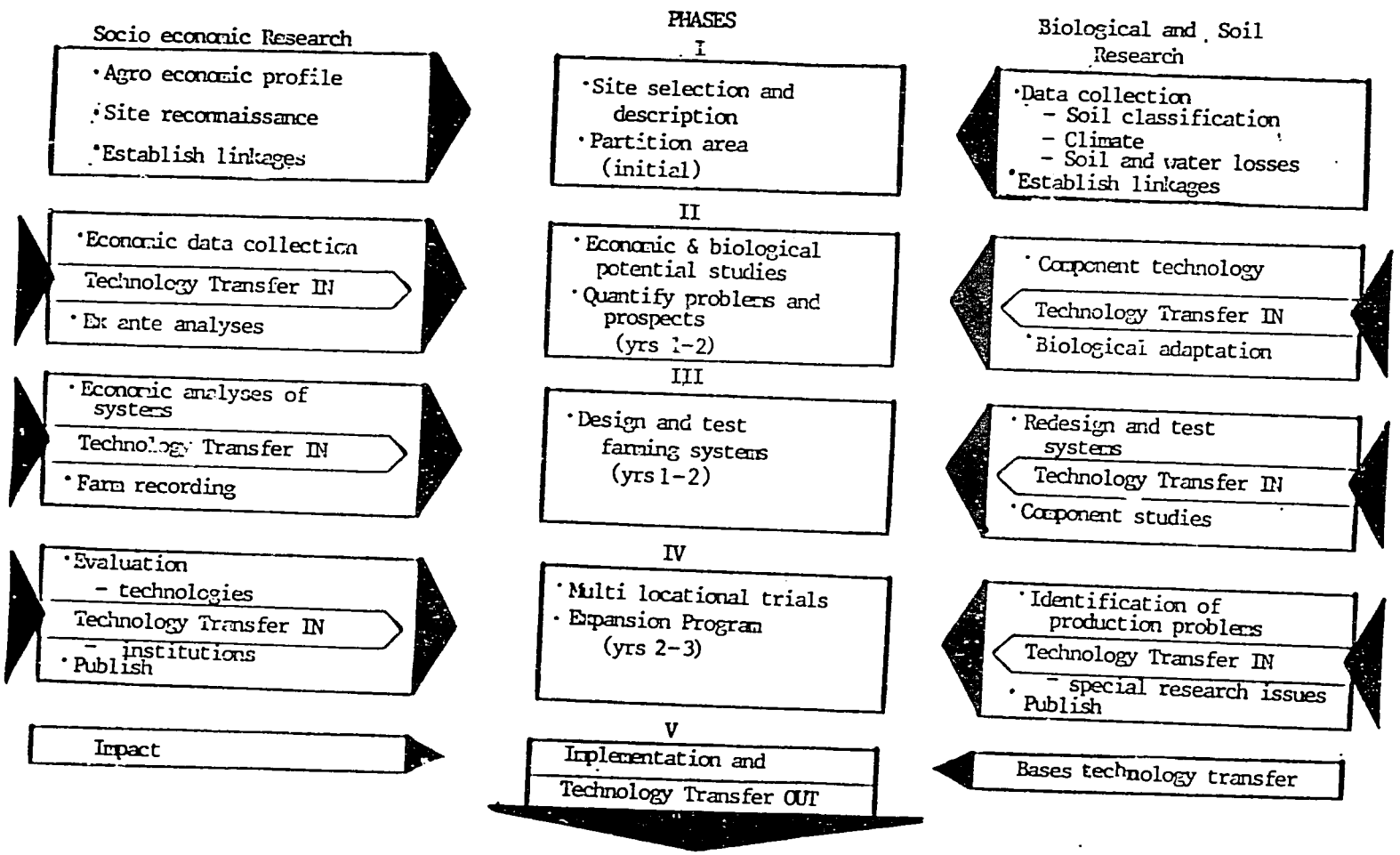


Figure 7. Time frame for research and implementation phases of a Farming Systems program with significant inflow of technology from research in areas with similar site descriptions. This technology transfer may reduce the research time in a target area by two or more years.

