Proceedings **1**

WORKSHOP ON FARMING SYSTEM RESEARCH IN INDONESIA

Sukamandi, 13-16 August, 1984

CENTER FOR AGRO-ECONOMIC RESEARCH
AGENCY FOR AGRICULTURAL RESEARCH AND DEVELOPMENT
MINISTRY OF AGRICULTURE
BOGOR, 1985

PROCEEDINGS

WORKSHOP ON FARMING SYSTEM RESEARCH IN INDONESIA

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FOREWORD

Presently, farming systems research (FSR) in Indonesia is agronomically oriented. Cropping pattern research in rainfed areas has generally been done rather than complete FSR because of the limitations of expertise and financial resources.

One of the main reasons farmers in rainfed areas were chosen as the target group was because of the complicated technology required to improve small farmer's productivity and income. The major source of small farmer income in the rainfed areas has commonly been from land based agriculture. Consequently, FSR teams decided to emphasize the cropping pattern approach because it represented the major source of farm income.

FSR activities are generally motivated by a desire to develop or improve production methods for small farms that focus on specific target areas, particularly food crop production areas. This "food crop based FSR" has been conducted by a rather isolated voluntary group, typically agronomists, so that the results tend to be on the development of new production techniques in an appropriate environment.

Because the cropping pattern approach has been used, we still lack information about the potential of small farmers' land, capital and labor which can be optimally used for fish culture and animal husbandry activities. To improve cattle, small ruminant or poultry enterprises, we still need information on how many animals a pasture can support and how much agricultural waste can be used as feed.

We also need to know more about the importance of animal husbandry and its contribution to the income of farmers. Moreover, we need information about animal labor and its availability to support land based agricultural activities. Interlinkages between land based and non-land based agriculture should be clearly defined so that resource allocations can be made to maximize farm income.

The present FSR is generally based on the individual farm model. Although this type of research is very effective in identifying production constraints, it is not necessarily conducive to sound regional development. The FSR methods should be able to implement the developmental objectives of the region by using the interlinkages among the sectors and within the agricultural sector. The FSR methods should also include meaningful participation of farmers as individuals, and as part of a group, in FSR activities.

FSR sites were proposed to represent defined agro-climatic zones. However, the economic analysis has been based on individual household accounts. Thus, FSR has tended to focus on increasing individual farm income, not increasing the social income. Because social income accounting requires the measurement of economic externalities, it has not been possible to measure the changes in social income by micro economic analysis.

The financial resources and expertise presently allocated to FSR are insufficient and inefficiently used. To a certain extent these conditions were caused by ineffective multidisiplinary and interinstitutional collaboration.

National research programs are generally organized along disciplinary lines, but FSR programs involve crossing discipline and commodity lines. Financial and manpower constraints are both common in this setting.

Developed technology suffers from the lack of developmental studies to support the widespread adoption of technology by farmers. One of the primary deficiencies has been due to the lack of involvement of farmers and the extension service in FSR activities. The proposed FSR model should be able to develop sound communications between experiment stations and the on-farm work and should be able to develop an active horizontal flow of information between research and extension. The active participation of farmers and extension workers is needed to determine felt needs, in trying new farming systems technology, and in the evaluation of the alternatives. The active participation of farmers is indicated by their willingness to mobilize the local resources for project work.

The papers presented at the Farming Systems Workshop and reported here discuss and analyze the aforementioned strategic issues.

Faisal Kasryno, Director
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and Development

A number of the AARD research institutes have simply changed the term cropping systems research in their program of work into farming systems research to qualify for special funding. But others suggest that FSR, even when it is superimposed with livestock, fish culture, and agro forestry, is not necessarily farming systems research because FSR should be FSR and not the sum of its component technologies.

Our standard practice is to verify or test a component technology or a package of improved technologies on farmers' fields before we demonstrate and recommend the package of technologies to the farmers. This verification process of tests on farmers' fields is oriented to farmer realities, but again this is not considered as FSR.

It is said that constraint studies on production yields in a production center for a certain commodity, or constraint studies on agricultural productivity in a certain district, a watershed or a province cannot be considered as FSR, as it does not deal with either a farm or a system.

It is also argued that the action research on rice conducted in 1962 - 1964 on sites of 50 hectares to study:

(1) the large scale application of a package of improved technologies,
(2) the supply of rural credit and agricultural inputs,
(3) the marketing of produce, and
(4) the group approach in extension

cannot be called FSR because it mainly addressed adoption-extension activities.

Home garden research may be considered as FSR by itself. A home garden is normally a multi commodity, multi-story farming system with coconut or kapok trees, coffee, papaya or banana, cassava, corn soybeans and vegetables. In many cases we will find poultry, small ruminants, cattle or fishponds. The comments I get from home garden researchers is that a home garden is usually a supplementary farm activity and not a whole farm system.

When I suggested that research basic to the development of the sorjan system, or the research to support development of the nucleus estate smallholders project (NES) is FSR, I got a polite yes to my remark, but I am told that I was mistaking the trees for the forest.

Now I am deep in the heart of the forest. I expect this workshop will show me the way out. What is FSR? These are some suggestions I received which I hope, will not lead you to more confusion:

(1) FSR should deal with both single farm models and aggregate regional farm models at the same time. It means that the single farm model should be derived from a hypothetical aggregate model, and not the other way around. This aggregate model should be designed based on economic and agro-environmental conditions of the region.
(2) Aggregate or regional farm models should be designed to make economy of scale possible in the development of the model (s).

FARMING SYSTEMS RESEARCH IN THE AARD

S. W. Sadikin*

Let me express my great appreciation and welcome on behalf of the AARD and the Government of Indonesia for your invaluable participation in this Farming Systems Research (FSR) workshop.

I chose a special site for this meeting, a rural setting because I hope it will encourage personal and informal interactions, and help improve the quality of communications among the participants. In the course of the workshop you are invited to speak freely, without formality if you like, based on your experiences and expert judgements concerning FSR, its goals and objectives, basic concepts, organization and management, past findings, and development strategy.

In the last 15 years agriculture in Indonesia has flourished. Rice, corn and palm oil production has doubled through the use of high yielding varieties, agricultural chemicals, and better pest management practices. Fish, egg and milk production has gone up steadily. The export value of our agricultural commodities has more than doubled in real terms.

But with all these successes in the area of production, it is sobering to note that there is a growing public concern about issues of a widening income and prosperity gap, of persistent under and unemployment, drudgery of farming, malnutrition in rural communities, erosion of natural resources, and deterioration of the environment.

In response to these issues, it is suggested that our research programs be guided by a trilogy of better farming, better business, and better living, and that the AARD pay more attention to farming systems research.

The suggestion is welcomed with enthusiasm, and FSR is taken up as one of the main thrusts in the programs of work of a number of the AARD research institutes. But the scientists and institute directors have difficulties in formulating FSR projects, in defining the objectives, in outlining the management approaches, and in organizing those projects within the AARD system. That is why we have organized this workshop.

We used to interpret the R & D in AARD as research for development. Research programs are to support and orient agricultural development. Most of the AARD research projects are already farming systems oriented. Some of us suggested that it would be more comfortable and more productive for the AARD to have a workshop on farming systems oriented research instead of FSR.

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THE ROLE OF FARMING SYSTEMS RESEARCH IN AGRICULTURAL DEVELOPMENT

Sjarifuddin Baharsjah *

Over the last 10 years all subsectors of Indonesian agriculture have shown growth. Rice production in particular has grown substantially in response to a broad set of complementary factors such as increased area, increased irrigation, improved varieties and relatively stable price incentives. The average annual growth rate in rice production during the period 1968 - 1981 was 4.3 percent, with a maximum growth rate during the period 1968 - 1971, with the introduction of high yielding varieties. After a decrease in output in 1972 because of adverse weather, the period 1973 - 1977 experienced a low growth rate due mainly to insect and disease problems. However, in 1977 - 1981 rice output increased at the spectacular rate of 8.5 percent annually. Rice production in 1981 reached 22.2 million tons exceeding the target set for the end of PELITA III. Figures for 1982 and 1983 showed an annual rice output of 23.2 and 23.5 million tons implying an annual average increase of 6.1 percent for the period 1978 - 1983. The average rice yields which were 1.96 tons/ha during PELITA II increased at the annual average rate of 7 percent to about 2.57 tons/ha at the end of PELITA III. Corn production during 1978 - 1983 increased by the average annual rate of 7.8 percent, mostly due to increased area harvested. Other palawija (secondary crops) such as cassava, sweet potatoes, soybeans and peanuts did not show significant increases. The production of meat, milk and eggs increased by 7.3, 17.4 and 17.2 percent per year, respectively, during PELITA III. Fisheries production increased an average of 5 percent annually; this included marine and inland fisheries. Estate crop production also showed significant increases. During PELITA III palm oil, cloves, sugar, tea and rubber production increased respectively, 12.9, 12.1, 7.7, 6.0, and 3.6 percent annually.

