Technological and Institutional Changes in the Indonesian Rice Sector: From Intensification to Sustainable Revitalization

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ABSTRACT

Agricultural development in Indonesia has been changing dynamically since the country's independence. This paper reviews the rice sector as part of agricultural development in Indonesia. It is remarkable that the agricultural sector was ignored when the oil boom benefited Indonesian economy. As revenues from oil dropped significantly, the agricultural sector emerged as an engine of economic growth in the 1980s. As staple food, rice was posited as top priority. Various rice intensification programs coinciding with the Green Revolution were launched, and several institutions were established to support these programs. The result was so significant that Indonesia was able to achieve rice self-sufficiency by 1983. But with the growing critical awareness about sustainable development, the intensification programs lost their relevance. The programs were replaced with an environmentally sound policy. However, as the industrial sector grew, again, the agricultural sector was neglected until an economic crisis hit Indonesia in 1997 and rice self-sufficiency could not be sustained. Realizing the importance of the agricultural sector, it is now being developed in equal measure as other sectors. Under the current administration, an agricultural revitalization program has been implemented, and in 2008, Indonesia has achieved rice self- sufficiency for the second time.

INTRODUCTION

Linkages of Agriculture and Economic Development

Development economics and agricultural economics have focused on how modernization of agriculture can best contribute to economic growth. A number of development economists tried to point out that while agriculture's share fell relative to industry and services, it grew in absolute terms, evolving increasingly complex linkages to non-agricultural sectors (Adelman 1984; Vogel 1994). They highlighted the interdependence between agricultural and industrial development and the potential for agriculture to spur non-agricultural sectors. The argument was that productive agriculture and

institutional links, with the rest of the economy, produce demand and supply incentives that further lead to a more vibrant agriculture.

Improving agricultural performance generates income in both rural and urban areas. As incomes increase, households save more and spend more, stimulating growth and investment in other sectors (Stringer and Pingali 2004). Such positive direct and indirect cross-sectoral linkages are mediated through lower food prices, labor migration and capital flows from agriculture to other sectors. However, there are also other channels through which growth in the sector impacts positively on economic development. For example, more efficient agriculture would save more resources which could be used for other sectors; eventually, such sectors would be more productive.

Most poor people in developing countries live in rural areas and depend on agriculture for their livelihoods (de Janvry and Sadoulet 2002). In most developing countries where agriculture dominates, agricultural growth leads to significant opportunities for reducing poverty and hunger. In countries where the share of agriculture in GDP is still significant, Timmer (2002) argues that agricultural productivity may impact on overall economic growth through various positive indirect and roundabout linkages which are classified in four categories: technology linkages; physical capital linkages; human capital linkages; and linkages through positive impacts on a number of efficiency shifters that determine the degree to which a frontier per capita income is reached.

However, enhancement of agricultural productivity can, if mismanaged, result in degradation or even depletion of the natural resource base. Many current agricultural practices have put a pressure on long-term sustainability, leading to environmental degradation. The excessive use of pesticides and fertilizers poison the soil and ground water, rendering them unusable or unsafe, causing significant human health problems. Land degradation and erosion lead to substantial declines in agricultural productivity. The challenge for sustainable rural development is to enhance agricultural productivity while conserving the natural resource base, increasing rural incomes, generating employment, and improving the nutrition and ensuring the food security of households and individuals.

Rice and Agricultural Development in Indonesia

Indonesia pays attention to agriculture in national economic development since it occupies a prominent role in the country's economy. Even though the relative position of the agricultural sector has declined significantly over the past four decades, its importance to the Indonesian economy has not decreased (Kawagoe 2004). In 1979, rice contributed 17.5 percent to the gross domestic product (GDP), or 56.8 percent of the total value of the agricultural sector. In 1981, the agricultural sector constituted 24.5 percent of GDP and employed 54.8 percent of the total labor force. In the 1990s, agriculture still provided approximately 50 percent of jobs and around 20 percent of GDP (Hill 2000). By 2005, agricultural employment is still dominant, particularly in rural areas, with 58 percent of the non-poor and 75 percent of the poor working in this sector (McCulloch 2008). However, the share of agriculture in GDP remains at 16 percent (Lee 2008).

Rice carries great emotional and symbolic weight, being associated with the rural family, whose importance is proclaimed in Indonesia's constitution (Kawagoe 2004). It is a staple

food that represents the largest caloric intake for more than 200 million Indonesians, despite the fact that corn, cassava, and sweet potato are important supplementary foods[1].

Politically, rice is a strategic product. Either a shortage or a highly variable price of rice in the domestic market has the potential of causing political instability. The shortage of domestic rice supply has become a more pressing problem in the Indonesian economy, not only because it is the main staple food, but also because price, especially in a developing country where a majority of the population are poor, is always matter of public concern (Widodo 1989).

There has been a long history of rice development in Indonesia. At least three political phases have stamped their distinctive marks on agricultural development. The first is the "Old Order" under the presidency of Soekarno (1945-67). During this period, development was focused on establishment of metropolitan infrastructures. In short, agriculture (of which the rice sector is a major part) was neglected, and was not regarded as a leading sector for economic growth (Kawagoe 2004).

The second is the "New Order" under President Soeharto (1967-98). During this era, more attention was given to the rice sector. Various programs were launched to enhance its productivity. The milestone of this era was the country's ability to achieve rice self-sufficiency (Fox, 1991), and President Soeharto was invited to address the World Food Summit in Rome on November 15, 1996.

The third is the "Post-New Order", or "Reformation" era which cover three administrations: Abdulrahman "Gus Dur" Wahid (1999-2001), Megawati Soekarno Putri (2001-04), and Susilo Bambang Yudhoyono (2004-present). Under the first two presidents, agriculture, with other sectors, underwent difficulties as a result of economic crisis brought about by political instability. Under the current president, there is a more favorable environment for agriculture, as current policy pays more attention to agriculture as one of the more important sources of economic growth.

