RICE DOUBLE CROPPING IN INDONESIA

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ABSTRACT

Under a tropical environment water is the most important factor in lowland rice cropping. By developing new irrigation systems lowland rice areas in Indonesia have been expanded from about 1.2 million ha in 1860 to 3.3 million ha in 1935 and 5.1 million ha in 1955. By 1980 the extent of lowland rice areas included 4.0 million ha with irrigation and 2.2 million under rainfed conditions. Since 1969 major programs have been implemented to increase rice production by intensifying cultivation and expanding the area planted to rice. Rice double cropping, using early-maturing varieties followed by an upland crop, is recommended in irrigated lowland areas. The average cropping intensity index of the whole lowland rice by 1982 was estimated to be 1.3. Building irrigation systems and the development of early-maturing non-photosensitive varieties are two important aspects for intensifying rice cropping. Major constraints in intensive rice-producing areas, however are pests and diseases and the possible decline of soil productivity. The current research program, strategies and activities to increase, stabilize and sustain high rice yields are discussed.

Introduction

Rice is the most important staple food of Indonesians. Rice production must be ever increased in order to keep up with the ever-increasing population and food demand. The Indonesian government has been promoting rice production since 1969 by expanding the use of high-yielding varieties, improved cultural practices, control measures for diseases and pests, better irrigation and water management, improved marketing channels, intensified agricultural extension, provision of credit and subsidized production inputs.

Starting in the first Five Year Development Plan in 1969 two main efforts were implemented to increase rice production: (a) Intensifying rice production on land already under cultivation and; (b) Expanding the area planted to rice. Expanding the area planted to lowland rice is restricted by the fact that irrigation water is limited. The emphasis, therefore, lies in intensifying crop production in the area under cultivation.

There are two important activities to increase rice production in certain rice-producing areas. The first is to increase rice yields per unit land area and the second is to increase the cropping intensity, using improved cultural practices.

Increasing the rice cropping intensity in lowland areas can only be achieved by growing early-maturing rice varieties with improved cultural practices. An improved package of technology, generated by research institutions, is extended to the farmers to support increased rice production.

The progress of the Indonesian rice intensification program in relation to the increase of the cropping intensity, including rice double cropping technology, will be discussed.

A brief history of rice double cropping

1 The rice environment

Geographically the Indonesian archipelago, which consists of more than 13,000 islands, is situated between 6° North and 11° South latitude, and has a humid tropical isothermic climate. The coastal lowland areas of Indonesia have temperatures which vary from 25°C to 30°C the

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year-round, while the highlands have a cooler climate (18-20°C). In general, the western parts of Indonesia have a wet climate with an average annual rainfall of about 2,500 mm per year; the eastern parts (some parts of Sulawesi and East Nusatenggara) have a semi-arid climate.

The weather and climate of the region are determined by *passat* and monsoon Asian winds. There are two seasons in the year : dry and wet. The wet season is characterized by high humidity and high rainfall, which occurs from September through March. The dry season is characterized by less rainfall and lasts from April through August.

Land capability and suitability for cultivating lowland rice are determined by the slope (physiography), soil texture and water table. In many parts of the country rainfed lowland rice and irrigated lowland rice are grown on lowland plain, lowland plateau, or sloping terrace. Lowland rice is also grown on flood plains and in tidal swamp areas (FAGI and LAS, 1984).

2 Lowland rice areas

When lowland rice culture began in Indonesia is not exactly known. SOSROPRAWIRO (1958) reported that in 1860 the extent of lowland rice in Java and Madura was about 1, 195,418 ha. In 1871 a committee was established to investigate the possibilities of expanding the irrigation system in different regions of Java. In 1885 a special service for irrigation was established as a division of the Department of Public Works (GIESSEN, 1943). Several years later different irrigation sections to manage and supervise the irrigation and other water affairs of a whole river basin were established, i.e. "Serayu" in 1982, "Berantas" in 1901, "Pekalen Sampean" in 1907, "Serang in 1908, "Pemali Comal in 1908" "Madiun" in 1909, "Cimanuk" in 1910, and some others.