Other crops, particularly copra, did not show sufficient growth. Copra production during PELITA III increased only 0.8 percent annually. This is not sufficient to meet the growing demand for cooking oil.

Although much progress has been made in the production of food and other agricultural commodities, there are important problems in the agricultural sector which remain unsolved. Farm income, farm productivity per laborer and farm wages are all lagging behind the levels achieved in other sectors of the economy. Much of the achievement in agricultural production can be attributed to the low subsidized cost of critical in outs such as fertilizers and pesticides and the availability of cheap agricultural credit. It is generally agreed that these subsidies must be gradually reduced and eventually eliminated. Much research and analysis needs to be done to determine the ultimate impact on productivity and income

* Secretary General, Ministry of Agriculture.

(3) FSR should be addressed to the production subsystems and services subsystems, including extension, transportation, credit and marketing.

(4) The main problem is: How and through what stages can the tested individual farm models be developed and extended to the region, with due consideration of farmers' conditions in general? What we need is feasibility with respect to the subjects, and not with respect to our perception.

(5) We have to distinguish between supplementary or minor components and major components. The latter should be done by all farmers cooperatively. Land and services should be consolidated. Supplementary activities are done individually or collectively within a small farmer group and may differ from farm to farm or from group to group.

(6) The objective function to optimize in FSR is income, for both individuals and society. This means that FSR should be able to provide farm technology for the future that addresses the following issues:
- soil conservation and recycling techniques,
- ways to lift up and ease the drudgery of farming through the introduction of labor saving devices without adverse effect on employment,
- proper linkage with agro-industry or rural urban interface,
- increase farm income and wages, and
- improve the quality of rural life.

These are some remarks on FSR within the AARD system. I am sure the workshop will straighten out any misunderstandings and misconceptions, and will clarify whatever confusion may still exist so that our researchers will have the essential directives to formulate good research proposals. With those remarks, I wish you every success with the workshop.

aim of FSR is to increase the overall productivity of the farming system in the context of the entire range of private and social goals given the existing constraints and potential imposed by the determinants of the existing farming system*.

Two approaches are generally recognized in FSR, i.e. the micro approach and the macro approach. The objective in the micro approach is to generate improved technology which is acceptable to farmers in their given production environments. The excellent work accomplished by the IRRI/AARD collaborative farming systems research program is a good example of the micro approach to FSR in Indonesia. The macro approach attempts to provide the necessary perspective on relevant policy issues at both the national and regional levels. Through the macro approach the effectiveness of the overall FSR can be further improved.

One of the most important issues to Indonesia, related to the macro approach, is the determination of the desirable and achievable farming systems required to support the national development goals. In analyzing how FSR could contribute in this context, some new approaches to the development of various subsectors of agriculture should be recognized and considered. Some of these approaches evolved in the last few years including the farmers group approach as illustrated in the FSR program in rice production; the nucleus estate smallholders (NES or PIR) approach in estate crops; the management unit approach in the PRPTE program in estate crops production; and the integrated farm approach in providing agricultural credit as in the MASKUT program.

The successful INSUS program marks a shift from the traditional individual farm approach in intensification programs such as INMAS to a farmers group approach. It is expected that farmers with adjoining fields covering an area of about 20 hectares will benefit through cooperation from larger scales of production, division of responsibilities and specialization. In the NES or PIR program, smallholders over a large area are expected to work together with a large firm (the nucleus) in a mutually beneficial arrangement. The 2 hectares estate crop farm of the smallholder is expected to generate income of about $US 1 500 to $US 2 000 per year. In the PRPTE program, smallholders with adjoining fileds covering an area of 50 to 100 hectares are not joined with any large firm as in the NES. Instead the program is designed to assist each individual smallholder in the planting of estate crops on his 2 hectares of land to the point where the smallholder is able to benefit from commercial credit. The MASKUT program aims to replace the commodity based agricultural credit as in BIMAS with integrated farm credit. The program is now at the pilot project stage in three subdistricts.

The emergence of the new approaches proves that increased production is not the sole target of agricultural development policy. Strengthening of the farming

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* Zandstra, H. G., "An Overview of Ongoing Applied Farming Systems Development Projects: What are farming systems and how they relate to development" Farming Systems Research Series, Paper No. 5 Kansas State University, Manhattan, Kansas, 1983.

should these policies be changed. Another problem area relates to credit recovery. Poor repayment of loans in the BIMAS program and unrecovered credit to large numbers of fishermen requires attention. The solution is not necessarily to discontinue the credit programs but to develop the necessary management skills and knowledge of the enterprises to which the credit is to be applied in order to insure the efficient implementation of the credit programs.

The basic parameters to the structure of the agricultural sector still imply the vulnerability of the sector. Farm sizes remain very small for the maturity of the farm polulation. Under the pressure of population growth and the inability of the non agricultural sector in rural areas to absorb the increased labor force, it is anticipated that further reductions in average farm size will occur. Clearly, the development of appropriate policies across all sectors of the economy is critical for further agricultural development toward the accepted national goals.

Maintaining a high rate of growth in agricultural production remains the foremost objective of the development policy. The level of self-sufficiency in rice which has been achieved needs to be maintianed. Non-rice food production must be accelerated. Production of estate crops for export will also have to be accelerated to increase export earnings and offset anticipated declines of oil export revenues.

At this stage of the development of the national economy, and considering what is expected of agriculture, the problem of unemployment and underemployment has become very important. Although the manufacturing industry has grown rapidly in recent years, even more rapid growth is needed to absorb a significant portion of the increasing labor force. Indeed, the national goals call for the achievement of a more balanced national economy, which requires an increase in the number of people who earn their livelihood from non-agricultural sectors. The contribution of non-agricultural sectors to national income are expected to grow at a faster rate relative to that of the agricultural sector. The composition of the country's exports will have to change to include more intermediate and final products. In the long run the industrial sector is expected to become the dominant sector of the economy, with agriculture playing a strong supporting role.

The anticipated structural changes will require a strong, efficient and resilient agricultural sector displaying the following characteristics. Agriculture should use resources in an optimal way, it should be resilient against adverse conditions such as prolonged drought, pest and diseases and unfavorable market conditions. At the same time, agriculture should be capable of adjusting its system and structure of production to accomodate changing technology along with changing consumer preferences. Finally, agriculture should contribute to national and regional development in terms of agricultural products, welfare of the society, employment, and particularly to the incomes of farmers.

It is within the context of agricultural development, as discussed above, that the role of farming systems research (FSR) should be analyzed. Indeed, the primary system has always been an important objective. In a situation where small farm size is a constraint, the farming system of a group of farmers is improved. FSR is expected to study, evaluate and monitor the performance of these approaches with the view of improving them in the future.