It is important to look at the development of agriculture, especially the rice sector across the different political eras. The next sections discuss efforts to increase rice production (after a long phase of being relegated to the background), intensification programs, centralized public investment and market interventions, the change to environmentally sound policy, then yet another phase of neglect, and now, the current favorable environment for agriculture.

EFFORTS TO ENHANCE RICE PRODUCTIVITY

Increasing Yield and Production of Rice

In the early 1980s, world oil price began to slide. By the middle of the decade, it settled to a range less than half of its 1980 peak. With the end of the oil boom, the Indonesian economy sank into slow growth and a difficult period of macroeconomic adjustment. Accordingly, policymakers intensified efforts to find ways for the economy to grow efficiently with less dependence on government budgetary expenditures. Agriculture, especially rice

[1] The importance of rice in agriculture is affirmed by the fact that more than 90 per cent of the world's rice is produced and consumed in Asia, where it is eaten three or more times daily. In 1999 for example, Asians consumed nearly 500 million tons of rice. Rice is very important to many of the region's poor who expend half to three-fourths of their incomes on it. Rice has been of special interest in most Asian economic development efforts. This is because Asia has some 250 million rice farms – mainly small peasant holdings where around 85 per cent are less than five hectares (Hayami 2004). This means that rice cultivation is also a substantial factor in Asian employment. Rice has an important role in trade and is an important foreign currency earner for many Asian countries (Runckel 2000).

production, was identified and established as a prime source of efficient growth.

There is evidence of the broad success of Indonesian rice policy in encouraging growth of rice output. Between 1955 and 1965, the annual growth rate of rice yield was about 0.2 percent, while rice production grew at 1.2 percent. From 1965 to 1985, efforts to improve rice production were intensified; the period coincided with the Green Revolution where productivity of land and production had annual growth rates of 4.1 percent and 5.6 percent respectively. A dramatic boost of 7.2 percent annual growth of production between 1977 and 1984 occurred. Most of this growth happened during the second of these two decades, when average yields increased from 2.8 to 4.2 tons per hectare (Pearson et al. 1991).

The effort to increase yield and production of rice has been continuing through wetland (irrigated paddy land) expansion as well as intensification[2]. As shown in Figure 1, wetland planted to rice expanded by 50 percent during the period 1980-2005. This expansion is largely due to conversion from dryland to wetland production, especially during the 1990s. Since production increases faster than land expansion, it is remarkable that most of the output gain was attributed to intensive productivity increases rather than to extensive expansion of rice land.

Improvements in Rice-Related Technologies

Seed technology

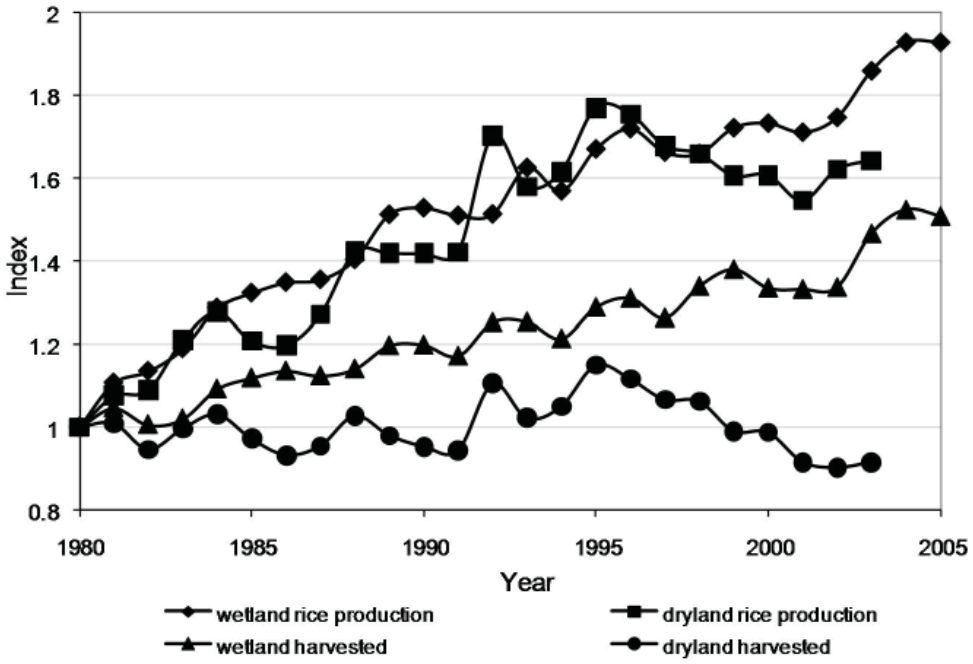
In Indonesia, hybrid technology in rice production has been widely adopted in the lowlands of Java, Bali and Sumatra since 1967. This technology is based on modern high-yielding varieties (HYVs) used with inorganic fertilizers, improved pest control, and other practices supported by rehabilitation and expansion of irrigation infrastructure. Local scientists and their Dutch counterparts who worked in the country, collaborated with international institutions in developing techniques to improve rice cultivation (Mears and Moeljono 1981).

As early as 1941, however, the Central Research Institute of Agriculture (CRIA) released improved rice varieties such as *Bengawan, Fajar* and *Peta,* and then followed by *Syntha* and *Sigadis* and others in 1952. These varieties were called national improved varieties. In 1967, IR8 and IR5 from the International Rice Research Institute (IRRI) were released in Indonesia. These varieties required higher fertilizer inputs. In the dry season of 1968, these two IRRI varieties were planted on 21,300 hectares. IR5 spread more rapidly than IR8 (Widodo 1989) because of its intermediate height, adaptability to diverse environments, and slightly greater resistance to several diseases.