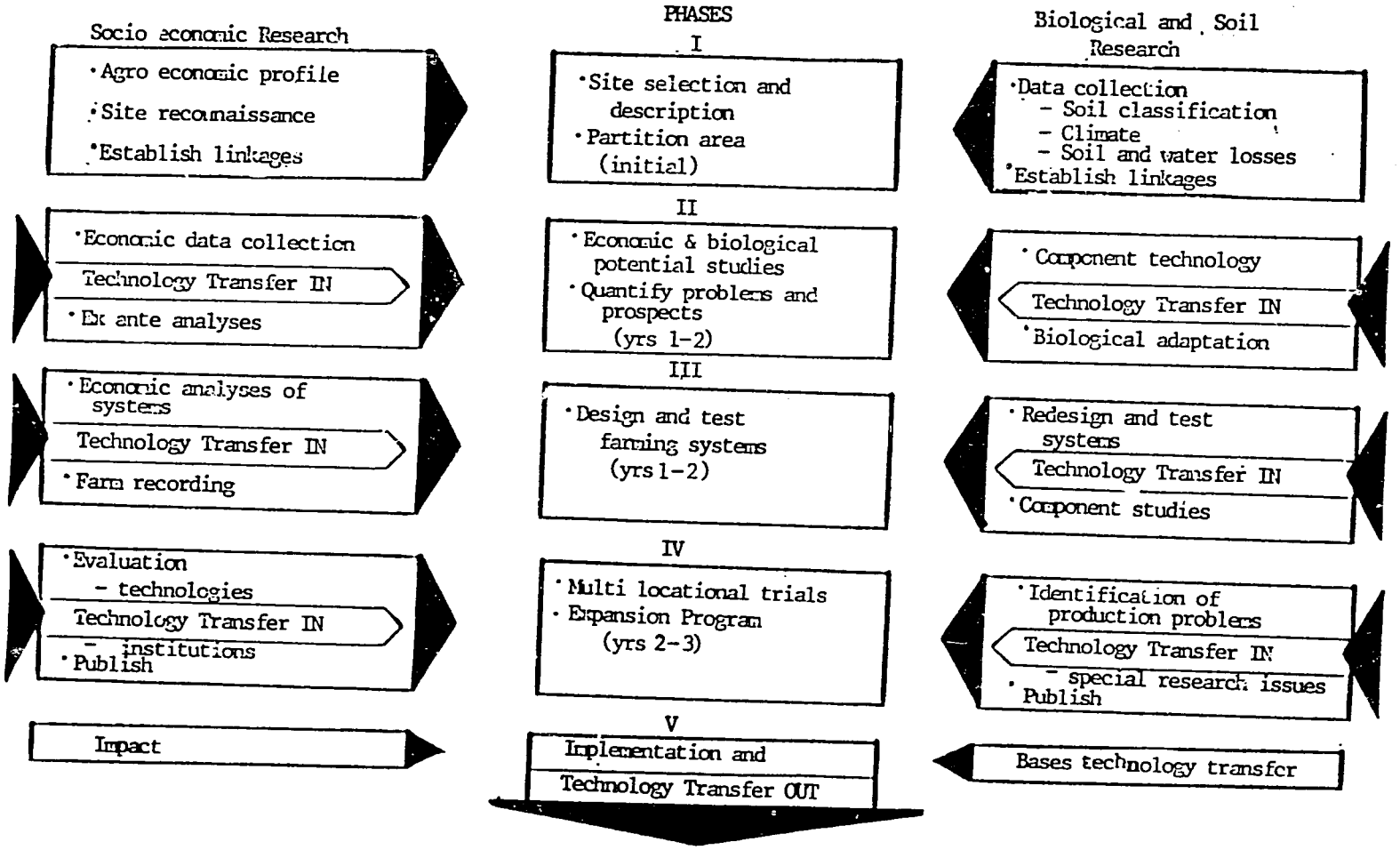


Figure 7. Time frame for research and implementation phases of a Farming Systems program with significant inflow of technology from research in areas with similar site descriptions. This technology transfer may reduce the research time in a target area by two or more years.