In addition, the macro approach of FSR should also address itself to the following problems:

1. The problem of poverty, equity and land. Very small farmers, fishermen, farm laborers, and farmers in critical areas have an annual per capita income of less than the equivalent of 320 kg of milled rice, the poorest amon them in several areas even earn less than the equivalent of 180 kg of milled rice. The resources which these poor farmers have are so few that they are unable to benefit from development programs extended by the government. FSR could provide the "bottom up" information for the formulation of special support programs.
2. The problem of choice of technology. In the densely populated rural areas the largest portion of the people find their livelihood in agriculture. With the inability of other sectors to provide adequate employment possibilities, the alternatives of superior technology available to agriculture is limited to those which are labor intensive. FSR, by extending its focus beyond the individual farm, could provide the information on how the farming system of a group of farmers could benefit from economies of scale and thereby widen the spectrum of alternative technologies from which it could choose to increase productivity in the use of all inputs, including labor.
3. The problem of integrating the farming system into regional development. One important question soon facing most regions is how to quickly establish and strengthen rural-based industries. Most industries would either be processing agricultural commodities or manufacturing tools and other inputs for the farm. The existing smallholder agricultural sector, which produces a large number of commodities on a small scale, cannot provide the needed support for the establishment of these industries. FSR could help identify farming systems which are able to provide this needed support.
4. The farm credit problem. Credit has always been an important component of programs designed to increase farmers' capabilities in increasing production through intensification. The BIMAS program is one very good example. However, as is also the case in the BIMAS program, farmers seem to face difficulties in the repayment of the loans. FSR should uncover better ways of extending credit to farmers based on the capability of the integrated farming system to apply it.
5. The problem of perpetuating natural resources and the development of life environments. As population grows more of the infertile marginal lands are cultivated, endangering the perpetuation of the resources. Imprudent use and management of natural resources such as deforestation, shifting cultivation and overfishing damage the habitat, giving rise to critical lands and decreasing

the supply of clean drinking and irrigation water. FSR, which is supported by many disciplines, could develop sets of recommendations based on the characteristics of the production environments' resource and cultural endowments to prevent further damage.

Finally, with its origin in farm management, and because FSR methodologies include the active participation of farmers, FSR provides an opportunity to strengthen the linkage between research and extension. In this context, the organizational aspects of FSR become very important.

SUMMARY AND CONCLUSIONS OF THE WORKSHOP ON FARMING SYSTEMS RESEARCH IN INDONESIA

Farming systems research is becoming an increasingly important agricultural research methodology throughout the world as scientists attempt to further boost agricultural production and income while efficiently utilizing production resources. The importance of this methodology is manifested by the limitations of commodity-oriented research.

Given this background, Indonesian and international agricultural scientists held a workshop on farming systems research during August 13 - 16, 1984 at the Sukamandi Research Institute for Food Crops. One and a half days of the workshop were devoted to discussion of definitions and concepts, methodologies, institutional linkages, constraints, and technology development in farming systems research. The main points of these discussions follow:

1. Definitions and concepts of farming systems research

Many definitions of farming systems research exist. The definition chosen by the members of this group for farming systems research in Indonesia is provided by Shanner, *et al.* (1982) and Simmonds (1984), respectively:

> "Farming systems research and development (is) an approach to agricultural research and development that (1) views the whole farm as a system, and (2) focuses on the interdependencies among the components under the control of members of the farm household and how these components interact with the physical, biological and socio-economic factors not under the household's control. The approach involves selecting target areas and farmers (agricultural households), identifying problems and opportunities, designing and executing on farm research and evaluating and implementing the results. In the process, opportunities for improving public policies and support systems affecting the target farmers are also considered".

> "FSR sensu stricto (is) the study of farming systems per se, as they exist; typically, the analysis goes deep (technically and socio-economically .. the view taken is nominally 'holistic' and numerical system modelling is a fairly natural outcome if a 'holistic' approach is claimed".

A differentiation was made between farming systems research and research on farming systems. Farming systems research in Indonesia has normally been thought of in terms of "on-farm research" with a "farming systems perspective". Regional/ macro issues are now being emphasized. In particular, the parameters related to marketing (available transportation systems and communication facilities) are considered critical to the set of feasible agricultural enterprises in a given location.

The question of the inclusion of non-agricultural income and employment opportunities in farming systems research was discussed. These were considered increasingly important factors in the overall welfare of agricultural households and should be measured and evaluated for their interaction with the choices of farming systems to be designed and tested. In general, all activities which compete for the use of the resources available to the agricultural household should be considered in farming systems research analysis.

The goals of farming systems research range from development of farming systems aimed at achieving national objectives of increased production, to those aimed primarily at affecting farmer welfare. In both cases, the unit of analysis is the farm. Factors beyond the farm (e.g. prices and markets) must be evaluated, but are exogenous to the farming systems research framework. Such broader analysis is regional development research and cannot be considered as farming systems research. By comparison, analysis of single crops or cropping systems without consideration of the total set of farm activities, essentially takes some on-farm activities as exogenous and is not farming systems research.

Farming systems research provides a framework for development and evaluation of technologies at the farm level but does not provide a complete basis for their evaluation. It is necessary to go beyond farming systems research to evaluation of regional impacts to determine the full potential of the technology. An example is the impact of high yielding varieties on harvesters' share of rice production.

2. Methodologies for farming systems research

The agro-ecological zone was considered to be the most appropriate unit of planning for farming systems research. Agro-ecological zones should be delineated where they do not yet exist. Emphasis was given to analysis of regional agro-ecological and socio-economic factors in the early phases of farming systems research projects to aid the development and testing of farming systems which are most appropriate for a target area.

Farming systems research is an iterative process that evaluates technologies or components of a total farming system in terms of their interactions with the other components (sets of production and consumption activities as well as the resource base). Farming systems research goes beyond farm management research. Once a technology is evaluated, the research group modifies the technology or develops techniques for bridging gaps in the proposed system. These modifications are then re-evaluated in the total farm framework to determine whether or not a feasible and appropriate technology or system has been developed.

Farming systems research should deal simultaneously with the single farm model and the aggregate or regional model. The farm model should be derived from regional parameters to take advantage of potential economies of scale along with a more efficient allocation of regional resource endowments.

The decision-making criteria used for determining the most appropriate farming systems were divided between those used by agricultural households and used at the regional or national level. The decision-making criteria used to determine the most appropriate farming system at the agricultural household level was believed to be more complex than only profit maximization. In this context it was considered to be important to measure the ability of agricultural households to accept risk and uncertainty.

At the regional or national level, different decision-making criteria are used in the selection of farming systems. Such criteria include the overall efficiency of resource use, the expected macro-economic impact from any change in farming systems, conservation/environmental issues, and national policy goals such as export targets or import substitution programs.

3. **Institutional linkages**

There is an urgent need to improve the communications between farming systems researchers within AARD and between AARD and other governmental agencies or institutions involved in farming systems research and extension. The sharing of information about methodology and results could improve the quality and efficiency of farming systems research. It is important to develop linkages with the Ministry of Interior, Ministry of Public Works, and the many universities in Indonesia currently carrying out farming systems research. Another need is the estimation of the necessary manpower requirements for implementation of farming systems research and the development of the necessary linkages with extension workers.

The recommendation was made to initiate a farming systems information network within the Ministry of Agriculture. One of the first activities should be to review the present information on farming systems in Indonesia and to compile an inventory of projects and personnel working on farming systems research.

4. **Organizational issues**

There is a need to develop a framework for farming systems research in the Ministry of Agriculture. This framework should include both the planning for farming systems research and the development of methodologies for evaluating the results of farming systems research. It was suggested that a working group be formed to coordinate these activities. An example of a possible framework for a farming systems research network in AARD is shown in Figure 1. The suggestion was made for project coordinators to be identified in each research institute to facilitate the flow of information.

5. **Technologies to be tested through farming systems research**

Technologies were categorized into two classifications. The first classification separates them into (a) existing technologies and (b) technologies to be developed (e.g. ensilage system of feed processing and storage). The second classification divides technologies into (a) incremental or evolutionary technologies and (b) drastic or revolutionary technologies.