In 1969, C4-63 from UPCA (University of the Philippines College of Agriculture) was introduced and rapidly spread because it matures early and is superior in eating quality. With the release of IRRI varieties that are early maturing, stiffer-stalked, and nitrogen-responsive, the CRIA altered its breeding objective and subsequently developed new varieties which were highly responsive to fertilizers. These types were named *Pelita* I/1 and *Pelita* I/2, and were released in 1971 (Fox 1991). These were accepted by farmers

[2] In some regions of Java, agricultural lands have been and still are being converted to non-agricultural purposes (Firman 1997). To some extent, there is creation of wetland *(sawah)* from dryland areas (Mariyono 2006), but exact rate of the conversion needs further analysis.

Figure 1. Rice production and land expansion



Source: Anonymous (2006)

because they performed well across a wider range of environments, fetched a relatively higher price (advantageous to farmers), and the taste satisfied the Indonesian consumers. Both *Pelitas* are similar to IR5 in terms of agronomic performance, but to some extent have stronger resistance to bacterial leaf blight; consequently, the *Pelita* varieties replaced IR5 in most areas (Widodo 1989).

Unfortunately, the *Pelitas,* IR5, and IR8 are susceptible to blast, *tungro* and grazy stunt viruses, and to brown planthopper (BPH). A series of IR varieties such as IR36, IR38 and IR42 were developed to overcome BPH infestations. Many new varieties with better taste such as IR64, *Cisadane,* and *Membramo* were also released in response to the development of pest resistance (Widodo 1989). A particular concern was on the biotype development of BPH (Fox 1991), a fast breeding invader pest (Gallagher et al. 2005). Rice research continues to find new varieties in keeping pace with resistance development of pests.

Mechanization

In Indonesia, mechanization of rice production mostly relates to land preparation and harvesting. However, there has been little mechanization except for widespread adoption of rice mills. Hand hoes, draft animals, and two- and four-wheel tractors are mostly employed in land preparation. In Java, only hand tractors are used on rice land, but off the island, the smaller four-wheel tractors are also used. In general however, the level of tractor use is very low (Heytens 1991a), despite the substantial increase in the number of hand tractors as given in Figure 2.

Limited mechanization was likely due to topographic and plot-size constraints, mechanical problems, and farmers' limited resources. The presence of large rocks or steep slopes sometimes prevented farmers from using tractors; very small plots are likely to be prepared using hand hoes.

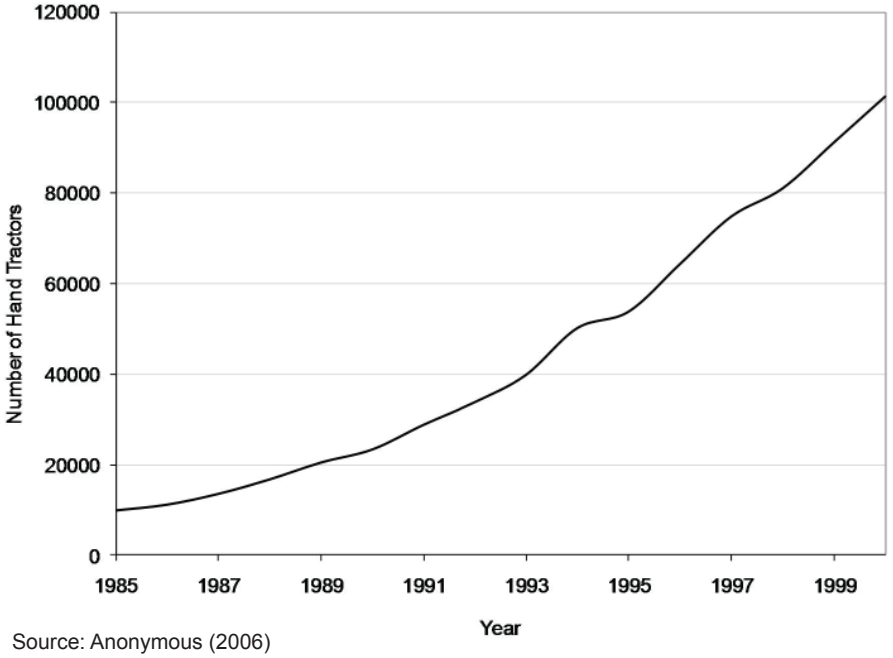
Some studies explain the low level of tractor use in the country. No agronomic reasons (Binswanger 1978) and no empirical evidence in Indonesia existed (Lingard and Bagyo 1983), proving that using tractors for land preparation provides any yield advantage over other techniques. Government policy has not promoted the use of tractor due to high costs of assembly; consequently the equipment did not come cheap (Heytens 1991a).

Agrochemical technology

Chemical inputs, consisting of inorganic fertilizers and synthetic pesticides, have been the keystones of the rice development programs in Indonesia. The rate of fertilizer use is high compared with other rice-producing countries in Southeast Asia. The application of inorganic fertilizers has also increased dramatically since the late 1960s and nutrient sources have become more diversified. Urea constitutes a large input, but has declined as a portion of total use. Triple super phosphate (TSP) accounts for a good portion of the remainder (Heytens 1991a).

The advantages of applying chemical fertilizers were evident to farmers. Yields increased in response to higher rates of application. Fertilizer use was greater on the higher productivity systems with good irrigation; fertilizers applied in a more stable and fertile crop environment were considered more likely to pay off and less risky than those applied in a variable environment. In the well-controlled paddy fields, farmers tend to apply less nitrogenous fertilizer during the wet season to reduce the risk of lodging, which is typically not a problem during the dry season (Heytens 1991a).

Figure 2. Number of hand tractors



Source: Anonymous (2006)

Synthetic pesticides have accompanied the use of inorganic fertilizers. Although first releases of the new rice varieties were responsive to fertilizers, unfortunately, these were also susceptible to pest infestations. Pesticides were used to protect them from pests to guarantee yields comparable to those in research stations. As shown in Figure 3, the use of nitrogenous fertilizers and pesticides at a national level increased substantially. The use of pesticides however, started dropping in 1987 when the government subsidy was gradually reduced. But the use of fertilizers continues to increase.