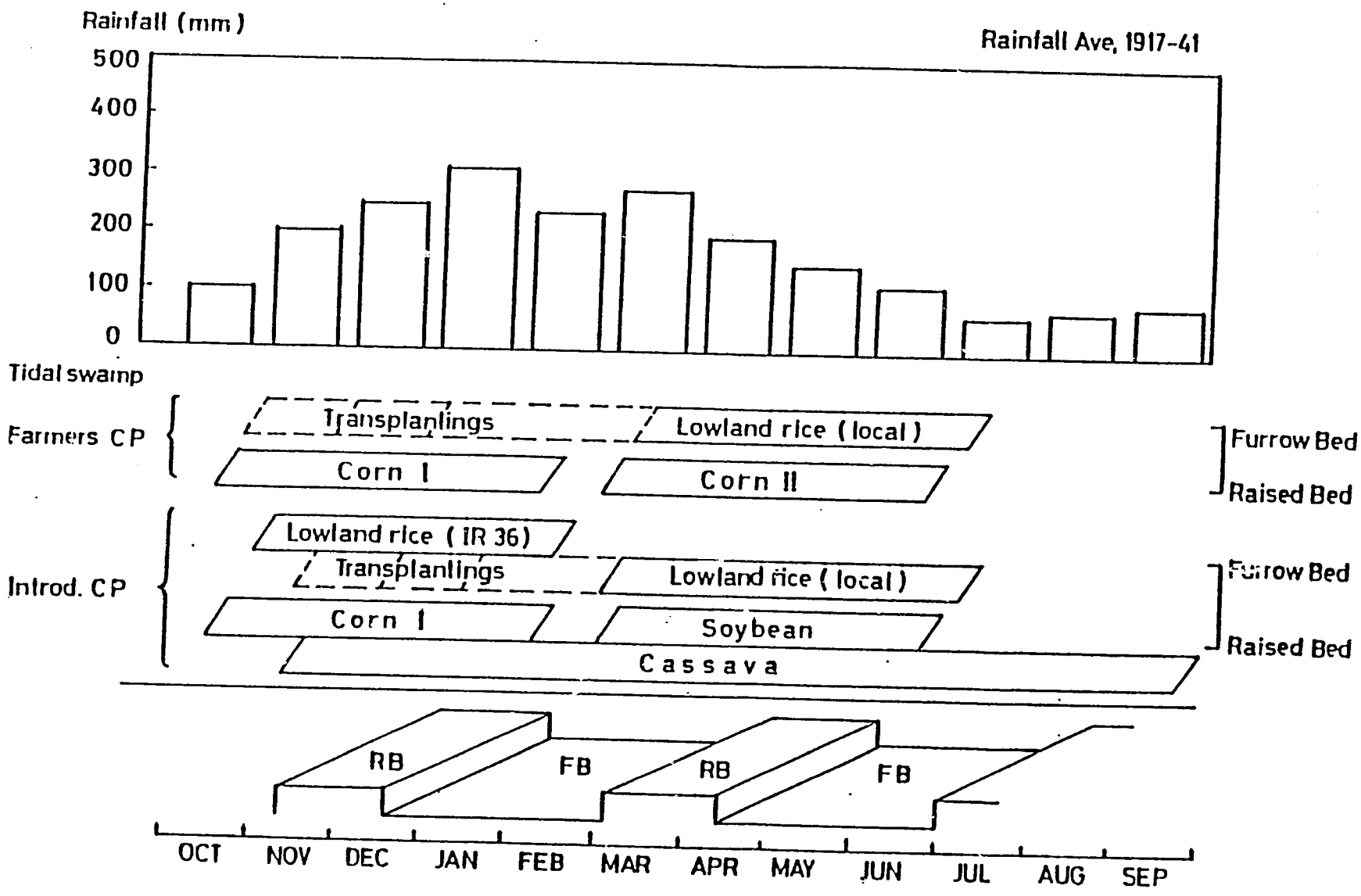


Figure 8. Rainfall distribution, cropping patterns tested and bedding arrangements for cropping system research in drained tidal swamp. Barambai, South Kalimantan. 1979-81.

Source: Annual Report, Banjarmasin Research Institute for Food Crops, 1982.

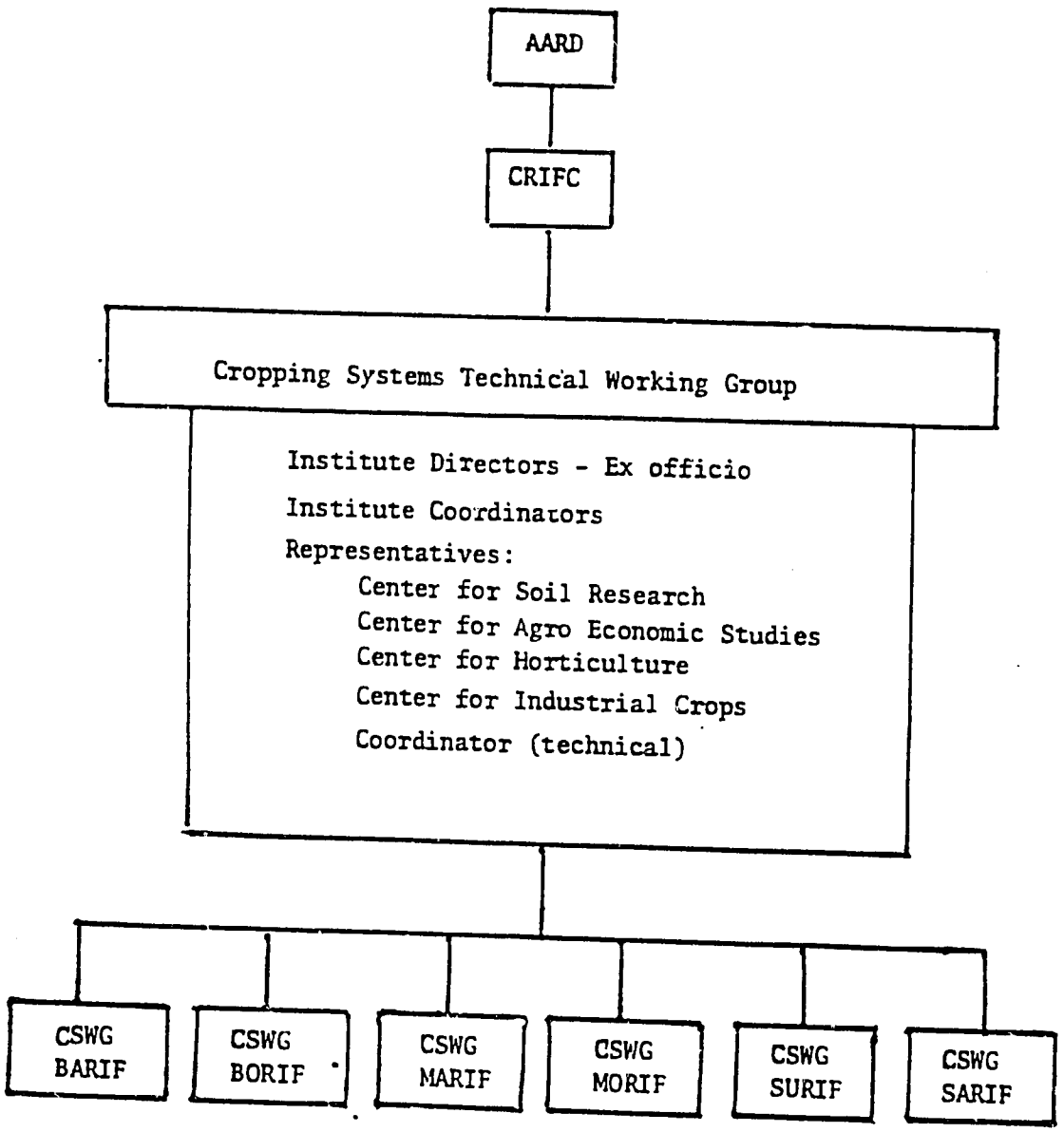


Figure 9. A possible administrative structure for technical coordination of cropping systems research.