By 1935 rice areas were expanded to 3.31 million ha, of which about 1.05 million ha are under technical irrigation. Total lowland rice area in Indonesia in 1955 was estimated to be 5.1 million ha. The ever-increasing demand for rice has caused further government efforts to expand irrigation in different parts of the country. By the early 1960s, the Jatiluhur Irrigation Project was completed and serves an area of about 260,000 ha. Since then many other irrigation projects have been implemented.

Land area available for wetland rice in Indonesia in 1980, compiled by CRIFC (1985), is shown in Table 1. Of Indonesia's 7,059,000 ha of rice land, 4,015,000 ha are irrigated, 2,255,000 ha are rainfed and the remaining 789,000 ha are tidal swamps and others. Irrigated rice occupies more than half of the total wetland rice area.

Table 1 Land area available for wetland rice in Indonesia in 1980

Irrigation type	Area (000 ha)
Irrigated:	(4015)
Technical irrigation	1558
Semi-technical irrigation	799
Simple irrigation	1658
Rainfed	2255
Tidal Swamp	450
Other	399
Total	7059

Source: CRIFC, 1985.

3 Rice cropping in lowland areas

1) Water availability

Traditionally farmers start preparing land for wetland rice cultivation when water becomes available, coinciding with the beginning of the rainy season. The onset of the rainy season varies with the region, therefore planting and harvesting also vary with the region. These variations occur even in certain regions due to irrigation water allocation or availability which can extend from one to two months.

DE VRIES (as cited by GIESSEN, 1943) divided Java and Madura into 8 regions and summarized the percentage of monthly rice harvest for the year 1920-1925, as shown in Table 2. This Table shows that the main harvest is in May and June, and accounted for

Table 2 Monthly rice harvest during the year, from 1920 to 1925, in different regions of Java and Madura

(%)

Region	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A*)	3.3	5.8	2.1	10.8	25.3	33.9	16.2	4.1				
B			13.6	17.5	15.6	10.1	7.4	9.4	7.3	4.0	2.9	3.1
C			4.1	16.5	21.7	16.4	14.4	7.5	6.1	5.8	2.7	
D			2.5	15.1	45.1	26.0	2.6				2.8	
E			2.2	16.3	39.6	30.2	6.1			3.7		
F			3.0	20.7	32.0	22.8	2.9			2.7	3.6	2.2
G				10.9	22.5	32.0	12.0				4.9	2.7
H	1.6	2.1	3.0	7.2	28.0	32.1	21.7	5.8	2.1	2.8		
Java and Madura			5.1	15.2		23.0	9.8	4.7	3.0		2.7	2.1

*) A = Banten, Jakarta, Jatinegara, Krawang, Indramayu, Cirebon; B = Bogor, Priangan, Banyumas, Kudu; C = Pekalongan, Kendal, Semarang, Salatiga; D = Demak, Kudus; E = Lembang, Gresik, North Surabaya, Madura; F = Yogyakarta, Surakarta, Madiun; G = Kediri, South Surabaya, Malang, Pasuruan, Probolinggo, Kraksaan; H = Lumajang, Besuki.
Source: GIESSEN, 1933.

51% of the total annual harvest. In most of the regions of Java and Madura rice is exclusively grown in the rainy season (West monsoon). Dry season crops are planted mainly in technically irrigated areas along the North coast of Central and East Java and are harvested in the months of September to November.

The development of irrigation systems in many parts of the country (mainly on Java) was initiated in the 1900s. The total harvest in the dry season (September-November) over 1920-1925 was about 8.5% as shown in Table 2. This evidence, in addition to the report of GIESSEN (1943), leads to the assumption that rice double cropping practices have gone along with the establishment of irrigation systems in different areas. GIESSEN (1943) reported further that improvement of irrigation resulted in the expansion of dry season rice areas, or rice double cropping. By 1940, out of the 3,384,330 ha of total paddy area about 3,724,133 ha of rice could be harvested, indicating a cropping intensity, in this period, of about 1.1.

2) Rice varieties

Before the 1940s several traditional lowland rice varieties were grown by farmers in many parts of the country. Some popular varieties have been improved by the General Agricultural Research Station in Bogor using the pure line selection method. Table 3 lists some improved varieties selected and introduced by that Research Station. Using late-maturing varieties which mature in 175 days, and traditional cultural methods, only one rice crop can be grown per year. Along with the development of irrigation systems, early-maturing, non-photosensitive, varieties are preferred for planting in the dry season (GIESSEN, 1943).