Irrigation infrastructure

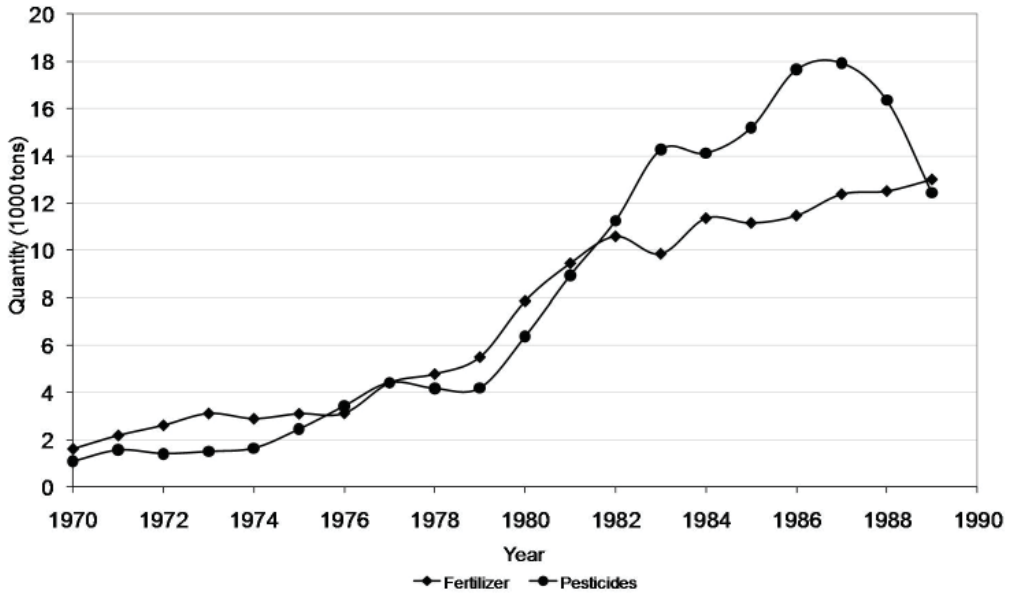
The promotion of advanced rice technologies was facilitated by investments in public infrastructure and irrigation systems, especially in Java. Improved irrigation was particularly significant to the success in the adoption of HYVs because the new seed varieties were specifically adapted for irrigated lands. Lowland areas with existing irrigation systems, including many regions in Java, were favored by the initial investments in irrigation between 1968 and 1975 (Heytens 1991b).

Figure 4 indicates a marked increase in investment in irrigation and expansion in area during the early 1980s, which levelled off in the mid-1990s, and fell in the late 1990s. This pattern of reduced public spending on irrigation resulted from a fall in the total development budget and a decline in the share of that budget devoted to agricultural investment.

Harvest and post-harvest facilities

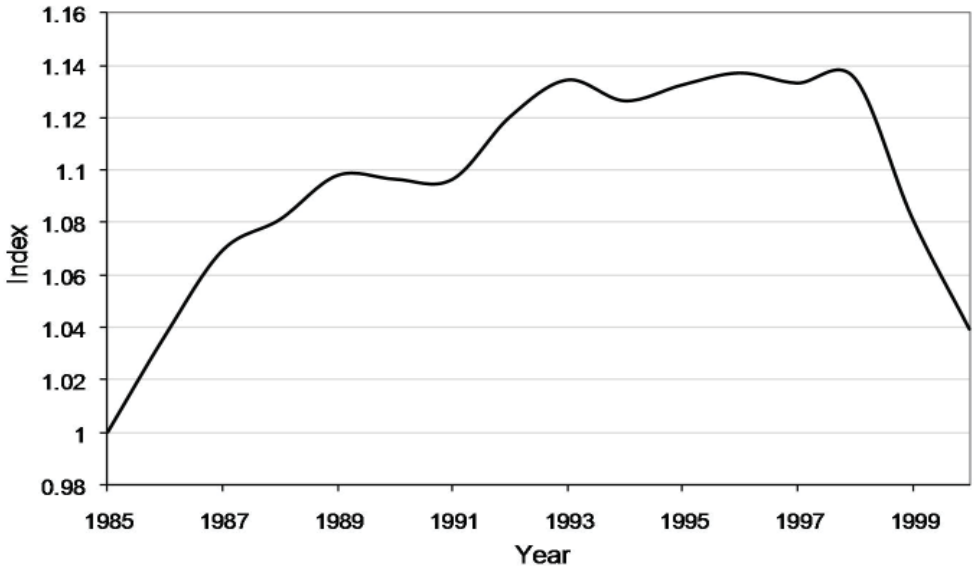
Along with improvements in agronomical technologies, harvest and post-harvest technologies were introduced. Called *Sapta Usahatani* (seven farming efforts), this effort

Figure 3. The use of fertilizers and pesticides



Source: Pemerintah Indonesia (1991)

Figure 4. Expansion of irrigated areas



Source: Anonymous (2006)

was added to the previous technological package *Panca Usahatani* (five farming efforts). The addition was based on the fact that post-harvest losses in rice due to poor drying, storage, and transporting facilities can range from 10 percent to 30 percent depending on climatic factors, distance from the farm to market, and other factors.

Moreover, new varieties have characteristics different from the traditional ones, requiring different harvest and post-harvest handling. The government, through village cooperatives, provided various facilities to address this issue. Mechanized harvesting tools and post-harvesting processes were introduced to replace traditional ones, where the losses due to dropped and broken rice were high. Drying yards were constructed close to rice mills to cut transportation time. Establishing these post-harvest handling facilities could prevent some of those losses. From a cost-benefit viewpoint, a 10 percent cut in harvest and post-harvest losses would be more cost-effective and beneficial than expanding the area of cultivation by the same 10-percent because in the former case, the rice grains are already harvested, while area expansion would still face the production risks and uncertainty of bad weather, pests, and diseases.