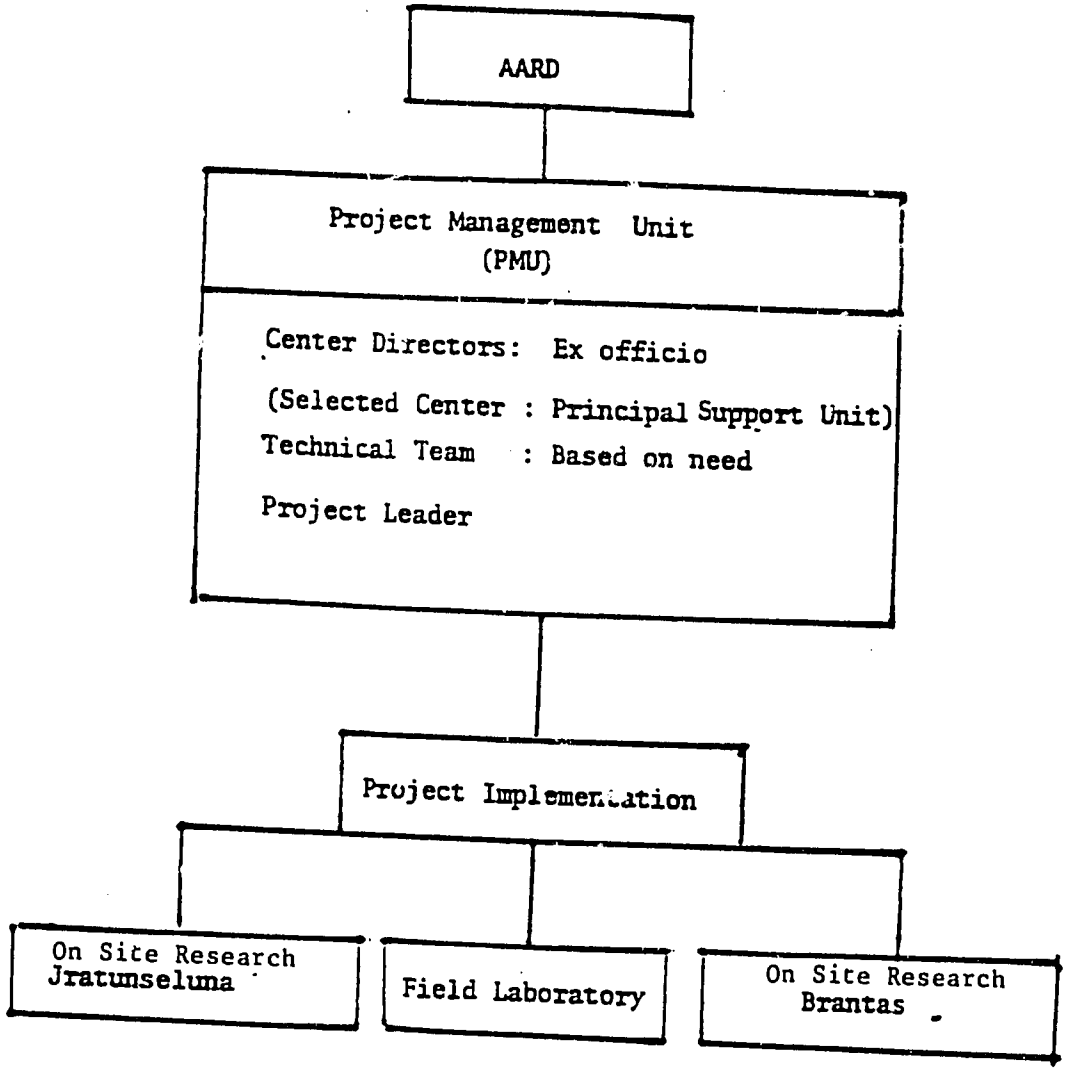


Figure 10. Organizational framework for Farming Systems Research in the Upland Agriculture and Conservation Project.