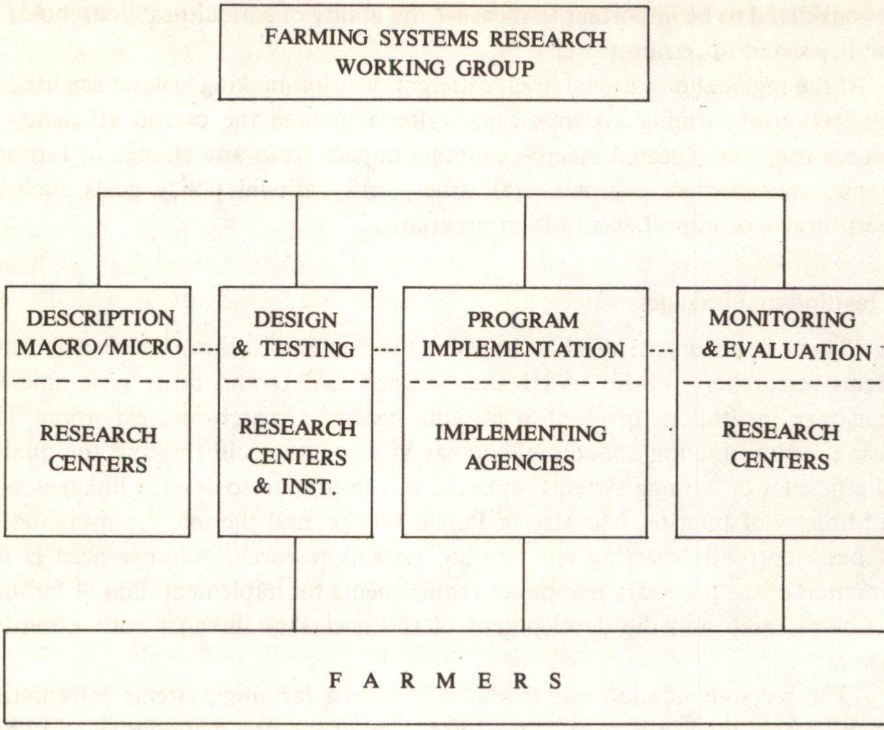

Figure 1. Framework for farming systems research network.

Agreement could not be reached on the categories which should be emphasized. However, there was agreement that the technologies should be adapted to the existing resource endowment. The most important point is to fit a technology into a system and/or develop methods or technologies for filling the gaps in a system.

A vast set of technologies exist in food crops, estate crops, horticultural crops, livestock and fisheries. A coordinated effort is needed to evaluate them in a farming systems research framework. Examples include:

a. Rice-fish culture and issues related to water management and pesticide use.
b. Running water fish production systems.
c. Recycling of agricultural by-products.
d. Evaluation of the stability of the nucleus estate smallholder systems (PIR).
e. Improved management of the coastal swamp resources.
f. Testing, modification and transfer of the "Sorjan system" to other areas.
g. Grafting and development of seed stocks for horticultural and estate crops.

6. Requirements for technology development

Various social, institutional, economic and technical factors often become constraints to the adoption of new technologies. The constraint levels need to be specified in order to evaluate the feasibility of a new technology before it is released to farmers. It is important to understand the importance of the role of constraints in determining which farmers are capable of adopting a technology and gaining from it as well as determining appropriate government actions to reduce the limiting effects of constraints. Such government actions include the existing credit and information components of the BIMAS program along with factor and product pricing policies. Future modifications of government credit and technical assistance programs should be based on a sound understanding of farming systems. Farm credit schemes should be integrated rather than the usual commodity-based agricultural credit. An example of such a system is the recently introduced MASKUT system (mass integrated farm credit).

The need for careful evaluation of agricultural technologies within a farming system framework, before implementation, was emphasized. The failure of a technology is not necessarily due to institutional or resource constraints on its adoption but may be due to poor design and testing prior to release.

The need for interaction between research institutions and extension groups at national and regional levels was supported. This involvement should occur throughout all phases of farming systems research and development. Figure 2 shows the changing levels of involvement of research and extension agencies during the process. Two methods were proposed for ensuring good interaction:

a. Formation of a working group with members drawn from relevant disciplines and institutions.
b. Designation of one institute to coordinate the farming systems research for all AARD research institutes.

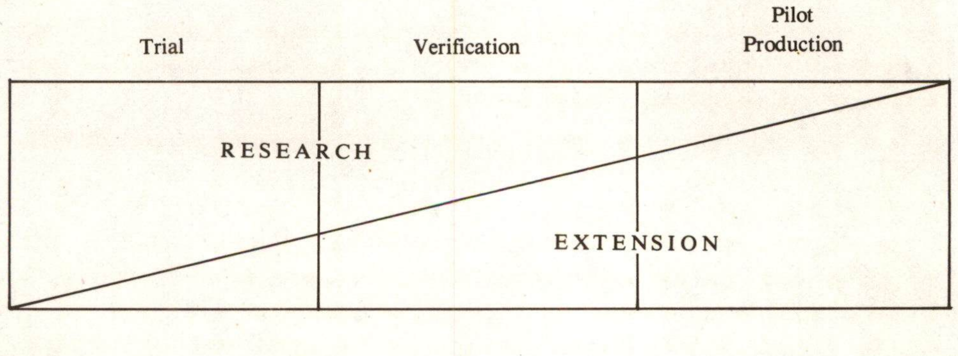

Figure 2. Relative involvement of research and extension agencies in phases of farming systems research activities.

7. **Role of funding agencies and international research centers**

The international research centers could assist farming systems research projects in several ways. These include the provision of up-to-date literature on the methodology and results of farming systems research in the region; training programs; training materials; and technical support through visiting international research scientists. The possibility of coordinated financial support from the international research institutes was also raised.

It is believed that local and external funding for research and training in farming systems would be forthcoming if well formulated research proposals or programs are developed. One example of financial support for technical assistance was offered by the Coarse Grains Pulses Roots and Tuber Centre in the area of agricultural marketing analysis.

8. **Research agenda**

Priority was attached to the development of a data base by all research institutes in the country. The data base would include basic agro-climatic and soils information as well as the assembly of the available socio-economic information for the area. High priority was given to farming systems research focusing on small farmers, landless laborers, and farmers located in the upland and semi-arid areas.

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27. M. Sudarsan
28. Sofyan Ilyas
29. Poerwito Martosoebroto
30. Poernomo Ronohardjo
31. Prabowo
32. Ibrahim Manwan
33. Soetaryo Brotosunaryo

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

Site location	Edaphic condition	No. Months with Rainfall > 200 mm and	< 100 mm	Most probable[1] Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
1. Bandarjaya, Lampung, Sumatra	Rainfed upland	5	2	Orthoxic Tropudult, loamy, mixed, isohyperthermic	4° 40'S ± 40 M	1973	1980	CRIFC

Descriptive phrases: Cropping systems, interdisciplinary, integrated and on farm research; food crop 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.

References:

1). Not official.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm and<100 mm		Most probable Soil Classification or type	Latitude: Elevation:	Year		Institution
						Started	Stopped	
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	1973	1978	CRIFC

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 yields 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.

Site location	Edaphic condition	No. Months with Rainfall >200 mm	and <100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year		Institution
						Started	Stopped	
3. Bandar Agung and 4. Komering Putih, Central Lampung, Sumatra	Rainfed upland	5	2	Typic Tropudult, clayey, mixed, isohyperthermic	4° 40'S ± 40 M	1975	1978	CRIFC

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

These sites are similar in many respects but were intended to represent "old opened" and "newly opened" land, respectively. Newly opened land in the Target Area is mainly settled by transmigrants from Java while the "old opened" areas are settled by indigenous people. It was found not feasible to work with both groups at the same time due to differences in cultures as well as farming systems. Both sites selected were settled by Transmigrants but Bandar Agung had been opened for about three years while Komering Putih was being newly opened.

Research followed the strategy developed in Indonesia and modified by contacts through the Asian Cropping Systems Working Group. Surveys were conducted in the Target and adjacent area to develop an agro-economic profile. Year around cropping patterns based on the Farmers Cropping Pattern (FCP), Farmers Cropping Pattern w/o Constraints (FCP, w/o C), and Introduced Cropping Pattern (ICP) were tested in farmers' fields. Ancillary component technology studies were conducted on weed control, soil fertility, varietal testing, entomology and farm record keeping. The basic cropping pattern developed in Bandarjaya was found to be acceptable to these areas with some options for flexibility in populations of crop species in the basic pattern of corn plus upland rice intercropped with cassava (after 30 days) and then peanuts followed by cowpea planted between the rows of cassava after harvest of the corn and rice. This pattern is illustrated by C + ULR / Cv / PNT - CP.