Market interventions

Indonesia has had a policy of keeping a domestic buffer stock intended to achieve stable rice prices and thereby enhance food security. The fundamental concepts underlining the stability of price for rice are based on four major policy objectives: (1) to set the floor price high enough to stimulate production, (2) to establish a ceiling price which assures a reasonable price for consumers, (3) to maintain a sufficient range between these two prices to provide traders and millers reasonable profit, and (4) to keep an appropriate price relationship between domestic and international markets (Mears 1984).

BULOG (Badan Urusan Logistik Nasional), the National Food Logistics Agency, has been successful in keeping rice prices stable since its establishment in 1974. *BULOG* set and protected the floor price by buying rice from farmers at the village cooperative (*Koperasi Unit Desa* or *KUD*) level, storing purchased grain in government warehouses, and selling the stock when the wholesale price approached the desired ceiling level. The band between the floor price and the urban retail price was maintained reasonably enough to allow for active private participation of millers and wholesalers in the storage and distribution of rice.

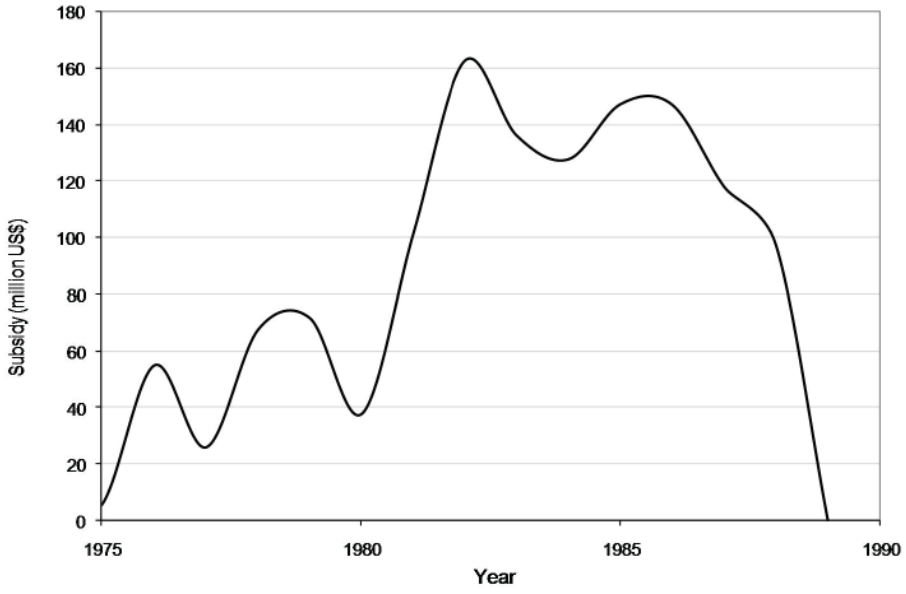
Government subsidies for fertilizer were also an important instrument of Indonesia's rice policy. Starting in the late 1960s, subsidies were given to farmers by setting the wholesale prices of urea, triple super phosphate (TSP), and ammonium sulphate (ZA). *KUDs* and traders were allowed to distribute fertilizers to farmers at the official retail price. Domestic fertilizer manufacturing plants have been constructed since the mid-1970s to ensure adequate supply.

Since 1968, the prices of all bio-chemical inputs in rice production have been influenced directly by government policy. The costs of seeds, water, fertilizer, pesticides, fuel, and machinery were reduced at various times by specific price or credit subsidies. According to Timmer (1990), the growth in rice production from 1968 to 1984 could be attributed mainly to improved incentives to farmers created by the fertilizer subsidy and stable rice prices.

Along with fertilizers, pesticides were also subsidized since these were imported. As discussed earlier, pesticides were used to ensure high yield of the new rice varieties which were more susceptible to pest infestation. Even though new pest-resistant varieties were released later on, the subsidy on pesticides continued to increase, at least until the mid-1980s.

As shown in Figure 5, pesticide subsidies started in 1975, and the amount increased substantially to more than 160 million USD in 1982. The subsidies were eliminated in 1989 when the effects of massive pesticide use became problematic. Meanwhile, fertilizer subsidies

Figure 5. Subsidy on pesticides



Source: Pemerintah Indonesia (1991)

were gradually reduced and from the beginning of 1994, only urea was left being subsidized. However, because of the deep financial crisis in 1987, the government likewise eliminated the fertilizer subsidy by the end of 1998.

SHIFTING FROM CHEMICAL INTENSIVE TO ENVIRONMENTALLY FRIENDLY TECHNOLOGIES

Intensification Programs

In the 1960s, domestic production of food crops was low (van der Eng 2000) compared to the potential production of rice (Hossain et al. 2006) and actual production in other neighboring Asian countries (International Rice Research Institute 1995). The government needed a priority program to enhance domestic rice production. The potential for increasing rice production came from three major components. The first was to encourage farmers to adopt *Panca Usahatani,* which was then expanded to *Sapta Usahatani* as mentioned earlier. The second was to send university students to live with farmers to act as modernization agents. The last component was to provide soft credits through the *KOPERTA* (*Koperasi Tani* or farmers' cooperative).

The *Panca Usahatani* promoted the intensive use of HYVs, appropriate and timely use of fertilizers, pest and disease control, improvements in cultivation methods, and improvements in irrigation and drainage systems. The decision to let the university carry out these projects and involve the students was considered a breakthrough. The project became administratively simpler and could therefore move faster. Approximately 440 university students were sent to about 220 villages covering more than 10,000 hectares of paddy fields in Java to help farmers in implementing *Panca Usahatani* and in accessing credits from *KOPERTA*.

In 1965, the programs were scaled up to a national program, called *BIMAS* (*Bimbingan Masal)* or mass guidance, and were organized by the Ministry of Agriculture. That year, around 1,200 university students (who were gradually replaced by agricultural extension workers recruited by the Ministry of Agriculture) were sent to regions covering 140,000 hectares of paddy fields, and 480,000 hectares in the following year. After that, the coverage continued to increase (Roekasah and Penny 1967).