Table 3 List of several lowland rice varieties selected by the General Agricultural Research Station, Bogor and released before the 1940s

Variety	Population origin	Maturity (day)	Bulu/ cereh	Reaction to photoperiod	Eating quality	Reaction to "mentek" disease
Bali Kambang	Blitar	176	bulu	non-photosensitive	good	susceptible
Djalen	Karawang	171	bulu	-	good	resistant
Baok	Cianjur	168	bulu	non-photosensitive	very good	susceptible
Beak ganggas	Lombok	169	bulu	non-photosensitive	good	susceptible
Untung*)	India	173	cereh	photosensitive	good	resistant
Brondol putih	Banten	156	gundil	-	good	resistant
Genjah Raci	Pasuruan	153	bulu	-	good	moderate
Major	Cirebon	152	bulu	-	good	moderate
Genjah beton	Akikarta	148	gundil	-	good	moderate
Lusi*)	India	140	cereh	photosensitive	moderate	resistant

*) Introduced variety.

Source: SOSROPRAWIRO, 1958.

Efforts to increase rice productivity through hybridization began in 1905, but not until 1930 were any serious efforts implemented (MEULEN, 1950). Improved characteristics to be obtained included : high yield potential, grain quality, maturity, resistance to "mentek" disease, non-lodging, tillering capacity and wide adaptability.

Success in breeding activities was realized in the 1950s by obtaining several improved varieties generated from 40C-selections (from Cina × Latisail), as listed in Table 4. Early maturity and non-photosensitivity are among the most important characters to be considered in increasing rice productivity through increased cropping intensity in irrigated lowland areas.

Table 4 Characteristics of different varieties originated from 40C-selections (Cina × Latisail crosses)

Variety	Selection No.	Maturity (day)	Reaction to "mentek" disease	Reaction to photoperiod
Fajar	2783	158	r*)	non-photosensitive
Cahaya	2775	175	r	photosensitive
Bengawan	2794	162	r	non-photosensitive
Intan	2400	151	r	non-photosensitive
Mas	2401	146	r	non-photosensitive
Peta	2802	149	r	non-photosensitive

Source: MEULEN, 1950.
*) r = resistant.

Present situation and future prospects

1 Progress in rice production

Lowland rice cultural practices have been improved through research, which was intensified since the 1960s. In a separate paper in this Symposium the author describes the current cultivation techniques adopted by farmers who grow lowland rice in irrigated as well as in rainfed areas.

Historical data reviewed by SATARI (1983) demonstrate the role of innovation in rice-gowing technology for the increase of rice production, as shown in Fig. 1. From 1962 to 1967 the average annual rice production was about 10 million tons, with 0.5% annual rice growth rate,

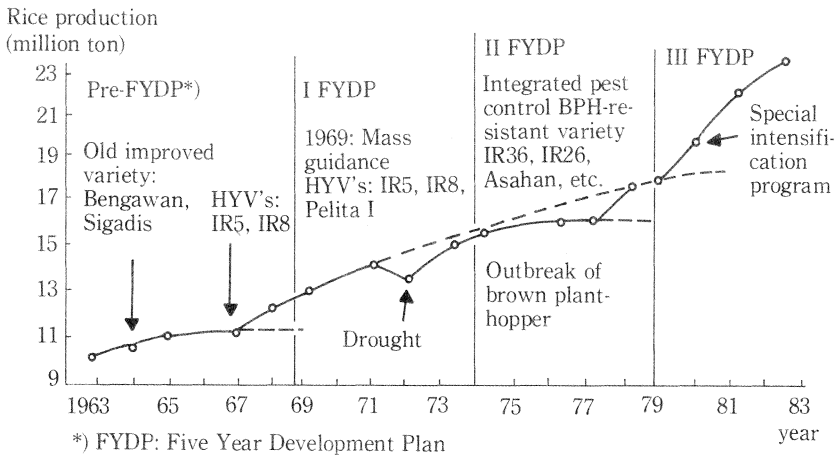

Fig. 1 Relationship between innovation and rice production in Indonesia from 1963-1982.
Source: SATARI, 1983.

due mainly to the intoduction of older improved varieties such as Bengawan and Singadis. Beginning in 1969, when the BIMAS or "Mass Guidance" program was initiated, a real breakthrough in rice production was realized by adopting five principles ("panca usaha"), i.e. : the use of high-yielding varieties, fertilizer application, pest and disease control, improved irrigation, and adoption of better cultural practices. An outbreak of brown planthopper in 1973 was overcome by adopting integrated pest management, including growing resistant varieties such as IR36 and Cisadane. A sharp increase in rice production occurred over 1980 to 1982 due to the new approach in intensifying rice production by a program aimed at grouping farmers in the rice-producing areas. Rice floor price policy also played an important role in this success. By 1984 total rice production was 25.8 million ton (CRIFC, 1985).