The crop yields and net returns were consistent with data from previous trials. Some management techniques and "rules of thumb" for management began to be apparent. These were:

a. Imperata is not a problem after initial land opening if the food crops are grown in year around cropping patterns and grow vigorously (receive fertilizer).
b. Shoot fly (corn), seedling fly (upland rice) and agromyza (legumes) are very serious pests and must be controlled. The best control measure was found to be carbo furadan applied with seed.
c. The soils require phosphorus fertilizer. This is most effectively applied in row with seed.
d. Neck blast on rice is a major problem. Local varieties less affected. Rates of nitrogen should not exceed 60 kg/ha on susceptible varieties.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm and	< 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
6. Way Abung Lampung	Rainfed upland	5-6	2	Plinthic Tropudult fine loamy, kaolinitic, isohyperthermic	4° 30'S ± 35 M	1976	1980	CRIFC/BORIF

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

This transmigration settlement is located in an upland area that has red-yellow podzolic soils and has been covered by *Imperata cylindrica* (alang-alang). The research activities included identification and quantification of problems and possibilities that farmers face in their fields, evaluation of new technology, verification trials and transfer of agrotechnology. Cropping patterns were designed and tested based on previous research in Lampung. Those were corn + upland rice ≁ cassava ≁ peanut - rice bean (main pattern) and corn I + soybean + corn II + mungbean - cowpea (alternative pattern). Productivity of these cropping patterns were stable after five years of testing. The use of simple agriculture tools increased labor efficiency. Further studies were conducted to evaluate the efficiency of fertilizer use in the cropping patterns and the effects of the treatments on the soil over a long term.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm and	< 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year		Institution
						Started	Stopped	
7. Batumarta, South Sumatra	Rainfed upland	7-9	2	Typic Tropudult, fine loamy, kaolinitic, isohyperthermic	± 4°S 90-120 M	1976	1980	CRIFC/BORIF

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

The area has an undulating landscape and had been covered by alang-alang (*Imperata cylindrica*) for many years. The top soils were very thin (10-15 cm), sandy textured, and subject to erosion. In this case maintaining and improving the soil organic matter was considered to be important to conserve nutrients, water and the soil itself. The introduction of year around cropping patterns and providing continuous cover to the soils and returning all of the crop residues were strategies designed to meet these requirements. To provide more stability to the farm systems, the land should be terraced, forage grasses grown on the risers, and perennial crops planted not only for cash income but also to stabilize the land against erosion. The inclusion of livestock in the food crops system will be further studied and evaluated. Component technology studies indicated that more tolerant upland rice varieties to blast disease were needed. For better growth and yield of crops, phosphorus fertilizer should be put with the seeds at planting.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
8. Blega, Madura, East Java	Rainfed upland	5	4	Lithic Dystropept, sandy, mixed isohyperthermic	± 7°S ± 100 M	1978	1980	CRIFC/MARIF

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

Production of rainfed upland crops in Madura has been constrained by low soil fertility and drought conditions. Madura has an old culture and the land has been intensively cultivated for many years. Crop removal and erosion have exacerbated the soil fertility problems. To reduce drought risk and soil fertility problems farmers use early maturing varieties of corn (± 65 days) and intercrop with other food crops, particularly peanuts.

They frequently plant three crops of corn + peanut per year. Considerable past research had shown the value of new varieties and increased fertilizer usage for increasing crop yields. The farmers pattern was evaluated under existing and improved management along with an introduced pattern (which included corn + upland rice as the first crop in the pattern) at low and optimum levels of input. The improved farmers' pattern was most profitable and productive when compared to the existing pattern or to the introduced patterns. Increased yields of peanut in the improved farmers' pattern were due to reduction in population of corn in the intercrop combination plus use of improved varieties and fertilizer. The introduced cropping patterns yielded well but the price of rice compared to peanut was not good enough to compensate. The farmers were happy with the rice (as a food crop) and the straw is useful for animal feed and compost. Consequently, in the long run the introduced pattern (low input) may be most attractive.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm and	< 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
9. Blega, Madura, East Java	Rainfed lowland, hilly area	2	4	Typic Tropudult, clayey, kaolinitic, isohyperthermic	± 7°S ± 75 M	1978	1980	CRIFC/MARIF

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

The existing farmers' pattern consisted of only one transplanted rice crop followed by a corn plus peanut intercrop after the rice harvest. Because of the undulating landscape, run-off and percolation rates are high and there was not enough water to grow two rice crops per year. By direct seeding rice at the beginning of the rainy season (gogorancah) and allowing the area to flood as the rains increase better rice yield could be obtained plus plenty of time would remain to grow two early season crops in addition.

The pattern (GRR-Mb-C + Pnt) was compared with the farmers' pattern at low and optimum levels of input. The introduced patterns both increased income about two times. The low input pattern gave less yield but higher returns to labor and material costs than the cropping pattern with optimum inputs. More research is needed to determine optimum input levels.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
10. Blega and Jrengek, Madura, East Java	Rainfed lowland, low lying area	3-5 3	4 5	Typic Pelludert fine, montmorillonitic, isohyperthermic	± 7°S ± 50 M	1978	1980	CRIFC/MARIF

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

The farmers' patterns usually consist of a transplanted lowland rice crop followed by mungbean or peanut. The heavy clay soil made it difficult to grow peanut. The extremely dry and long dry season and the concomitantly short wet season made it difficult to grow transplanted lowland rice early in the crop year. These are the conditions, however, that are best suited for gogorancah. Consequently, the introduced patterns all included gogorancah as the first crop and then followed by walik jerami (or minimum tillage lowland rice). The yields were consistently high (by at least 50%) for the first crop. The second crop yields were comparable to those of the farmers. Furthermore, the land was much easier to prepare for the subsequent palawija crops. Mungbean seemed to yield better than the peanut. Again, the differences in yield due to higher inputs did not appear to be profitable, more research is needed in this area.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm and < 100 mm		Most probable Soil Classification or type	Latitude: Elevation:	Year		Institution
						Started	Stopped	
11. Tajau Pecah, South Kalimantan	Upland rainfed	6	4	Typic Tropudult, fine loamy, kaolinitic, isohyperthermic	4°S 20-50 M	1978	1982	CRIFC/BARIF

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

In general soils are more rolling and less fertile than those in similar areas where we have worked in Sumatra. These soils are very responsive to phosphate fertilizers and are erosive. Successful management of the soil is dependent upon strategies to maintain organic matter, prevent erosion and recycle crop residues. But stable and sustainable land use is likely to depend upon the development of mixed farming systems. These systems should be designed to provide sufficient food products for subsistence but most of the land should be devoted to perennial and pasture crops to provide cash income and stabilize the soil. Since this was a newly opened area there was no traditional cropping pattern. The farmers, however, were from Java and had experience with corn plus upland rice intercrop combinations. They were not used to growing cassava on an extensive scale. Consequently, the introduced patterns included cassava while the farmers pattern consisted of corn + upland rice followed by corn (C+ULR-C). The introduced patterns were C+ULR/Cv/C-Pnt at two management evels. The cassava greatly added to the food supply and added stability to the system. The low management introduced pattern was the most profitable (Rp. 246,150) compared high management introduced pattern (Rp. 215,559) and the farmers' (Rp. 75,458). This again indicates the need for more adapted and responsive varieties.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm and	< 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
14. Bontoa, Maros, S. Sulawesi	Rainfed lowland	5-6	3-5	Aquept	5° 3'S ± 5 M	1978	1982	MORIF

The objective of cropping systems studies in this area is to increase cropping intensity by introducing an additional rice crop and one or two upland crops (legumes). The cropping pattern alternatives in this area are:

Farmers C.P. : Lowland rice-local or improved rice varieties
Introd. C.P. : Lowland rice + legumes — improved rice varieties + mungbean or peanut (or sweet potatoe)
Introd. C.P. : DST - Lowland rice + legume — improved varieties + mungbeans or peanut

The introduced pattern was able to produce 6 to 10 tons of rough rice/ha or about 150 to 300 percent higher than the farmers pattern.

The problems encountered with the introduced pattern were:

a. Harvesting the DRS during the peak of the rainy season. Drying the harvest also is a serious problem if the rains are continuous.
b. Need early maturing rice varieties with good eating quality and resistant to Rice Tungro Virus and Brown Planthopper.
c. The dry season crops may be affected by salinity. Need to identify crops resistant to salinity.
d. Land preparation on dry land is very hard and requires much power or labor. The use of four wheel tractor may be appropriate.
e. Weeds in DSR are difficult to control by hand.

