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CROPPING SYSTEMS RESEARCH ACTIVITIES IN INDONESIA*)

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INTRODUCTION

The research described in this paper consist research highlight of the total research activity for cropping systems in CRIA including research activities that has been done, being done and needs to be done in the near future.

The research was started in 1973 in Indramayu and Lampung from funds routinely budgeted for Cropping Systems by CRIA. Supplemental funding was received from the International Development Research Center of Canada through IRRI in 1975 for initial two year period. The expaded activities that resulted from the additional funding has been of great value. We have been able to increase the number of research sites within each target area from one up to three. Funds for an annual workshop, short term training in Indonesia and at IRRI and degree training have provided the environment and the level of technical expertise needed for good research.

The Cropping System research is problem oriented. Target areas are selected for in depth research. For each target

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area the activities include identification and quantification of problems or possibilities, evaluation of new technology in the field, pre production testing (pre BIMAS testing) and transfer of technology to new target areas as shown in Diagram 1.

At each step the Extension Service is involved. Usually the research phase lasts for three years and the involvement of the Extension Service and other provincial Services increase each year. In this way the interface between CRIA and Extension as well as Extension and farmers is increased and the involvement of the provincial planning Agency (BAPPEDA). BAPPEDA together with the Agricultural Extension Service seems to contribute a big role especially for strengthening and facilitate as well as supporting the production program after a package production technology has been obtained. CRIA's targeted inputs ends with the implementation phase. But of course the routine support continues.

RESEARCH RESULT IN TARGET AREAS

Significant results and implications from the research may be summarized as follows:

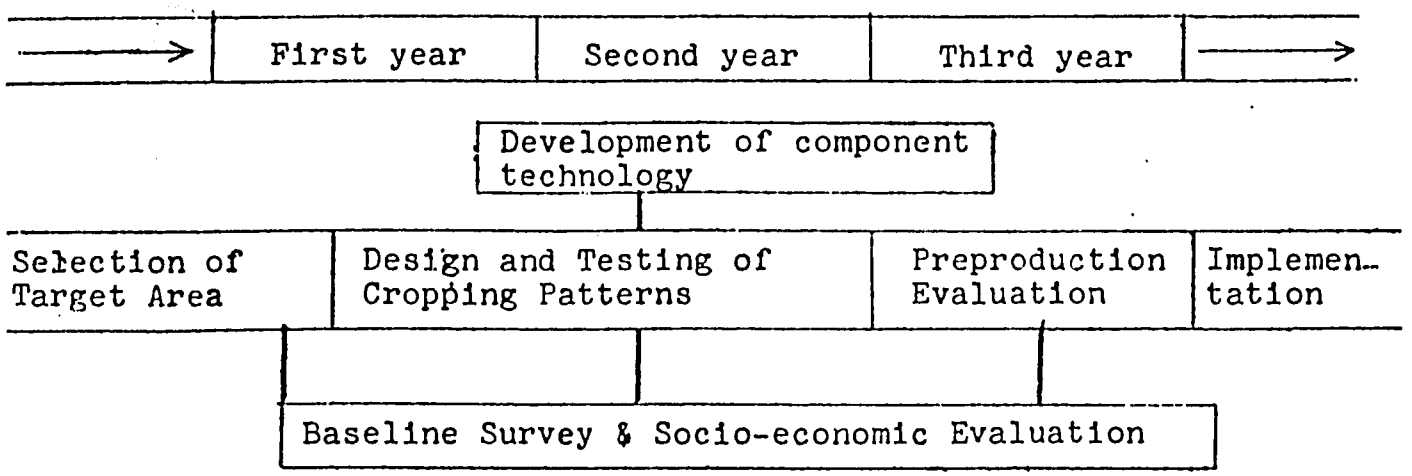
A. Indramayu. This area represents the irrigated and partially irrigated lowland rice producing areas of Java (including smaller areas of the outer islands).