The program results made it more apparent that the logistics of timely and appropriate use of fertilizers and pesticides was a difficult task and intensive supervision was not necessarily available. Two modifications to the programs were made in 1967. First, the loans received by *BIMAS*-participating farmers included costs of living and transportation to ensure that farmers would have enough funds to allocate for their farm operations, and second, the loans had to be paid back in cash, instead of in-kind. Another intensive supervision program, called *INMAS* (*Intensifikasi Masal* or mass intensification) was established in the mid 1960s; the Old Order under the presidency of Soekarno covered rice intensification programs up to this phase.

In the New Order, from 1967 under President Soeharto, *BIMAS* was one of the top national priorities. *BIMAS* was modified into *BIMAS Gotong Royong* (or Cooperative *BIMAS*). But *BIMAS Gotong Royong* was considered a failure. In this program, the approach was very rigid. Farmers were instructed to strictly follow the *BIMAS* procedure instead of adopting it in a flexible manner. It is important to note that technological change cannot be made mandatory because it involves a long process of innovation, adoption and diffusion, along

with institutionalizing the necessary economic, social, legal, and political measures to support the change process (Jaffe et al. 2001; Knudson and Larson 1989). The entire system provided opportunity for abuse, from mark-up pricing of material inputs, cheating over the quantities and qualities of distributed inputs, and black market selling of the inputs obtained from the program. Consequently, the resulting yields were reported to be lower than the targets, and the repayment rate of loans was as low as 20 percent (Piggott et al. 1993).

Because of the failure, by the early 1970s, Indonesia became the world's largest rice importer. Although the country's imports then already represented about 20 percent of world rice trade, food shortage was still a problem. Hence, a new rice intensification program was established. It was called *BIMAS yang disempurnakan* (or improved *BIMAS*). In this program, the *BRI* (*Bank Rakyat Indonesia* or Indonesian People's Bank) played a significant role by setting up a number of village and mobile units to overcome problems of lending to small farmers. The private sector started participating in selling fertilizers and pesticides to the *BIMA*S market – under massive price subsidies (Mears and Moeljono 1981).

BIMAS was able to do essential tasks quickly and promptly. It provided relatively easy access to the needed capital when farmers underwent financial difficulties. *BIMAS* also provided useful information on better agronomical practices and developing irrigation systems. Better cultivation techniques were disseminated, and use of modern inputs such as hybrid seeds, fertilizers, and pesticides were widely adopted by farmers.

The *BIMAS (yang disempurnakan)* program was continued through the 1980s, despite its lackluster achievements compared to those in the 1960s and 1970s. Other similar programs were developed: *INSUS* (*Intensifikasi Khusus* or special intensification) in 1979, which was then modified into *OPSUS* (*Operasi Khusus* or special effort program) in the early 1980s, and finally, into *SUPRA INSUS* (or super special intensification) in 1987.

Within the first ten years (around 1970-1980), approximately 45 percent of rice areas in the country were covered by the intensification programs; around 75 percent after another 10 years; and more than 80 percent 25 years after the program started. The result was a steady increase in rice yields (Sawit and Manwan 1991; Pearson et al. 1991; Tabor 1992; Piggott et al. 1993). By 1983, for the first time, the domestic production met the domestic demand for rice, and Indonesia was declared as a rice self-sufficient country (Widodo 1989).

Overall, the intensification programs seem to have been effective. Especially from a national point of view, the approach can be considered a success. Indonesia attained self-sufficiency in rice in 1983, after having been the world's largest importer for many years (Resosudarmo and Yamazaki 2006). The political turmoil coinciding with the famine in the 1960s ensured that food security remained a national priority. Price relationships were carefully managed such that most farmers continued to make a decent living, while rice remained available at reasonable prices.

By the mid-1980s, major issues with the intensive approach became apparent, however. The economic issue was the extremely high costs of the program which were mostly underwritten by government revenues from the oil boom in the 1970s. Through subsidies, *BIMAS* unwittingly encouraged the use of more pesticides and fertilizers than necessary. In the mid-1980s, the rate of subsidy for these two inorganic inputs accounted for more than 50 and 80 percent of their market prices, respectively. As reported by Barbier (1989), the total subsidy in 1986-87 was around US$ 725 million.

This was around 66 percent of total budget of agricultural development for the fiscal year.

A political issue was related to the involvement of high ranking officers of the Ministry of Agriculture in the chemical companies. They were either part-owners, franchisees, distributors, or retailers or they otherwise vigorously promoted use of the inputs and got commissions from the agrochemical companies. The fact that the intensification programs made farmers use fertilizers (which were typically inorganic) and synthetic pesticides benefited the suppliers of these chemical products. The involvement of Ministry officials made it possible for the intensification program to "force" farmers to apply increasingly more chemical inputs.

An agronomical issue was the excessive use of pesticides (one of the features of *BIMAS* was the intensive use of these chemicals). The initial new varieties of rice, although fertilizer-responsive, were quite susceptible to pests. However, without intensive use of fertilizers and pesticides, their yields were lower than the traditional varieties (Cleaver 1972). Even though the pest-resistant varieties were released later on, pesticide use did not decrease (Fox 1991) as there was a belief that pesticides were a necessary measure to protect crops from pest infestations.

Overuse of pesticides resulted in pesticide-resistant pests, pest resurgence and secondary pest outbreak, while overuse of fertilizers, particularly nitrogen (urea), reportedly made the rice more attractive to pests (Untung 1996). The first secondary pest outbreak was the case of the brown planthopper or BPH that destroyed more than 450,000 hectares of paddy fields in 1976-77. At the time, pesticide use was meant to control rice stem borers, which were major pests, and not to control BPH, which was then not a major pest. The estimated yield lost to the pest outbreak was equivalent to 364,500 tons of milled rice, which could have fed three million people for an entire year (Settle et al. 1996; Resosudarmo and Yamazaki 2006). The reaction to the pest outbreak was to encourage farmers to use even more pesticides. Another BPH outbreak occurred in 1986, which was hypothesized to be a pest resurgence resulting from excessive use of pesticides (Barbier 1989; Settle et al. 1996; Rola and Pingali 1993; Useem et al. 1992).

