Prospects of Nature Farming for Rice Production in Indonesia

M. S. Wigenasantana and T. Waluyo
National University, Jakarta, Indonesia

Abstract

Increased rice production is urgently needed in Indonesia to supply the food demands of an ever increasing population. Because of the growing shortage of good agricultural land, intensifying rice production on current farm land is the primary alternative. However, intensification without conservation of natural resources and protection of the ecosystem will lead to the degradation of the natural resource base and create problems in the production process that will likely require greater energy inputs.

Natural based cropping systems are the best agricultural alternative for avoiding the rapid degradation of natural resources, and for maintaining the stability, productivity, and long-term sustainability of our farming systems. An understanding of the complex interactions between effective natural resources and technological input is a vital prerequisite for promotion of rice production. Therefore, research on natural resources as an integral part of the process of agricultural intensification should be planned and implemented.

Introduction

The long-term economic development program for Indonesia which began in 1969 continues to emphasize the importance of agricultural development because it is a necessary prerequisite for economic development. The long-term objective of economic development in Indonesia requires a practical and workable balance between a strong agriculture and a strong and productive industrial community. A strong agriculture means an efficient agriculture that is capable of conserving and protecting the natural resource base so that it is ecologically-sustainable, economically-profitable, and produces high quality agricultural products that conform to market demand.

This paper deals with the promotion of rice production. The main reason for selecting rice for such promotion is because rice is a staple food for most of the Indonesian people and provides 55 percent of their total calories and 60 percent of their total protein. Rice culture is also a major source of employment and income for at least 70 percent of the population in rural areas. Rice is primarily produced by small farmers of which 65 percent cultivate less than one hectare of land.

Before Indonesia first reached self-sufficiency in rice production in 1984, it was the world's leading rice importing country. Since then, Indonesia has again had to import rice, Therefore, the main objectives of Indonesia's rice production program are:

1) To increase rice production.
2) To increase farmer income.
3) To decrease rice imports and to use existing foreign exchange to import equipment needed for industrial development.
4) To achieve a long-term, self-sufficiency in rice production for Indonesia and a stable and equitable market price for farmers.

There are four main goals in the promotion of rice production for Indonesia. These are intensification, diversification, extensification, and rehabilitation. The implementation of these goals is intended to conform with local natural conditions. Nevertheless, since the natural resources for agriculture are very limited, intensification of production on currently farmed land is considered to be the highest priority.

Rice Production in Indonesia

Many factors influence the level of rice consumption in Indonesia. These include the economic capability of consumers, availability of rice in the marketplace which dictates the price, the existence of other carbohydrate sources at comparable prices, and consumer behaviour and prestige. The changes in per capita carbohydrate consumption of three major food sources are shown in Table 1.

Table 1. Per Capita Consumption of Rice, Corn, and Cassava, 1969 to 1985.

Year	Consumption		
	Milled Rice	Corn	Cassava
		Kg y^{-1} capita^{-1}	
1969	118	14.6	56.5
1970	108	17.8	51.2
1975	114	17.0	60.7
1980	131	17.2	71.0
1985	143	12.9	60.6

Source: Food Balance Sheet as cited by Rosegrant et al. (1987) in Indonesian Agricultural Research and Development Journal Volume 10 Number 1, 1988.

There is a general trend in Indonesia, that increased rice consumption coincides with increased income as a result of economic development. People consume more rice as their standard of living improves.

Rice production in Indonesia has increased to fulfill the demand for rice and, consequently, rice imports have decreased. Rice production, harvested area, and average yield for 1968 to 1987 are shown in Table 2.

Table 2. Harvested Area, Average Yield, and Production of Rice in Indonesia, 1968 to 1987.

Year	Harvested Area	Average Yield	Total Production
	Mha	*Mg ha^{-1}*	*10^6 Mg*
1968	8.02	1.46	11.7
1969	8.01	1.53	12.2
1970	8.14	1.62	13.1
1975	8.50	1.79	15.2
1980	9.00	2.24	20.2
1985	9.97	2.66	26.5
1986	10.00	2.70	27.0
1987	9.94	2.74	27.2

Source: Directorate of Agricultural Development Program, Department of Agriculture, Indonesia, 1988.

Table 2 shows that the increase in harvested area is not as large as the increase in rice production. The harvested area in 1987 was 9.94 Mha, a 23.9 percent increase compared to the harvested area in 1968. However, rice production in 1987 was 27.2 million Mg of milled rice, which is 133 percent higher than rice production in 1968. The increased production is mainly due to increased yield, rather than an increase in harvested area. For example, the yield average in 1987 was 2.74 Mg ha^{-1}, or 87.7 percent higher than the yield average in 1968. The yield increase is mainly due to technological inputs that have enhanced intensification. These include the introduction of high yielding varieties, increased use of nitrogen and phosphate fertilizers, improved cultural techniques, and improved irrigation practices. Pesticide usage to control pests that infest the crop has been relatively high. Production inputs which have been distributed for the intensification program from 1969 to 1986 are in Table 3.