2 Cropping intensity

While the harvested area was not significantly increased, the rapid increase in rice production over 1970 to 1982 was due mainly to the increase of yield per unit land area and the time span of the rice production intensification program, as shown in Fig. 2. In this connection the time factor may relate with the cropping intensity.

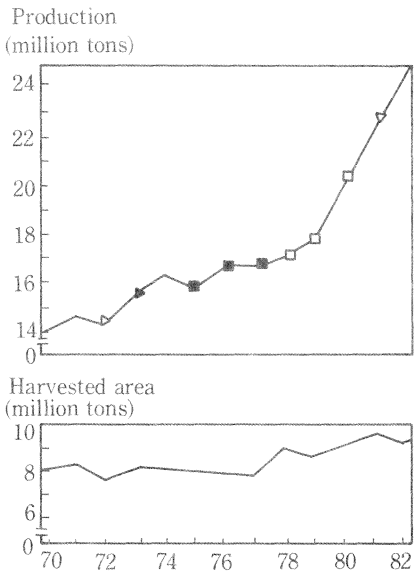

Fig. 2 Harvested area and total rice production in Indonesia, 1970-1982.
Source: SIWI, 1983.

As stated by GIESSEN (1943), in 1920-1925 lowland rice was exclusively planted in the rainy season (West monsoon) using late-maturing varieties and the peak of harvest was in the months of May-June (Fig. 3). Major changes took place about 60 years later : wet weason rice is harvested in March through May by planting early-maturing varieties. Table 5 shows the extent of harvested area of early-maturing HYVs in 1983-1984. These data indicate that at present a larger portion of the rice-producing areas is planted with HYVs.

Available recent data shown in Fig. 4 indicate that by using early-maturing non-photo-

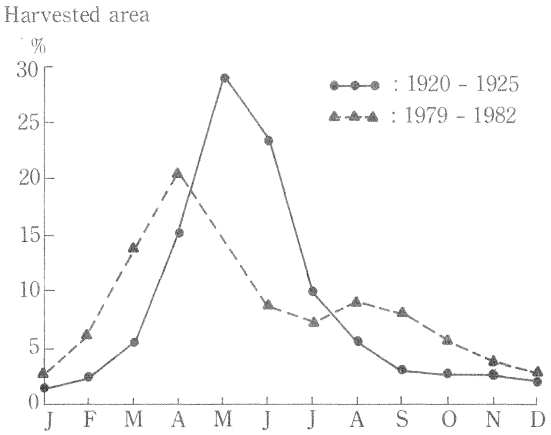

Fig. 3 Percentage of harvested area by month in Java and Madura (1920-1925) and in Indonesia (1979-1982).
Source: GIESSEN, 1943 and D.G. Food Crops, unpublished.

Table 5 Five most popular rice varieties in Indonesia, 1983-1984

Variety	Area harvested (000 ha)	
	DS 1983	WS 1983/84
IR 36	922.2	1825.3
Cisadane	599.6	1136.6
IR42	171.4	240.6
Krueng Aceh	83.0	105.1
IR54	92.0	89.0
All varieties	2865.6	5379.7

DS = dry season
WS = wet season
Source: CRIFC, 1985.

sensitive varieties rice can be planted any time in the year if water is available. The majority of the areas are planted in December and January (wet season) and harvested in March-May. Dry season plantings are made in March and April and harvested in August and September. Averaging the data over 1979 to 1982, the total planted and harvested areas of lowland rice were 8,285,340 ha and 7,870, 589 ha, respectively. Using figures of total irrigated and of rainfed lowland rice cropping areas of 6,270,000 ha (Table 1), the cropping intensity index of lowland rice at present is about 1.3.