Human and ecological health issues were related to the toxic pesticides and environmentally detrimental fertilizers. When intensive agriculture is used worldwide as has been argued by Cleaver (1972), the technology would raise ecological problems. Byerlee (1992) has identified some cases of adverse impacts associated with intensive agriculture over the world. After the publication of Silent Spring by Rachel Carson in 1963, the global community became more aware about the negative effects of intensive agriculture (Pretty et al. 2000; Pretty and Hine, 2005). The health effects of excessive chemical use on Indonesian farmers have been studied by Kishi et al (1995) and Pawukir and Mariyono (2002).

Environmentally Friendly Technologies

In response to the unexpected negative outcomes of intensification, the government attempted to address the issue of excessive use of inorganic chemicals through a variety of ways. Along with the decline in oil revenue in the early 1970s that resulted in an economic recession in Indonesia, the credit package for farmers was eliminated.

By the end of the 1970s, Indonesian scientists had learned from worldwide reports and various studies they had conducted about the many problems associated with the use of pesticides in agriculture (Antle and Pingali 1994; Bond 1996; Pimentel et al. 1992). They

concluded that Indonesia had to stop relying solely on these chemicals and needed to utilize other pest control techniques which included synchronized planting, crop rotation, and use of natural enemies, with pesticides as the last alternative.

This strategy was commonly known as integrated pest management (IPM). Indonesia was reported to be one of the leaders in the use of IPM in Asia (Anonymous 2002). Since 1989, a national IPM program has helped Indonesian farmers reduce their dependence on pesticides and increase their harvests. It has also dramatically reduced the incidence of pesticide-related illnesses and environmental pollution. Pearson et al. (1991) point out that the development and dissemination of new varieties of rice are significant to the success of IPM and the continued increases of rice output.

The nationwide BPH outbreak in 1986 caused concern in *BAPPENAS* (*Badan Perencanan Pembangunan Nasional* or National Planning Agency). With intensive consultations with the president concerning the need to implement the IPM program, *INPRES or Instruksi Presiden* No. 3/86 (Presidential Decree No. 3/1986) was declared to support the implementation of the IPM.

INPRES 3/86 introduced an impressive array of policy measures that provided an important support for the extension effort, which included the banning of 57 broad-spectrum insecticides for rice (Fox 1991; Rolling and van de Fliert 1994), leaving ten brands (with only four different active ingredients) of narrow-spectrum insecticides – most of them considered especially effective against brown planthoppers.

IPM was initially implemented through the training and visit (T&V) system, the same method used in the old intensive program (Matteson et al. 1993). The approach proved unsuitable; farmers could not absorb the principles of IPM through the rigid system designed to move simple messages to a large number of passive "receivers". Moreover, decision-making was still largely dependent on the government officials. At about the same time in 1987, the government started reducing the pesticide subsidy, which it totally eliminated by 1990 (Useem et al. 1992). Thus the early 1990s coincided with the end of the intensification program and the turning point for environmentally related policy in the agricultural sector, particularly for rice.

A transformation from within was needed to meet the new challenges from outside. In 1989, the National IPM Program was approved to start the large-scale implementation of a revised IPM extension approach in major irrigated rice growing areas. The dissemination of IPM shifted from mechanical instructions for field sampling and spraying based on centrally determined economic threshold levels to more ecological principles. These "new" principles required a different approach to extension, called *SLPHT* (*Sekolah Lapangan Pengendalian Hama Terpadu* or IPM farmers' field school).

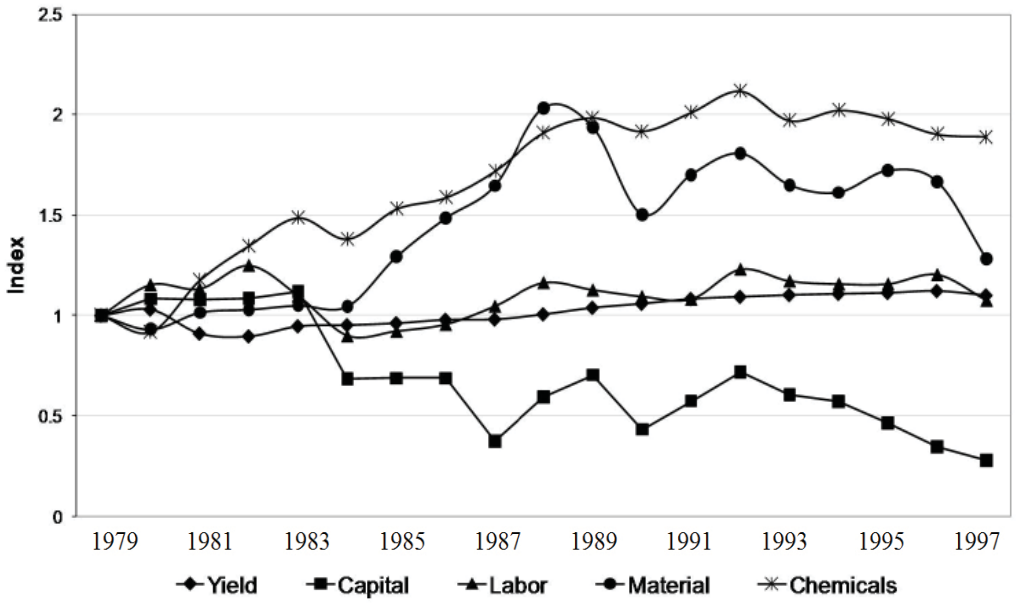
The objective of SLPHT was to enhance human resource development, where farmers become experts in IPM. They were expected to be able to conduct observations, to analyze agro-ecosystems, to make their own decisions, and to implement pest control strategies based on the results of their field observations. IPM addressed not only pest control but also other aspects of farming such as balanced and efficient fertilizing, efficient use of water, crop rotation, and soil conservation – all of which indirectly help keep pest populations in check. The following IPM principles were central to the SLPHT: growing healthy crops, conserving and utilizing natural enemies, carrying out regular field observations, and developing farmers as IPM experts in their own paddy fields (Untung 1996).