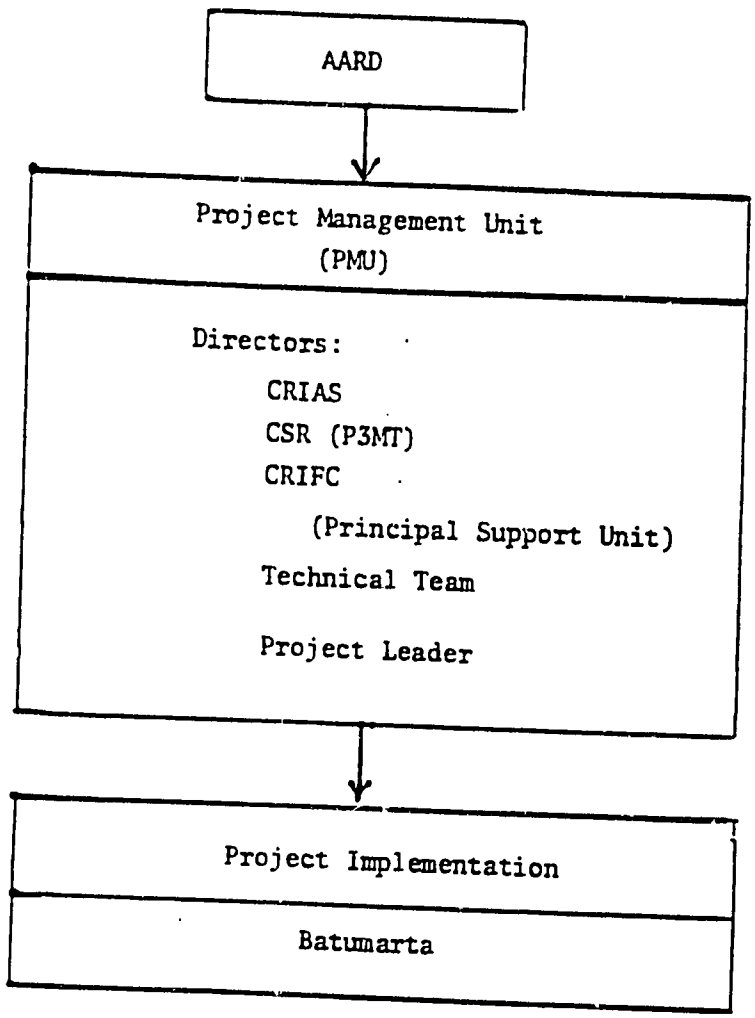


Figure 11. Organizational framework for the crop/livestock project in Batumarta, South Sumatra.

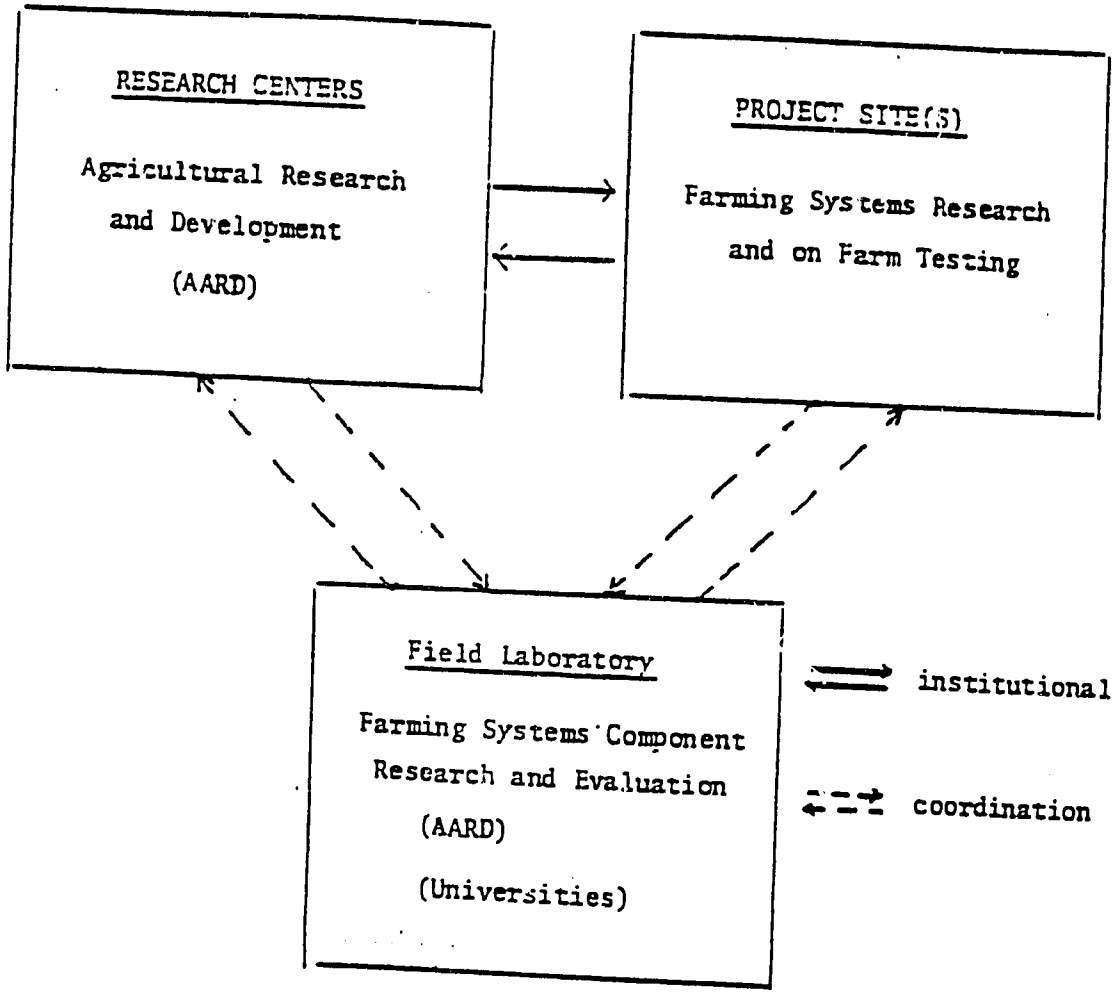


Figure 12. Development, evaluation, testing and flow of technology for Farming Systems Research and Development.

Table 1. Research Institutes and their mandates, within the Central Research Institute for Food Crops.

Banjarmasin BARIF	- Tidal Swamp Areas
Bogor BORIF	- Pioneer Research
Malang MARIF	- Palawija Crops Areas
Maros MORIF	- Upland Rainfed, Drought Prone Areas
Sukarami SARIF	- Upland Rainfed, Humid Areas
Sukamandi SURIF	- Lowland Rice Areas

Table 2. Status of Cropping Systems Research in terms of land areas, research and implementation phases, present impact and potential for cropping systems development in Indonesia.