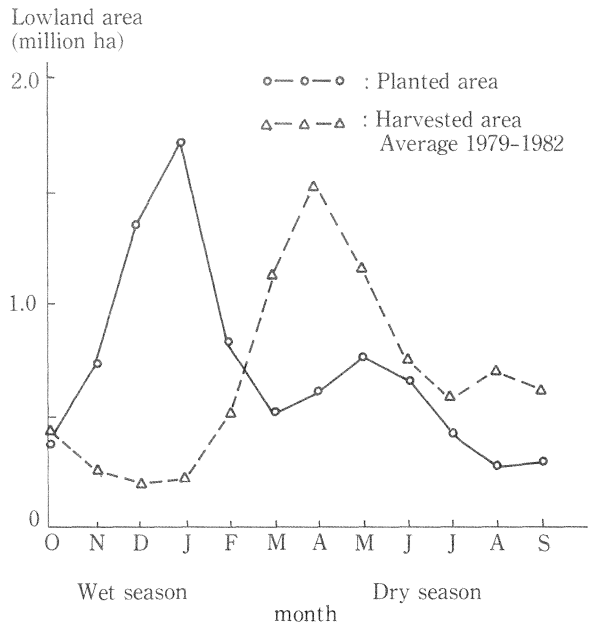

Fig. 4 Planted and harvested area of lowland rice by month in Indonesia, averaged from 1979-1982.
Source: D.G. Food Crops, unpublished.

3 Future development

In the irrigated lowland areas the cultivation of two crops of rice is becoming the general farming practice. The remaining time is used to cultivate upland crops. In rainfed areas, one crop of rice can be planted with great success at the beginning of the rainy season if flood is not a problem. As reported by PARTOHARDJONO (1986) in this Symposium, the second crop of rice called, "walik jerami rice" or no tillage rice, can be planted successively. In fact, this practice has been followed by farmers in some areas for a long time.

The general guidelines for the rice cropping pattern in zones A, B_1 and B_2, with 6 to 8 wet months have been given by the Directorate Food Crops Production (D.G. Food Crops, 1981). Potentially rice can be double-cropped in these rice areas.

Increasing yield per unit land area is also being implemented by improving the quality of the rice intensification programs. Special intensification program (INSUS), initiated in 1979, increased the average milled rice yield from 2.6 t/ha to 3.31 t/ha in 1981. Since 1979 the area under the INSUS program has been expanding from 0.4 million ha in 1979 to 3.6 million ha in 1982 (BIMAS Program as cited by PARTOHARDJONO *et al.*, 1983).

The expansion of new paddy field areas has also been implemented in many parts of the country. In the fourth Five Year Development Plan (1984-1988) approximately 350,000 ha of new paddy field area was targeted (D.G. Food Crops, 1984, unpublished).

Major constraints

Most of the rice produced in Indonesia comes from lowland areas. The role of the rice production intensification program has become increasingly important to the total rice production figure as compared to non-intensified rice areas since 1977. By 1981 rice produced

from intensified areas accounted for about 80% as compared to 20% for non-intensified areas. It is now the government policy to develop and expand areas under intensification programs to further increase rice production (BIMAS, 1982).

As valuable national resources, lowland rice ecosystems should be conserved in order to maintain and increase their productivity, stability, and sustainability, as well as equatability. Lowland ecosystems under a tropical environment have potentials as well as limitations, which are physical, biological and economic. In the rice-producing areas under the intensification program, as an example, farmers may apply a heavy dosage of inorganic fertilizers (mainly N and P), while at the same time removing rice straw from the field (i.e. in Ponorogo areas of East Java) for sale to increase income. In the long run these practices may lead to the deterioration of soil fertility. Research (PARTOHARDJONO *et al.*, 1983; SUDJADI and ADININGSIH, 1986) has demonstrated that straw application/incorporation can increase rice productivity.

Green manuring of lowland rice in Java and Madura has been reported by GIESSEN (1943). The three most popular green manure crops used by farmers in different rice areas in Java were *Crotalaria usaramoensis, C. anagyroides* and *C. juncea.* The former two can be plowed under within 3 to 4 months, while the latter within 2 months. At present, however, the use of green manure is no longer popular among farmers for many reasons.