Site location	Edaphic condition	No. Months with Rainfall >200 mm and	<100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
15. Pammana, Wajo, S. Sulawesi	Rainfed lowland	2-3	5-7	Aquept	4° 8'S ± 20 M	1979	1983	MORIF

The objectives of the cropping systems studies were to stabilize rice production and to increase cropping intensity by adding one or two secondary crops such as peanut, mungbean, and sesame to the systems.

Alternatives cropping pattern are:

Farmers C.P. : Lowland rice — (Land preparation and transplanting depend on rainfall. The beginning of the rainy season and amount of rainfall varies from year to year. Transplanting ranges from April to early June).

Introd. C.P. : DSR — palawija — (palawija) then followed by one or two secondary crops.

The introduced pattern was able to increase the rice production to about 150 to 210 percent over the usual lowland rice crop. The highest yields were from DSR - sesame, then DSR peanut, and DSR mungbean.

The problems encountered in this area were:

a. Land preparation under dry conditions. The use of animals to plow the land may be alright, but the use of more powerful tractor is the proper method.
b. Need to identify and provide seeds of early to medium maturity rice varieties (115 to 125 days).
c. Weeding by hand is very time consuming and difficult. The use of herbicide may solve the problem.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm and	< 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
16. Bone-bone, Luwu, S. Sulawesi	Rainfed upland	7-9	2-3		2° 36'S 35 M	1981	1983	MORIF

The objectives of the studies in this area were to increase the crop production of upland crops by improving cultural practices (such as fertilization, time of planting, plant population), cropping pattern, integrated pest management.

Since the rainfall is quite high, there are many cropping pattern practiced by the farmers. However, the result of the studies in this area suggested cropping pattern studies as follows:

Upland rice + corn - cowpea + corn
Upland rice + corn ≠ cassava - cowpea
Upland rice + corn - soybean + corn

Problems encountered in this area were:

a. Rice varieties resistant to Blast are not available.
b. High yielding crop varieties suitable to the area need to be identified.
c. Good quality seeds or planting material should be available on time.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and< 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
17. Puriala I,	Rainfed upland	3-4	2-3	Tropudult	4° 45'S 30 M	1979	1982	MORIF
Puriala II,	Rainfed upland	3-4 (D2)	2-3	Podzolic, Hydromorph	4° 45'S ± 30 M	1983	1984	TRANS
Wawotobi,	Rainfed upland	3-4 (D2)	2-3	Podzolic	4° 40'S 30 M	1981		TRANS (P3MT)
Kendari, Southeast Sulawesi								

The objectives of studies in these areas were to identify the major constraints to food crop production, to select the most appropriate crop and cropping pattern, and to provide information as to how to manage the yellow podzolic soils which are the major soil type in the region.

The soil has low pH (pH < 5), high Al content, low percentage of organic matter, low P and very low rainfall. The study indicated that the soil could be converted into productive land by pooper application of Phosphorus, Nitrogen and Potassium, and appropriate cropping patterns. The cropping patterns showing good performance and acceptable to the transmigrants were:

Upland rice + corn / cassava + peanut - cowpea
Soybean + corn - peanut + corn - pigeonpea + cowpea

Problems need to be solved are:

a. To identify varieties resistant to rice Blast.
b. Corrective measures for low pH and high Al which are acceptable and at reasonable cost to the farmers.
c. Good quality and available of seeds.
d. Low price of harvest due to poor transportation.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
18. Pasir Pangarayan, Riau	Rainfed upland	6	2	Typic Tropudult	1°N 50 M	1980	1983	CRIFC/BORIF

Descriptive phrases: Cropping systems on farm research; food crops, perennial crops and horticulture crops component studies.

This research was designed to develop food crop systems in upland transmigration areas to meet the subsistence needs and provide income for farm families. Three food crop patterns were tested to develop acceptable alternative cropping patterns. Two years' research showed that both relay and sequential intercropping of early maturing food crops into longer maturing crops permitted development of promising cropping patterns. Four to six food crops can be arranged into these cropping patterns. Patterns developed provided food enough for four and five transmigrant families in terms of total calories needed. Further research is needed to reduce labor costs. Also, rice blast disease is still a problem that needs control. Mineral fertilizers and liming are badly needed for food crops production. However, for long term it will probably be necessary to use organic fertilizers.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year		Institution
						Started	Stopped	
19. Sukabitetek, Atambua, NTT	Rainfed upland (drought prone)	4	6	Vertisol	9°S 250 M	1980	—	CRIFC/BORIF

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

Generally, the existing cropping systems in the area barely meet subsistence needs. Most farmers do not know about technologies such as improved varieties, fertilizers and pesticides. Therefore, the initial research activities mainly involved introducing improved cultural practices and new varieties into their systems. Apparently, the soils are quite productive. The main limitation for crops grown the year around is the short rainy season. In the improved cropping patterns new legume crops such as peanut were introduced. The improved systems increased production many fold over the existing farmers' cropping patterns which are a mixed cropping of corn + cowpea / pigeonpea. Early maturing and drought tolerant crops are the bases for increasing the cropping intensity. The hillsides with rather steep slopes may also be used intensively for crops production. In these areas soil and water conservation management practices were introduced. Lamtoro is one of the important crops for preventing erosion as well as providing feed for livestock.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
20. Yogyakarta, DIY (3 locations)	Upper river watershed	5	3-5	Oxic Dystrandept	8°S 130-700 M	1980	—	CRIFC/BORIF

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

This research was part of a rural development project. Most emphasis was placed on technology verification and transfer. The areas had slopes ranging from 3 to more than 50%. Erosion and declining soil fertility are the main problems. As a component of the farming systems, year around cropping systems for humid, upland conditions were tested along with various varieties of crops and fertilizer management practices. The year around cropping patterns included upland rice, corn, cassava and legume (peanut, soybean) and gave good performances and were more productive compared with the farmers' existing patterns. The upland rice varieties C22 and Cipunagara showed good adaptation and yield potential. The corn varieties Harapan Baru, Arjuna and Bromo were also well adapted. The cassava varieties Adhira I and Gading yielded higher than the local variety normally used by farmers. Perennial crops, forages and livestock should be included in the systems to stabilize the production and income. Farm record keeping was carried out to permit an economic evaluation.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
21. Citanduy, West Java (5 locations)	Upper river watershed	5-6	3	Oxic Dystrandept	7° 5'S 100-850 M	1981	—	CRIFC/BORIF

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

The increasing population and limited suitable land for agriculture production has forced farmers to expand their farming activities to the hill sides. It is common for soils up to 100% slope to be cultivated. Erosion becomes a most serious problem when the land is cultivated without proper soil and water conservation management. Food crop systems to meet the subsistence needs of the farmers were tested on these lands using bench and contour bund terraces. At the same time forage grasses and perennial crops such as coconut, cloves and fruit trees were grown on the risers to stabilize the systems. The local variety of upland rice, Sagi, yielded about 2 ton/ha and showed some degree of tolerance to blast disease. Improved varieties of soybean (Orba, Galunggung, Lokon, Guntur), Mungbean (No. 129, MB 423), Peanut (Gajah, Kidang) and corn (Harapan Baru, Arjuna) showed good adaptation and yield potential. Similar problems of pests and diseases that are normally found in upland areas for upland rice, corn and legume crops were also identified.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm and	< 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
22. Semboja, East Kalimantan	Rainfed upland	5	Nil	Typic Tropudult, loamy, mixed, isohyperthermic	0° 40°S 5-60 M	1983	—	AARD

Descriptive phrases: Mixed farming systems, interdisciplinary, integrated, holistic and on farm research; food crop, soil conservation, perennial crop and economic component studies.