Presently, there are about 3.94 million hectares of irrigated rice land in Indonesia. Generally, two crops of rice per

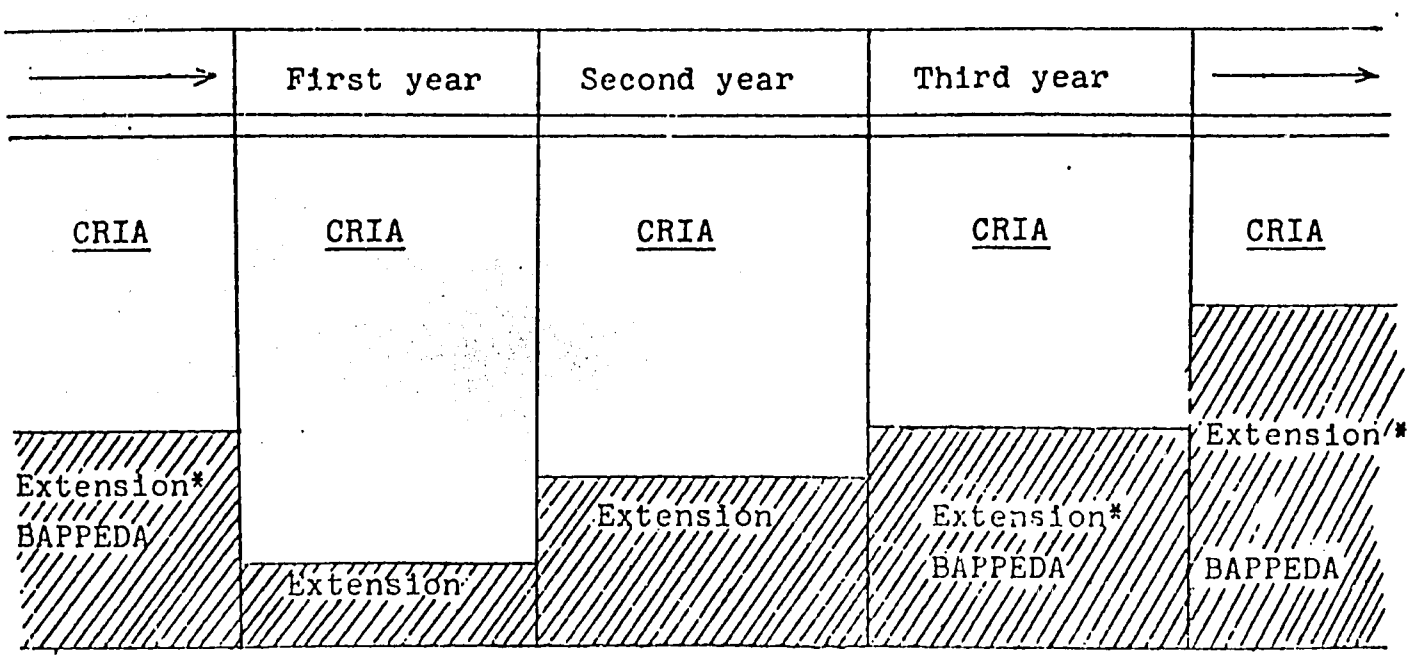
Diagram 1. Time phase and work load for cropping systems research in Target Areas.

ACTIVITIES

CRIA-Cropping Systems Working Group.



Work Load Distribution



And other Provircial Agencies within the frame work of the BAPPEDA.

year are planted on 50% of this land. From our research in Indramayu it has been shown that except for two years with a long wet season the yield of the second rice crop is reduced because of insufficient water in the partially irrigated areas with less than 9 months of irrigation water. This has been particularly true if the rice varieties used needed more than 120 days to mature. The data show the potential for two good rice crop yields and a legume crop in one year. For these irrigated areas totalling more than 3.94 million hectares enough rice could be produced to meet most of the Indonesia need. Preliminary research results for 1977-78 showed that IR-36 followed by IR-36 produced average yields of 6.8 tons/ha and 5.7 tons/ha within 240 days for the first and second rice crops, respectively. Furthermore there was sufficient time and water for a soybean crop after either one or two rice crops. Taking into account losses from insects and diseases and the amount of land that is presently double cropped the average yield of rice should exceed 4 tons/ha for 6.6 million hectares of crop harvest land. This would result in a total rice production of 26.4 million tons of gabah or 17.55 tons of beras. Based on a per capita consumption of 120 kg this is enough rice for 145 million people. The average yield of soybean should be at least 0.7 ton/ha for 3.94 million hectares of land to give a total of 2.76 million tons. Based on a minimum daily requirement of 55 gm per day this

yield of soybean (35% protein) would provide enough protein for approximately 48.1 million people for one year and could supply 0.50 million tons of edible oil. The present cooking oil shortage could be alleviated and there would be sufficient protein to supplement the starch produced from cassava in the outer islands and Java. These kinds of data and calculations raise two very important questions. First of all, are the basic assumptions true? Secondly, if the assumptions are true, why have the present production programs not produced the same results?