Prior to 1969, Indonesian farmers practiced a traditional, subsistence-type agriculture. Rice varieties planted were mainly local selections which were well-adapted to local environmental conditions. Therefore, pest infestations were not a serious problem. However, these varieties were not responsive to chemical fertilizers. Seedlings were transplanted at a relatively late growth stage in order to avoid flooding and, thus, the regeneration process was not sufficient.

Table 3. Distribution of Subsidized Fertilizers and Pesticides for the Intensification Program, 1969 to 1986.

Year	Urea	KCl	Insecticides	Fungicides	Rodenticides
	Mg	*Mg*	*kg*	*kg*	*kg*
1969	202,000	-	-	-	-
1970	308,000	-	-	-	-
1975	670,000	-	2,360,000	7,510	84,800
1980	1,680,000	8,780	6,370,000	43,400	73,800
1985	2,550,000	297,000	15,000,000	213,000	82,400
1986	2,610,000	286,000	17,200,000	439,000	85,900

Source: Indonesian Agricultural Research and Development Journal, Volume 10, Number 1, 1988.

The high production that is needed to achieve rice self-sufficiency in Indonesia has created new problems in the rice ecosystem involving the plant nutrient equilibrum. Most farmers believe that high rates of nitrogen fertilizer will produce proportionately higher yields. Consequently, they tend to use more and more nitrogen fertilizer. This is counterproductive since excessive use of nitrogen and phosphate fertilizer can cause nutrient imbalances that may suppress the availability of other important nutrients in the soil. For example, some rice producing areas now need other fertilizers in addition to nitrogen and phosphorus. These include sulphur, potassium, and micronutrients.

Another problem associated with the introduction of high yielding varieties is their increased susceptibility to pests and the concomitant increased use of pesticides.

Problems and Challenges of the Future Promotion of Rice Production in Indonesia

Rice self-sufficiency which was achieved in 1984 should be maintained in order to sustain the national food security. It is recognized that maintaining sustainable rice self-sufficiency involves complex problems and challenges. Among these is the declining rice producing area on the Island of Java because of an expanding area devoted to other crops. Moreover, with increased population growth, expansion of production into new areas is not proportional to the functional change of the rice area. This is because it is difficult to move people into newly developed areas, especially if these areas have a low production potential.

Therefore the primary goals that have been emphasized for promotion of rice production in Indonesia are: intensification for increasing soil productivity; diversification for increasing farmer income, minimizing risk, and suppressing pest population growth by creating variety in the ecosystem; expansion of the total agricultural land base, which often includes marginal soils of low fertility that require costly inputs and technology to attain acceptable yields; and rehabilitation of degraded agricultural lands.

By the year of 2000, the total population of Indonesia will be approximately 220 million people. This is 44 million more people than in 1988. Rice demand in 2000 is estimated at 37.5 million Mg of milled rice for human consumption, feed, industry, and additional stock to stabilize the price. In order to meet the food demand in 2000, the food crop area should be expanded from 18.5 Mha to 22.1 Mha. The general policy of intensification that has recently been implemented should be closely monitored to avoid any adverse health and environmental effects that can occur with the increased use of agricultural chemicals. Intensification should conform with the potential carrying capacity of the existing agricultural land resource base.

There are a number of problems that should be addressed in promoting the intensification of rice production in Indonesia.

The Availability of Plant Nutrients in Soil

During the early phase of the Indonesian agriculture development plan, nitrogen and phosphorus were considered the two major plant nutrients needed by the high yielding varieties. Today, however, the situation is quite different and additional plant nutrients are needed to sustain yields, including sulphur, potassium, and an array of micronutrients. The nutritional requirements of the rice crop and

the availability of nutrients in soil and irrigation water should be calculated to ensure the proper amount of fertilizer for each field. Effective time and method of application are other important factors which can be exploited to avoid adverse effects from excessive fertilizer application and unbalanced nutrient levels in the soil.

High Yielding Varieties

Improved local varieties together with the improved cultural practices during the first phase of the rice production program resulted in increased yields. However, due to the narrow genetic variability in the breeding materials, the yield increase was limited to the maximum level of the base population. In order to establish a better balance between rice supply and demand based on a limited cropping area, improved breeding programs are needed to enhance the yield potential and adaptability of rice varieties. The main objective in rice breeding is to develop new high yielding rice varieties that will ensure optimum and stable yields. Other factors that should be considered in rice breeding are resistance to major pests and tolerance to environmental stresses.