This research is designed to develop practical bases for farming systems in upland transmigration areas. Food crops establishment and production for subsistance is the first priority. The main objective of the farming systems research is to develop a model that can provide an income of about US$ 1,500/year/family. Perennial and home garden crops will be introduced into the model in the second year. Experience shows that these soils are very sensitive to erosion. The top soil was destroyed by mechanical land cleaning during land opening. Consequently, appropriate land development and soil conservation practices must be developed to rehabilitate the land. Contour bund terraces have been shown to be effective in controlling erosion under farmers' condition. Planting lamtorogung (*Leucaena lepucocephala*) seedlings that are 3-4 months old with improved grasses such as *Bahia* sp. to strengthen the terrace bunds is very promising technology for land development. The upland rice variety Sentani and Orba and Willis soybean varieties, C-1 Hybrid corn, *Centrosema plumeri* and *Pueraria javanica* (cover crops) all showed good adaptability to soil and environmental conditions in Semboja.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
23. Mijen and Demak, Central Java	Rainfed lowland	5	6	Vertic Tropoquept	6°50'S 1-5 M	1983	—	CRIAS

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.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
24. Klepu and Semarang, Central Java	Rainfed lowland	6	6	Oxic Dystrandept	7°S 200-300 M	1983	—	BPT

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

The aim and the research techniques are the same as in Mijen and Demak, but for the upland areas.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
25. Sitiung, West Sumatra (Blocks II-E)	Rainfed upland, undulating	7-9	1-2		± 1°S ± 150 M	1979	1982	SARIF
26. Sitiung, West Sumatra (Block IV)	Rainfed upland	7-9	1-2		± 1°S ± 150 M	1982	—	SARIF

This research was designed to find out the technologies that may be used to improve the productivity of soils that have disturbed by scraping in land development and the most simple but effective soil conservation practices. The research was carried out by farmers on their respective farms under researchers' direction. Applications of two to three tons of lime in combination with two hundred kilograms TSP and normal rates of N and K fertilizers were able to increase the production of food crops (upland rice, corn, soybean or peanut, cassava and cowpea or mungbean) 3-5 times under these conditions. The soil erosion was reduced to 1/10 of the control treatments. Application of 6-10 tons of organic matter reduced the requirement of lime by 1-1.5 ton/ha and reduced soil erosion further. Growing legume tree crops on contour lines at 4-5 meter row distances and returning the crop residues as mulch reduced soil erosion to unmeasurable quantities.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
27. Nakau and 28. Way Abung, Lampung; 29. Batumarta, South Sumatra; 30. Anjungan, West Kalimantan	Rainfed upland	5	2	Typic Tropudult, clayey, kaolinitic, isohyperthermic	± 0-5°S ± 40-100 M	1982-83	—	CSR/CRIFC

Descriptive phrases: Long term fertilizer efficiency and cropping systems research; plant and soil analyses, varietal testing and economic component studies.

Long term and fertilizer efficiency trials have been established for two years in three locations in southern Sumatra on Ultisols. These trials have included studies on partially acidulated phosphate rock, lime x phosphate and slow release nitrogen.

We expect, however, to increase the number and establish a transect of sites in at least 10 sites on Sumatra, Kalimantan, Sulawesi and Java for upland cropping patterns for lime x phosphate and slow release nitrogen studies this year (1984-85). We hope to classify the soil (Soil Taxonomy) and characterize the climate well. These sites will be used for long term and fertilizer efficiency studies and for evaluation of advanced breeding lines for upland rice and palawija crops. These integrated research activities will provide the bases for understanding the long term effects of management strategies (treatments) on the soil and soil productivity but also provide bases for evaluating varietal adaptation, better understanding of environmental effects on disease incidence and for coreelating crop performances and soil test results.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm and	< 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
31. Sitiung, West Sumatra (several blocks)	Rainfed upland, undulating	7-9	1-2		± 1°S ± 150 M	1983	—	CSR/Tropsoil
A long term program (10 year) to study land reclamation methods in relation to soil productivity and conservation.								
32. Bireun North Aceh	Rainfed lowland rice	4-5	4-5	Alluvial (pH 6.7)	± 5°N ± 20 M	1981	—	SARIF
In cropping systems studies, zero tillage soybean, corn and mungbean after rainfed lowland rice yielded 160-200% more than the same crops grown under full tillage (tractor or hoe). With straw mulch the yield increased further (20-28%). Weed problems were solved by using gramoxone and applying a straw mulch 2-3 days after planting. The yields of soybean under zero tillage but with gramoxone plus mulch was 2.3-2.7 ton/ha. Corn under the same treatment yielded 3.3-4.2 tons/ha.								

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
33. Batumarta	Upland rainfed, newly opened	7-9	2	Typic Tropudult, fine loamy, kaolinitic, isohyperthermic	± 4°S 90-120 M	1984	—	AARD Trans III

Descriptive phrases: Farming systems, interdisciplinary, integrated and on farm research; food crop, perennial crop, animal and economic component studies; land clearing and post clearing management.

This research is designed to build an existing research technology in upland rainfed agriculture through more indepth research particularly in land clearing from forests and post clearing land management. Existing food crops technology will be refined, particularly, to provide research stability. The new crop/livestock project will provide technology particularly for small ruminants. This project will carry out research to develop methodologies for perennial crops research for small farm conditions and develop recommendations for perennial crops to be used and appropriate management practices.

References:

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
34. Batumarta	Rainfed upland	7-9	2	Typic paleudult, fine loamy, kaolinitic, isohyperthermic	± 4°S 90-120 M	1984	—	AARD BORIF

Descriptive phrases: Farming systems, integration, interdisciplinary, integrated 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.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and < 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
35. Jratunse-luna	Upper river watershed	6	2	Andepts to Vertisols	± 7°S 200-1000 M	1984	1991	AARD
36. 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.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and > 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
37. Cikampek	Rainfed upland	4	5	(Laterit)	± 50 M	1982	1986	BORIC

Descriptive phrases: Cropping patterns for industrial crops and food crops and economic component studies.

The objective of this research is to study several cropping patterns with cashew with intercropping of annual crops during the gestation period (period between planting and the first harvesting) of the main crop (cashew nut), so that during that period farmers could have an income. Also to investigate the effects of intercropping to the main crop (cashew nut).

The analyzed variables are cost production, yield and net income for each cropping pattern.

The cropping patterns tested are:

Pattern A : Cashew nut - upland rice - peanut - water melon
B : Cashew nut - banana - pineapple - small green pea - water melon
C : Cashew nut - corn - small green pea - water melon
D : Cashew nut - pineapple - peanut - corn - water melon
E : Cashew nut - upland rice - peanut - banana - water melon
F : Cashew nut (Index)

Data have been collected and preliminary results show that the cropping patterns that gave the highest output is: upland rice - peanut - banana - water melon.

Pattern C (corn - rosella - small green pea - water melon) did not give any earning or losses. It may be caused by the low yield of small green pea.

From this research, it is clear that small green pea in Cikampek is not suitable. Water melon planting after harvesting peanut, upland rice, small green pea, corn, and rosella gave high earnings.

We must determine the correct time of planting for each component.

Site location	Edaphic condition	No. Months with Rainfall >200 mm	and >100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year		Institution
						Started	Stopped	
38. Lembang, Bandung, West Java	Rainfed upland	4	3	(Andosol)	6° 80'S ± 1200 M	1982	1986	BORIC

Descriptive phrases: Cropping systems research.

Flax, an annual crop, can be used in mixed-cropping systems in upland areas as well as in a crop rotation after rice at an elevation ranging from 400-600 M above sea level.

The expansion of flax in Indonesia is closely related with the small holders extension scheme.

The aim of this research on this crop either for mixed-cropping combinations or with crops like tomato, endive, carrot and maize or in the monoculture systems is to determine the optimum cropping pattern for flax with those crops mentioned earlier without changing the existing farmer enterprises but at the same time attempt to increase the farmer's income.

The results for the year 1983-1984 is not available, because the trial has not been finished yet. The results for the year 1982-1983 showed a significant effect on the farmer's income (in Rp.) The highest yields were found for tomato as monoculture followed by cabbage, flax + tomato, radish, and flax as monoculture.

Site location	Edaphic condition	No. Months with Rainfall >200 mm and	>100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
39. Kayuwatu, N. Sulawesi	Rainfed lowland	8	0	Latosol	± 85 M	1980	1990	MORIC

Multi-storeyed cropping systems research is being conducted in which more than one perennial crop are allowed to grow to different heights, under a coconut canopy. The two main objectives of this research are to study the physiological interaction between coconut (it is 25 year old plantation planted in a 9 M by 9 M square system) and the intercropped species, and to the economics of using these intercrop combinations.