The best data available for land area in irrigation by catagories of 10, 7-9, 5-7 months, indicate that there are approximately 4 million hectares of irrigated land in Indonesia. The exact breakdown of water availability by months is not available. But from our research in Indramayu and other places, we believe that the technology is available to grow two rice crops per year. Furthermore, we believe that in these irrigated and partially irrigated areas where considerable water control exists (for irrigation and drainage) a legume crop such as soybean (preferably soybean) could be grown after two crop of rice. And this cropping pattern can maintain a good soil fertility, by having legume in the rotation.

The second question is more difficult to answer. Until 1977 we did not have a high yielding early maturing rice variety like IR-36. Pelita which is a vigorous high

yielding variety with high quality takes about 140 days to mature. Consequently, many times the second crop has yielded only about one fourth of that of the first crop because of water stress during the flowering stage. This helps explain the fact that the average yield per hectare for all of Indonesian is about half the potential yield. The rate of failure of the second crop in the non irrigated and rainfed areas is, of course, much higher. The availability of additional power to facilitate land preparation (to minimize the drudgery associated with rapid and timely land preparation only) and turn around time must be given some consideration. Presently, there appears to be no need for additional power for planting, weeding and harvesting. But, we feel additional power for land preparation is needed and will in the long run increase the need for an acceptable forms of labor (for example, harvesting by women, older men and children) for those who need it most by making it easier to grow extra crops.

There are other factors involved which are much more difficult to solve than fitting rice varieties to water availability and providing new sources of power. In order to have a concentrated production program for the irrigated areas certain organizational arrangements must be simplified and strengthened. The irrigation water must start and terminate within a unit area in step with the land preparation, planting and harvesting operations for the crop sequence

agreed upon. Agricultural extension, irrigation and local government officials must work closely together with the farmers in a specific irrigation and agro-climatic unit of a manageable size. Credit and material inputs (including seed) must be available on time. These conditions are not new and the present BIMAS program covers many of the same points. But new technology and effective leadership within a production complex must be combined with guaranteed markets in order to implement such a program.

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

The productive capacity of these soils has been seriously questioned by many agricultural scientists. In fact they have been described as alang-alang (*Imperata cylindrica*) infested waste lands. There are constraints to production such as low inherent soil fertility, exessive drainage and low pH. But on the positive side there are several assets. The rainfall and distribution are very good for year around crop production. Rainfall exceeds 200 mm monthly for 6 months and 100 mm for 3 months. The remaining 3 months are drier but the average rainfall in only a little less than 100 mm. Since the soils are well drained, the heavy rains during the rainy season do not inhibit upland crops production. Run-off problems are minimized by the rapid infiltration of rain

water. Consequently, the soils are leached and acid. But fortunately the soils do not contain excessive levels of aluminum. There is sufficient clay and organic matter to hold applied nutrients but fixation of phosphorus is not a problem. Insect problems (seedling maggots etc.) usually associated with upland crops can be eliminated with systematic insecticides. Consequently, these soils can be highly productive if managed properly. Fertilizers and insecticides are absolutely necessary but in amounts comparable to those used on rice on Java on some of the best agricultural land in the world.

Research has been conducted for 4 years in these areas. During this time there have been years with virtually no dry season and years in which there was practically no rain in May, June and July. In a sequence of Upland rice+Corn/ Cassava/Peanut-Rice bean have had no trouble growing upland rice plus corn intercropped with cassava. The peanuts interplanted in the cassava grew well even in the driest years but sometimes were severely damaged by pod borers. There was difficulty in establishing a stand of cowpea or ricebean after the peanut*).

From these results and our field observations we feel that sustained crop production on these soils in feasible. Judicious use of fertilizers and crop sequences including

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*) The yield figures was reported at the Annual Report Cropping Systems Research Indramayu and Lampung 1976-1977.

legumes and rice can actually increase the fertility of these soils.

The crop arrangements and relative proportions of individual crops within a cropping pattern should depend upon available markets and the farmers preference. It is also important to note the highly profitable nature of cassava in this pattern. This was due to the low cost of production as well as to the high productivity of cassava. Rice also can be very profitable. But at present we still have problems with rice blast.

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

RESEARCH PROGRAM IN SHORT COMING

Irrigated areas

Lowland rice based cropping pattern in several catagories of irrigation water availability will be extended to the area surrounding Indramayu covering 4 kabupatens. These areas are influenced by Jatiluhur irrigation system and covering more than 250,000 hectares of land. These activities are budgeted by Sukamandi agricultural research as a part of the whole agricultural development scheme for Jatiluhur irrigation systems. Component technology for each crop commodity will back stop the cropping pattern suitable for these area and projected toward suitable cropping and farming systems to increase in food production as well as farmer's income. The production program will be a systems approach program to obtain a suitable, effective and profitable farming systems.