Cropping Intensity

Increased cropping intensity is the only solution to a fixed or limited agricultural land base. Currently, the cropping intensity in the irrigated rice area is still less than 200 percent. In the rainfed area, cropping intensity is less than 150 percent. To expand the harvested area, cropping intensity for irrigated rice could be increased to approximately 250 percent, and the rainfed area to 200 percent. Hypothetically, the potential cropping intensity for the irrigated area is 300 percent but should probably be avoided because of the likelihood of increased pest infestations.

Diversity

Food crops are usually grown with clean cultivation since weeds or undesirable plants will compete for nutrients, water, and solar energy. Clean cultivation using a single high yielding variety on a large scale has contributed significantly to increased rice production. However, increasing pest problems have been observed under intensified production, which have led to a decline in yield. Less diversity of plant species - rice varieties have only one or few major genes of resistance - and plant structure has resulted in less diversity among insects. This has led to population growth of insect pests without any significant constraints. An outbreak of a major insect pest in an area which cultivates a single rice variety has often occurred in Indonesia with devastating results.

Pest Management

Increasing pest problems have been observed on large-scale intensification areas. Yield losses due to major pests vary widely according to pest species, varietal vulnerability, and the farmer’s ability to cope with the situation. Factors which have been recommended in intensification can also contribute to the increased pest problem, including continuous and staggered planting, increased application of nitrogen fertilizer, heavy use and dependence on pesticides, and decline of varietal diversity over wide areas. These factors have probably contributed to the outbreak of a serious rice pest, the brown plant hopper, during the last few years. Pest management which is based on the manipulation of several effective components of the rice ecosystem should decrease the need for pesticides.

Prospects of Nature Farming for Promotion of Rice Production

In general, agriculture is a human effort to exploit and manipulate natural resources for man’s benefit. Agricultural activities are not always compatible with the interdependent nature of the major components of ecosystems. Therefore, the stability of agricultural ecosystems is quite different than that of natural ecosystems. The stability of agricultural ecosystems is artificial and man-made and requires continuous inputs of energy in the form of fertilizers, irrigation, and pesticides.

To meet the food demands of an ever increasing population requires that agricultural technology inputs be effectively integrated with the natural resource base. In practice, the technological inputs should be implemented judiciously.

Nitrogen fertilizer is a prospective component of natural resource-based rice production. Nitrogen

resources in nature are derived from rainfall, decomposition of straw, and green manure. Recently, *Azolla* spp. have provided a potential source of nitrogen for irrigated rice. At present, however, the potential contribution of nitrogen from rainfall, straw decomposition, and other sources such as *Azolla* is not receiving sufficient consideration. Research is needed to establish credits for these natural nitrogen sources so as to minimize the amount of nitrogen fertilizer that has to be applied. There is some indication that rice plants are more susceptible to certain pests due to excessive application of nitrogen fertilizers. The excessive use of chemical fertilizers such as nitrogen and phosphorus can lead to a nutritional imbalance in soils. A proper balance or combination of chemical fertilizer and organic fertilizer will help to maintain adequate soil fertility and enhance soil productivity. Therefore, research on the use of organic materials as fertilizers is urgently needed.

It is a general hypothesis that intensification leads to increased pest infestation. When Indonesia began its intensification program by introducing high yielding varieties, chemical fertilizer, better irrigation, and cultural practices, pest infestations occurred coincident with those practices, and could only be controlled by applying pesticides. At that time, pesticides were used excessively to control pest infestations. This approach resulted in some serious adverse effects such as resistance of pests to certain pesticides, increased production costs due to pesticides, and decreased farmer benefits. To overcome this situation, integrated pest management has been intensively implemented. The main principle of integrated pest management is to manipulate the effective components of the agricultural ecosystem in maintaining pest populations below the economic threshold. The major components which play a role in maintaining low pest populations are ecosystem diversity, homogeneous planting to interrupt pest cycles, resistant varieties, balanced fertilizers, and judicious use of pesticides.

Pest management in rice ecosystems is generally divided into two phases i.e., preplanting phase and postplanting phase. The activities in the preplanting phase are determination of planting time (late or early) and selecting resistant varieties to major pests. Postplanting activities are monitoring of plant growth, pest populations and their natural enemies, and pesticide applications when necessary. However, pesticides should be applied judiciously when other activities cannot suppress the pest population below the economic threshold.

To support this approach, we must be able to identify the critical stage when a plant is most vulnerable to a certain pest. On the other hand, the life cycle of the pest itself must also be studied to identify the proper time of pesticide application so as to avoid adverse effects on natural predators. Natural resource-based cultivation as an alternative to current agricultural practices has the potential to sustain a stable, productive, profitable, and environmentally sound agriculture for the future.