The eight treatments are arranged in a Randomized Block Design with three replications. The treatment combinations are: (A) coconut only (control), (B) coconut with clove, (C) coconut with coffee, (D) coconut with ginger, (E) coconut with clove and ginger, (F) coconut with coffee and ginger, (G) coconut with clove and coffee, and (H) coconut with clove, coffee and ginger. There are 20 effective palm per plot and 20 palms used as a single row border. The average size of each plot is about 0.097 ha and total area used is about 7 hectares.

Preliminary findings

The figures for ginger harvested from the different combinations for 1982-83 are given below.

Table 1. Production of ginger during 1982-83

Treatment	Yield per plot (kg) 1982	1983
Coconut and ginger	85.67	75.00
Coconut, clove and ginger	50.33	45.00
Coconut, coffee and ginger	87.33	59.67
Coconut, clove, coffee and ginger	101.67	56.33

Fruit yields from these experimented palms and the others in the farm have been recorded six times each year since 1973. Thus, the data for the whole of 1980, even though the trial commenced towards the end of the year, are presented in Table 2. The vegetative growth of the intercropped species during 1981-84, can be seen in Tables 3 and 4.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm and >100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year		Institution
					Started	Stopped	

39. Kayuwatu (continued)

In all treatments, the coconut palms receive 6,500 gram fertilizer per tree per year consisting of 1,400 gram Urea, 1,000 gram TSP, 3,000 gram KCI, 500 gram NaCI, 600 gram MgO and 100 gram Borax while the intercropped species received fertilizer based on their age. From one year until three years after planting, they received fertilizer at the rate of 10%, 15% and 25% of the coconut dose, respectively. From 1983 onwards, the intercropped species will receive fertilizer at the rate of 25% of the coconut dose.

The combined net income of the intercropped species and the coconut on a hectare basis is presented in Table 5. Three years after planting of the intercropped species, the combinations of coconut-ginger gave the highest return.

Table 2. Production of coconut (from effective palm)* for 1980-83. (Mean for 20 palms)

Treatments	Yield of nut/palm							
	1980		1981		1982		1983	
	nut No.	copra Kg	nut No.	copra Kg	nut No.	copra Kg	nut No.	copra Kg
Only coconut (control)	1482	391.25	909	239.98	1336	352.79	825	215.16
Coconut with clove	1379	364.06	844	222.90	1359	358.86	693	182.86
Coconut with coffee	1539	406.30	999	263.74	1262	333.08	778	205.48
Coconut with ginger	1373	362.47	874	230.65	1238	326.28	793	209.35
Coconut with clove and ginger	1534	404.98	935	246.84	1437	379.28	769	203.02
Coconut with coffee and ginger	1473	388.87	964	254.41	1281	338.08	826	217.98
Coconut with clove and coffee	1333	351.91	898	237.07	1303	344.08	791	208.82
Coconut with clove, coffee and ginger	1422	375.41	889	234.70	1418	374.26	792	209

*Excludes border rows

Site location	Edaphic condition	No. Months with Rainfall >200 mm and>100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution

39. Kayuwatu (continued)

Table 3. Height, number of branches and girth of trunks of coffee plants.

Treatments	1981 Ht. of plant cm	1981 Girth cm	1981 Branches no.	1982 Ht. of plant cm	1982 Girth cm	1982 Branches no.	1983 Ht. of plant cm	1983 Girth cm	1983 Branches no.	1984 Ht. of plant cm	1984 Girth cm	1984 Branches no.
Coconut, coffee	72,60	5,02	7	118,86	7,82	17	173,91	12,95	32	188,18	14,46	35
Coconut, coffee and ginger	76,92	4,05	8	129,89	8,46	16	147,24	13,44	31	183,71	15,61	33
Coconut, coffee and clove	57,32	3,95	6	96,70	6,47	12	150,86	11,75	24	164,22	12,58	27
Coconut, coffee, clove and ginger	75,50	3,45	7	116,28	7,28	15	172,70	14,88	31	189,05	15,41	36

Data available up to April only.

Table 4. Height, number of branches and girth of trunks of clove plant

Treatments	1981			1982			1983			1984		
	Ht. of plant cm	Girth cm	Branches no.	Ht. of plant cm	Girth cm	Branches no.	Ht. of plant cm	Girth cm	Branches no.	Ht. of plant cm	Girth cm	Branches no.
Coconut, clove	82,86	2,28	7	154,11	5,30	18	192,81	7,00	23	211,78	9,56	29
Coconut, clove and ginger	86,31	2,61	9	132,88	5,00	19	206,43	7,25	26	245,28	11,19	32
Coconut, clove and coffee	87,75	2,70	11	126,29	5,31	19	190,48	8,93	25	239,70	11,49	31
Coconut, clove, coffee and ginger	101,98	2,90	13	164,85	6,51	22	224,02	9,50	28	278,00	12,21	35

Data available up to April only.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm and>100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year		Institution
					Started	Stopped	

39. Kayuwatu (continued)

Table 5. Cost and return of coconut and intercrops (per hectare basis), 1983

Treatments	Income	Expenditure	Profit/Loss	B/C Ratio
	Rp/ha			
Coconut only	575,405	480,105	95,300	1.20
Coconut, clove	605,840	580,170	75,675	1.14
Coconut, coffee	625,170	770,675	(145,505)	0.81
Coconut, ginger	2,133,600	1,729,325	404,275	1.23
Coconut, clove and ginger	1,732,900	1,423,640	309,260	1.22
Coconut, coffee and ginger	1,957,270	2,032,165	(74,895)	0.96
Coconut, clove and coffee	712,020	673,590	38,430	1.06
Coconut, clove, coffee and ginger	1,898,910	1,939,765	(40,855)	0.98

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and >100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
40. Pandansari, Ciawi, Bogor, West Java	Medium altitude irrigated rice field	10	0	Red sandy clays	± 400 M	1982	—	BPT, Ciawi

Descriptive phrases: Improvement of farmers' benefit from rearing livestock, and improvement in the efficacy of the village farming systems.

Initial base data collection, livestock and forage productivity monitoring, constraint analysis, develop closer ties with farmers through farmer groups, and use of cooperative members to try out and demonstrate ideas for improvement of productivity and profit.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and >100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
41. Rancamaya, Ciawi, Bogor, West Java	Medium altitude mixed gardens	10	0	Red sandy clays	± 400 M	1983	—	BPT, Ciawi

Descriptive phrases: Improvement of farmers' benefit from rearing livestock, and improvement in the efficacy of the village farming systems.

Initial base data collection, livestock and forage productivity monitoring, constraint analysis, and develop closer ties with farmers through farmer groups.

Site location	Edaphic condition	No. Months with Rainfall >200 mm	and >100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
42. Sukamandi, Ciawi, Bogor, West Java	High altitude mixed gardens	10	0	Red sandy clays	500 M	1981	—	BPT, Ciawi

Descriptive phrases: Improvement of farmers' benefit from rearing livestock, and improvement in the efficacy of the village farming systems.

Livestock and forage productivity monitoring, constraint analysis, develop closer ties with farmers through farmer groups, and use of cooperative members to try out and demonstrate ideas for improvement of productivity and profit.

43. Peltong, Larangan, Pamekasan, Madura	Low altitude mixed gardens (dryland)	3-6	6-9	Sandy clay-loam (limestone based)	$\pm$ 20 M	1982	—	BPT, Ciawi/ Dinas Peternakan

Descriptive phrases: Improvement of farmers' benefit from rearing livestock, and improvement in the efficacy of the village farming systems.

Initial base data collection, constraint analysis, production trials with farmers animals, other trials, and use of cooperative members to try out and demonstrate ideas for improvement of productivity and profit.

Site location	Edaphic condition	No. Months with Rainfall > 200 mm	and > 100 mm	Most probable Soil Classification or type	Latitude: Elevation:	Year Started	Year Stopped	Institution
44. Sopaah, Padamau, Pamekasan, Madura	Low altitude irrigated rice field/dryland mixed gardens	3-6	6-9	Heavy cracking clay (limestone based)	± 50 M	1982	—	BPT, Ciawi/ Dinas Peternakan

Descriptive phrases: Improvement of farmers' benefit from rearing livestock, and improvement in the efficacy of the village farming systems.

Initial base data collection, constraint analysis, production trials with farmers animals, and other trials.