Rainfed areas

Lowland rice based cropping systems,upland rice based cropping systems as well as perennial crop based cropping systems will be studied and target areas have been selected.

Development of rainfed agriculture was recognized and reaffirmed as one of the major priority area of action in cropping systems research program.

The choice of development of rainfed agriculture as one of the priority areas was welcomed to improve the inbalance

of income growth and welfare gains between farmers in the irrigated lands and the majority of lands were dependent on rainfall. An approach on a wide front is needed, covering research, training, demonstration and development projects. The need for crop live saving research and the efficient use of fertilizers will be emphasized in this area. We reaffirmed the development of rainfed agriculture, with special emphasis on appropriate cropping systems and soil management, as one of the priority areas, since it affects at least 60% of the arable land in Indonesia. The scope of rainfed areas should be extended to include not only high rainfall humid areas like Lampung but also low rainfall areas. For increasing and stabilizing agricultural production in rainfed areas, the research will be projected, among others, (a) analysis of hydro-meteorological and ecological factors for designing and selection of cropping systems, (b) selection for kind of crops suitable to these area and breeding of high yielding varieties suitable for rainfed areas, particularly upland rice and seed production and distribution of identified crops and varieties, (c) sound soil and water conservation and management practices, (d) mixed farming integrating crops and livestock, (e) fuller utilization of atmospheric nitrogen, organic manures and plant residues, (f) farm machinery research and development.

Projecting for increasing yield stability rather than record yields is the goal, that small increases over large areas make a more significant contribution than high yields on a few farms,

and that there should be a shift in emphasis from the individual crops to the environment and systems it has generated.

Under the development of new technology it should be emphasized particularly (a) development of flexible approaches to crop production with the aim of increasing yield stability (b) identification of critical inputs rather than adoption of an unselective "Package" approach (c) improvement of food legumes, oil seed and vegetable crops by fitting them into farming system of the staple cereals (d) increasing efficiency of fertilizers and complementary sources of plant nutrient, (e) breeding for varieties to suit "non-ideal" conditions (f) improved seed technology and seed supply and simple local seed storage at the farm and village level (g) integrated approach on land management techniques, farming systems and small farm mechanization (h) food technology and simple food preservation to stabilize food supply, (i) to identify major causes for low crop productivity in rainfed areas.

Improve farm equipment and power

Unfortunately, it is difficult to cultivate one hectare of land by hand labor from the family. Additional power is needed. This is true based on our observation for land preparation in lowland irrigated as well as in upland area.

The older transmigration schemes provided each family with 2 hectares of land. From our studies and observation it appears a farmer has difficulty in using much more than one half hectare

the first year after opening land. Gradually more land can be opened and used, but not more than one hectare can be cultivated and this is due to a lack of sufficient power for land cultivation, and this remains a constraint.

There appear to be several alternative ways of solving this problem. Traditionally the farmers interplant coconut, palm, clove, coffee and tree fruit crops in the food crops. They can reduce and spread out labor and open more land. They derive some income from the perennial crops. These crops provide stability but are not highly productive if compared to food crops. Most important, they do not supply enough food for the family. The labor requirement has been reduced and more evenly distributed so that more land can be used. This approach has been described as the perennial crop based cropping systems.

Some farmers have increased their power supply by adding animals to their farming systems. Some land must be set aside for forage production but more can be cultivated for food crops. In addition to power the animal can produce meat, milk and manure. Introduction of the cow into the farming system permits more efficient use of the farmers resources with a minimum of capital inputs. A stable and productive farming operation can result and the system will be more stable in terms of maintaining even increasing soil productivity and stabilizing food production for their own as well as some amount to sell.

Mechanization through the use of hand tractors for power is an alternative solution. In some instances the farmers may not want an animal. They may not like to work with animals nor have the time. A tractor might be more efficient, particularly, if the farmer has an off farm job for some supplemental income.

We need to study alternative sources of power in real farm situations. This could be easily done in new transmigration areas in Lampung and South Sumatra. It is proposed that a series of research trials be undertaken involving several combinations of human, animal and mechanical power to compare the resulting areas under cultivation, changes in labor productivity (per family unit) and production and net returns for individual crops and cropping patterns.

The major objective would be to assess the possible area of expansion through introduction of supplemental power. A second objective would be to examine the relative costs and benefits associated with use of alternative power sources.