Planting and harvesting data shown in Fig. 4 favor the development of pests and diseases if control measures are not taken. SOENARDI (1978) reported that in the dry season of 1976 and wet season of 1976-1977 about 450,000 ha at rice areas were damaged by the brown planthopper, grassy stunt virus and ragged stunt virus. OKA (personal communication) stated that staggered planting was responsible for the outbreak of tungro virus in Bali in the early 1980s.

Planting of early-maturing rice varieties in the rainy season may cause problems in harvesting and post-harvest handling if the harvest time coincides with high rainfall. Immature grains of young panicles will be harvested together with fully ripened grains when a sickle is being used. Grain quality will be impaired by delayed drying and threshing. A survey made by the Bureau of Logistics 1980—1981 indicated that grain loss in the wet season and dry season amounted to 12.5% and 11.28%, respectively (SUKAMANA *et al.*, 1982).

Current research activities

In Indonesia research is conducted by Research Institute of the Ministry of Agriculture as well as Universities. The main endeavour concerning rice research is to maintain the self-sufficiency that has been achieved since 1984, after long efforts beginning in the early 1960s.

The Central Research Institute for Food Crops (CRIFC), the leading Institution in rice research, has formulated a research program strategy and activities for the 1980 decade which can be summarized as follows (SIWI, 1983).

The objectives of rice research in irrigated lowland rice are:

(1) Formulate packages of technology to support the rice production program by providing high-yielding varieties, integrated pest control, improved cultural practices and better post-harvest techniques.
(2) Generate innovations for agricultural development in the future.

The strategy for research is directed toward:

(1) Develop new rice varieties which are superior to those which are currently planted in irrigated areas.
(2) Formulate recommendations for pest and disease control, including weeds.
(3) Formulate alternative methods of cultivation, fertilizer application and soil conservation.
(4) Improve methods of post-harvest handling, standardization of rice quality, and equipment being used.
(5) Determine socio-economic constraints on increasing rice production and recommend alternatives for solving the problems.

Research activities in irrigated lowland rice include:

(1) Breeding for better rice varieties, early maturity, good eating quality and good grain quality.
(2) Research on resistance to major pests, i.e. brown planthopper biotypes and green leafhopper.
(3) Breeding for resistance to important diseases, i.e. tungro, grassy stunt, ragged stunt, bacterial blight and blast.
(4) Pesticide use and insect resistance to pesticides.
(5) Soil fertility studies, including balanced nutrient applications to rice.
(6) Identify important weeds and their ecology and control.
(7) Socio-economic research focusing on identifying major constraints on rice production, including marketing.
(8) Post-harvest technology research including harvesting, drying and storage.
(9) Research on irrigation focused on water use efficiency to increase cropping intensity.

Research on various aspects of rice cultivation is also carried out in rainfed lowland areas as well as in tidal swamp areas.

Fundamental research is conducted on (1) selection methods and genetics, (2) population dynamics, bio-ecology and insect taxonomy in relation to the use of advanced technology, and (3) biology of pathogens for diagnosing the diseases, epidemiology and toxicology.

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Discussion

Kennedy, J.M. (Liberia): In your presentation you indicated that several obstacles hamper rice-producing areas in Indonesia. One of the reasons you mentioned is the possible decline of soil fertility. I would like to know what is the position of your government in this regard.

Answer: As lowland areas cultivated to rice are valuable natural resources, emphasis is placed on the preservation of soil fertility. The removal of straw from the fields in case of very intensive cropping may become a problem in the future. Formerly the farmers used to include green manure crops in the rotation with rice. However with intensive cultivation this practice is often omitted and heavy application of inorganic fertilizers (urea, TSP, KCl) may be associated with the deficiency in other nutrients, in particular micro-nutrients such as zinc and sulfur. We are now promoting sound balance fertilizer application to alleviate these shortcomings.

Dat Van Tran (FAO): Could you describe the "Special Intensification Program" in more detail?

Answer: The "Special Intensification Program" which was implemented in 1979 aims at the following objectives: 1. Organizing farmers over wider areas of 60–100 hectares with regard to several production aspects; 2. By doing so, the various activities can be performed timely and properly, i.e. nursery management, fertilizer application, pest control and extension activities can be carried out more efficiently. The impact of this institutional innovation on the increase of rice production has been remarkably significant.