Land areas	Research: Sites	Research: Phase	Research: Cropping pattern	Implementation: Location	Implementation: Status	Implementation: Target 1982-83 (ha)	Implementation: Potential Area (ha)
Lowland							
Irrigated	Indramayu	Implementation	LLR-LLR-Leg[1]	Rentang & Jatiluhur irrigation system	Prod.program	150,000	1,070,779
Partially irrigated & Rainfed	Indramayu	"	GRR-LLR-Leg[2]	Lampung	Prod.program	72,000	
	Serang	"	or	Serang	Pilot prod.	5,000	2,900,000
	Cibarusa	"	GRR-Leg	Madura	Pilot prod.	5,000	(partially irrigated)
	Madura	"	"				
	Bontoa	"	"	S. Sulawesi	Prod. program	75,000	1,800,000
II. Rainfed upland				NTB (S. Lombok)	Prod. program	26,000	(rainfed)
Humid areas	Sumatra						
	Sitiung	Testing	C+ULR/CV/PNT-CP[3] (main)	Lampung	Opsus	-	6,000,000
	Pasir Pangaraian	"	and	S. Sumatra	Pilot prod.	-	(1/3 x total)
	Pematang Panggang	Pre-prod.	C+SB-MB-CP (aux)	Riau	Pilot prod.	-	
	Baturaja	Pre-prod	"	S. Kalimantan	Pilot prod.	-	
	Tulangbawang	Pre-prod	"	Yogyakarta	Opsus	30,000	
	Way Abung	Pre-prod	"	Lampung		-	
	Bandarjaya	Implementation	"	Lampung	Pilot prod.	-	
	Kalimantan						
	Tajau Pecah	Implementation	"	S.Kalimantan	Pilot prod.	-	
	Sulawesi						
	Luwu	Implementation	"	S. Sulawesi	Pilot prod.	-	
	Puriala	Testing	"	S.E. Sulawesi	-	-	
	Java						
	Madura	Implementation	C+ULR/CV-PNT		Pilot prod.	-	

[1] Indicates the pattern: Lowland Rice followed by Lowland Rice followed by Legume.
[2] GGR indicates gogo rancah rice — rice that is direct seeded on aerobic soil and later flooded.
[3] Indicates the pattern: Cassava interplanted into an intercrop combination of Corn plus Upland Rice (the latter two crops planted about the same time). After harvest of Corn plus Rice, Peanut is interplanted in the Cassava and followed by Cowpea.

Land areas	Research			Implementation			
	Sites	Phase	Cropping pattern	Location	Status	Target 1982-83	Potential Area
						ha	ha
Drought prone	Atambua	Testing	C+ULR/CV-CP or C+PNT/CV-CP	NTT			
Upper river watersheds	Panawangan	Preproduction	C+ULR/CV-PNT-CP	West Java	Pilot prod.		
	Solo	Preproduction		C. Java	Pilot prod.		
III. Deep water	Kayu Agung	Site selection		S. Sumatra			
IV. Tidal swamp	Barambai	Implementation	Surjan system	S. Kalimantan	Pilot prod.	1,000	2,000,000
	Karang Agung	Design	Raised bed: C+PNT or SB/CV-CP Lower part: LLR-LLR	S. Sumatra			

Table 3.. Comparisons of yields and economic returns from Farmers' and Introduced Cropping Patterns. CRIA - C.S. Project, Indramayu, West Java. 1975-78.

Cropping Patterns	Irrigation category		
	10 months	7-9 months	5-8 months
	Ave. yield - kg/ha[3]		
Farmers' C.P.[1] (1975-77)			
Lowland Rice -	5,560	5,334	3,628
Lowland Rice -	5.820	2.758	2.250
Net Returns	Rp.381,317	Rp.250,599	Rp.131,178
Introd. C.P.[2] (1975-77)			
Lowland Rice -	5,314	5,647	4,781 (GRR)
Walik Jerami Rice -	5,032	4,578	4,630
Legume -	768	944	541
Net Returns	Rp.379,591	Rp.422,237	Rp.222,872
Introd. C.P.[4] (1977-78)			
Lowland Rice -	6,915	7,195	3,451 (GRR)
Walik Jerami Rice -	4,910	4,550	2,901
Soybean -	462	610	---
Cash Surplus[5] to rice	Rp.527,923	Rp.523,099	Rp.205,539

[1] Farmers' cropping pattern.

[2] Introduced cropping pattern. Walik jerami rice is rice directly planted after preceding rice crop w/o plowing the land and Gogo Rancah Rice (GRR) is rice directly seeded on aerobic soil at beginning of rainy season. It is flooded later.

[3] Yields were measured by sampling from 1000 M^2 plots. There were 3 replications/treatment/year for the 2 years, 1975-77.

[4] Yields were measured by sampling from contiguous areas of approximately 3 hectares for each irrigation category for pre-production test trials, 1977-78.

[5] Cash surplus is gross returns minus cash costs for materials and labor, while net returns is gross returns minus costs for all materials and labor, including farmers' labor. One US dollar equal to 425 rupiah at time of research.

Source: Annual Reports, Cropping Systems Research in Indonesia.

Table 4. Adoption of gogo rancah in Lampung. 1976-83.

Year	Nambahdadi	Way Seputih	Lampung
	---------- hectares	----------	
1976-77	0.1	-	-
1977-78	4.0	-	-
1978-79	30.0	-	-
1979-80	212.5	-	-
1980-81	262.0	-	-
1981-82*	640-0	5,517	7,000
1982-83**		8,000	72,000

*PROGRAM Insus

**Target

Source: Tim Studi Dampak.

Table 5. Yield performance of crops in the introduced cropping pattern tested in ten different rainfed upland areas.

Location	No. years of testing	Yield of crops (t/ha)*				
		Corn +	upland rice /	cassava /	peanut -	ricebean
1. Bandarjaya	5	2.1	2.4	25.6	0.6	0.5
2. Way Abung	5	1.4	2.3	14.7	0.5	0.3
3. Batumarta	5	1.6	1.8	14.8	0.7	0.5
4. Tulang Bawang	2	1.1	2.4	17.7	0.9	0.5 (cowpea)
5. Pematang Panggang	2	0.9	1.3	6.1	0.9	0.4 (")
6. Kotanegara	2	1.2	0.7	9.8	0.5	0.3 (")
7. Tajau Pecah	2	0.7	0.7	9.7	0.6	0.3 (")
8. Pasir Pangaraian	2	1.5	1.2	8.0	1.0	0.4 (mungbean)
9. Puriala	2	1.0	2.1	11.2	0.4	0.3
10. Lahat - Tebingtinggi	1	2.4	2.8	14.9	0.6	0.3

*Dry grain for corn, rice and legume and wet root for cassava when grown in the crop combinations indicated (+ means planted together, / means intercropped with and - means followed by).

Table 6. Production and economic comparison of the farmers' existing cropping pattern with the introduced cropping pattern in two different rainfed upland areas. Southern Sumatra, 1976-82.

	Way Abung		Batumarta	
	FCP	ICP	FCP	ICP
Yield of crops (t/ha)				
Corn	0.6	1.4	0.6	1.6
Upland rice ≠	1.5	2.3	1.2	1.8
Cassava ≠	7.8	14.7	4.2	14.8
Peanut -		0.5		
Rice bean or Cowpea		0.3		
Total calories (KCal/ha/year)	15,081	31,732	9,972	32,326
Rice (gabah) equivalent (t/ha/year)	6.3	13.2	4.1	13.5
Total labor (man-days/ha/year)	285	605	245	517
Total cost of production (Rp/ha/year)	164,300	444,920	193,250	504,045
Gross return (Rp/ha/year)	348,000	1,004,500	297,750	1,097,523
Net return (Rp/ha/year)	183,700	559,580	104,500	593,478

Note:

FCP = Farmers' cropping pattern
ICP = Introduced cropping pattern
1 US$ = Rp.970.

Table 7. Research goals for farming systems research and the degree to which these goals have been attained in upland Transmigration Areas.

Goals for Systems Research	Status
I. Initial subsistence (cropping systems)	
• Appropriate food crops systems	- OK
• Productivity (subsistence)	- OK
• Economical (break even)	- OK
• Acceptable level of risk	- Still too high
• Stability (Short term)	- Need economic stability
• Family labor use	- Not adequately used on farm (off farm labor sought)
• Land resource use	- Still land not used
II Long term (farming systems research)	
• Subsistence + Cash income	- Need more cash income
• Full use of family labor	- Opportunity for more on farm labor needed
• Full use of land resource	- Options for use fallow land
• Low risk	- Need for technology for alternative agricultural interprises
• Stability	
Production	a. Subsistence needs met with food crops
Economic	b. Alternative interprises, for example, animal and perennial crops needed.
• Sustainability	
Production	Perennial crops needed to make better use of land and provide production and economic stability and sustainability.
Economic	

SAMPLE RESEARCH BRIEFS

Cropping/farming systems research sites that have been completed and those that are on-going, AARD.

Site location	Edaphic condition	No. Months with Rainfall >200 mm	and <100 mm	Most probable Soil Classification or Type	Latitude: Elevation:
1. Bandarjaya, Lampung, Sumatra	Rainfed upland	5	2	Orthoxic Tropudult, loamy, mixed, isohyperthermic	40° 40'S

Descriptive phrases: Cropping systems, interdisciplinary, integrated and on farm research; food crops and economic component studies.

This research was designed to determine the potential for food crops production on red-yellow podzolic soils through improved soil fertility and crop management practices. The research was carried out under researchers' management but in farmers' field. The research showed that these soils were very responsive to phosphorus and that year round cropping patterns under good management were able to produce food calories and protein equivalent to that from at least 15 tons of rough rice. Through improved crop management and returning of all crop residues the crop production remained stable and soil phosphorus and organic matter increased over the seven years the project was in effect. This research showed the potential for crop production on these soils and provided the bases for expanded research and transmigration activities in areas where similar conditions exist.

Years: 1973-80 Institution: CRIFC

Site location	Edaphic condition	No. Months with Rainfall >200 mm	and <100 mm	Most probable Soil Classification or Type	Latitude: Elevation:
2. Indramayu, West Java	Lowland rice: Full Irrig. Partial Irrig. 7-9 months 5-7 months Rainfed	3	4	Vertic Tropaquept, clayey montmorillonitic, isohyperthermic	6° 20'S ± 5 M

Descriptive phrases: Cropping systems, interdisciplinary, integrated and on farm research; food crops and economic component studies.

Strategies were developed to intensify cropping intensity by at least one extra crop per year for each of the edaphic conditions listed through use of earlier maturing varieties of rice and palawija crops, earlier planting of rice (gogorancah where appropriate) and reduced turn around time (walik jerami where appropriate). In partially irrigated areas two extra crops were grown per year (gogorancah plus soybean). This technology was rapidly adapted after farmers were obliged to use the brown planthopper resistant variety IR-36 which matures in about 110 days. Previously even where two crops of rice had been grown the second crop many times suffered from drought and produced low yields. Consequently, new technology brought about increased production per unit area of land by increasing cropping intensity and increased yield from dry season crops. Component studies showed the problems with weeds for gogorancah rice and with gall midge for rice planted in January and February. Constraints to palawija crop production in dry season are mostly related to surface water drainage at time of planting and drought stress later in season. Shallow surface drains spaced according to severity of the situation are practical solutions to these problems.

Years: 1973-78 Institution: CRIFC.

Site location	Edaphic condition	No. Months with Rainfall >200 mm	and <100 mm	Most probable Soil Classification or Type	Latitude: Elevation:
5. Nambah Dadi, C. Lampung, Sumatra	Partial Irrig. ± 5 months	5	2	Typic Paludult (presently has an aquic moisture regime)	4° 40'S ± 35 M

Descriptive phrases: Cropping systems, interdisciplinary, integrated and on farm research; food crops and economic component studies.

While research on cropping systems was being condicted in Bandarjaya it was observed that cropping intensity was higher in the upland than in the adjacent lowland areas where some irrigation water was available. This anomaly caused us to open a research site in the Way Seputih Irrigation Area to see if the rain and irrigation water could be used more efficiently. We were able to grow two rice crops and a palawija crop by using earlier maturing varieties, direct seeding (gogorancah) and reduction in turn around time. The farmers had become dependent on irrigation water which permitted them to grow one crop of lowland rice. But they had not effectively made use of rainfall. Crop yields per year in cropping systems studies showed that total production could be increased from 3.7 tons (lowland rice) to 5.6 tons (gogorancah) rice plus 2.9 tons (walik jerami) rice plus 0.7 ton of cowpea per year. This technology spreads spontaneously throughout the Way Seputih Irrigation project and has since been adopted as a production practice for similar areas in Lampung.

Years: 1975-78 Institution: CRIFC.

Site location	Edaphic condition	No. Months with Rainfall >200 mm	and <100 mm	Most probable Soil Classification or Type	Latitude: Elevation:
24. Mijen and Demak, Central Java	Rainfed lowland	5	6	Vertic Tropoquept	6° 50'S 1-5 M

Descriptive phrases: Animal systems, interdisciplinary, integrated and on farm research; animal feeds and nutrition and economic component studies.

This research was designed to maximize the utilization of crop by-products for ruminants among smallholders in rainfed lowland areas that tend to flood. Understanding the interaction among ruminants, food and industrial crops, and environment is the prime objective. The research is carried out under farmers' (and key farmers) management and with close collaboration among researchers from Balai Penelitian Ternak (BPT), Livestock extension officers and Universities. Breeding, feed technologies, animal health and management, and to some extent marketing, are all part of the research.

Years: 1983 Institution: CRIFC.

Site location	Edaphic condition	No. Months with Rainfall >200 mm	and <100 mm	Most probable Soil Classification or Type	Latitude: Elevation:
35. Batumarta	Upland rainfed	7-9	2	Typic paleudult, fine loamy, kaolinitic, isohyperthermic	+ 4° S 90-120 M

Descriptive phrases: Farming systems, integrated, interdisciplinary, on farm research; crop/livestock and economic component research.

This research is designed to develop methodology for interdisciplinary research involving crops and livestock. It will be carried out in older parts of the Batumarta Transmigration Area where original research was conducted on cropping systems from 1976-1980 and where more recently component studies on terracing and fertilizer efficiency have been conducted. Specific research objectives will be to (1) identify and remove constraints to improved crop and livestock production systems in upland rainfed transmigration areas, (2) further develop relevant component technologies for both crop and animal systems and (3) develop methodologies for effective and interdisciplinary farming systems research.

Year : 1984 Institution: AARD and BCRIF

Site location	Edaphic condition	No. Months with Rainfall >200 mm	and <100 mm	Most probable Soil Classification or Type	Latitude: Elevation:
36. Jratunseluna	Upper river watershed	6	2	Andepts to Vertisols	± 7° S 200-1000 M
37. Brantas		5	5		± 8° S 200-1000 M

Descriptive phrases: Farming systems, interdisciplinary, integrated and on farm research; food crops, perennial crops, animal, soil conservation and socio-economic component studies; terracing and post terracing management.

This farming systems research is a component of a comprehensive research and development project in upper river watershed areas of the Brantas and Jratunseluna rivers systems. The purpose of the research is to refine existing and develop alternative farming systems technologies adapted to the specific agro-climatic conditions found in these watersheds and to evaluate fully the economic and financial returns of these alternative systems. Together with the results stemming from the Citanduy project, which would also be monitored in this project, the information developed will provide a technological base for production and soil conservation programs for these and other similar watersheds with the ultimate objectives of increasing incomes and agricultural productivity of rainfed upland farmers and conserve soil and water natural resources. Specific emphasis will be placed upon component research for food subsistence, animal and perennial crops production for cash and soil conservation practices. These will be preceded, accompanied and followed by socio-economic studies.

Years: 1984-1991 Institution: AARD.

APPENDIX II

SAMPLE: CARD INDEX REFERENCES

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