The project promoted IPM and improved cultivation not only of rice, but also of other food and horticultural crops (World Bank 1993). This second phase however underwent difficulties associated with a complex administrative obstacle (Pretty and Waibel 2005) such as delays in the transfer of funding from the government to project implementers (Feder et al. 2004a). As a result, training was not fully synchronized with the rice cropping calendar and budget for meals and supplies and training materials for participants were irregular. Further, there was a relatively high rate of farmer absenteeism in "school" sessions during the three-month training period – which coincided with the whole length of one rice cropping cycle. Some efforts were made to improve the SLPHT through a monitoring and evaluation system, and training quality was enhanced during the last two years of the project (1996-1998) (Mariyono 2009).

The Impact of Environmentally Friendly Technologies

The impacts of the change into environmentally friendly technologies became apparent (Figure 6). Yield of rice rose slightly when the new policy was implemented starting in 1989; on the other hand, the use of material inputs during the same period decreased. While the use of agrochemical inputs steadily increased during the implementation of the green revolution, there was a decline in their use during the environmentally friendly policy period, although this did not immediately happen with the change in policy[3].

Figure 6. Dynamics of yield and use of inputs in difference phases



Source: Author's calculation

[3] The fall in agrochemical input use, particularly pesticides, was due mostly to the banning of a number of pesticides for rice and elimination of pesticide subsidies (Rolling and van de Fliert 1995; Untung 1996).

Applying environmentally friendly technology has made rice agriculture more efficient as evidenced by increases in yield despite the reduction in the use of agrochemicals and material inputs. The technology makes it possible for farmers to apply agrochemicals judiciously. Specific fertilizers were applied at the right stage of rice development, at the right dosage, and using the right method. For pesticides, farmers mostly delayed spraying since the technology enables them to observe pests and diseases before application, instead of calendar spraying (spraying according to a set schedule).

Eventual impact of this shift in practice is a healthier environment and better quality of lives for rice producers and consumers alike. Mariyono et al. (2010) confirms that shifting from the Green Revolution to IPM-based technology brought rice production to agrichemical-saving technological change. But, the decline (reduction in agro-chemical use) was delayed because the new technology was disseminated in small scale (Feder et al. 2004a), and the performance level of dissemination during the first three years of the IPM program was moderate (Mariyono 2009).

CURRENT STATUS OF THE RICE SECTOR

Agriculture once again plays a prominent role in the Indonesian economy. Along with an ongoing decentralization program where the local governments are empowered to take ownership of their own development paths, current policy is now revitalizing the agricultural sector (Sinukaban 2005). The agricultural decentralization, which includes decentralization of rural services and agricultural research, is expected to provide a favorable atmosphere for agricultural revitalization.

Agricultural credit is considered important in assisting farmers to finance their farm operations. Based on past experience where the credit programs had generally been dismal and funds were not allocated appropriately for farming, current government interventions in credit markets have taken the form of directed allocation of loans, subsidized interest rates, and state ownership of rural banks (Lai and Cistulli 2005). Farmers' groups are being supervised by the District Agricultural Services *(Dinas Pertanian Kabupaten)*. This action is expected to be more effective since farmers would be less likely to allocate the loans for non-farming activities.

The decentralization of agricultural research efforts has been identified in some countries as a necessary step for improving the performance of research by making services and research outputs more accessible and relevant to regional or local levels (Anonymous 2002a). This policy enables local governments to explore and use their local resources to increase agricultural productivity. For example, during the decentralization, local agricultural services have released various varieties of rice, which were considered suitable to local conditions such as soil fertility levels, water resources, and cropping patterns.

Revitalization of agriculture is a wise strategy. Agriculture has always been a significant contributor to the economy, based on this sector's share of GDP and percent of the population that depends on it for their livelihood. Moreover, agriculture was the only sector that showed positive growth during times of economic crisis. As stated by the current President of Indonesia, Susilo Bambang Yudhoyono:

> "Realizing the sustaining importance of agriculture in Indonesian economy, Indonesia committed to reinvigorate its role by launching the policy of agricultural revitalization as one of the national economic development priorities. This policy would be a general strategy to reduce unemployment, poverty and unbalanced development in some areas'. (Yudhoyono 2006: 4)"

Revitalization of agriculture means that this sector should be revived and further enhanced for it to continue contributing to national development. Las et al. (2006) point out however that agricultural revitalization should not be advanced at the expense of jeopardizing the environment.

The government is again giving top priority to rice since it has played an important role in maintaining economic stability, and social and national security. With more than 200 million of its people relying on rice as the staple food, Indonesia needs to maintain its self-sufficiency in rice. Meeting the domestic demand for rice through domestic production is an essential part of national development. Rice contributes 66 percent of the food crop sub-sector to GDP, and still provides jobs for more than 21 million households.

Current constraints faced by agricultural development are the stagnancy of technological innovation, agricultural land conversion, agricultural land degradation resulting from decline in environmental quality, and shortages in irrigation (Las et al. 2006). Rice policy is aimed at achieving significant increases in production and productivity of existing cultivated areas, development of new rice bowl areas and regional buffers to increase farmers' incomes, and laying a strong foundation for food security.

Establishment of new irrigation networks and rehabilitation of existing systems, creation of paddy lands, conservation of land and water resources, and financial assistance to farmers constitute the priorities of the agricultural revitalization program. These are supported by stabilizing prices and establishing institutional marketing in order to shorten the supply chain from farmers to consumers. Rice-based development is aimed at improving efficiency through innovation and adoption of technology, to utilize natural resources optimally, and to empower farmers and rural societies.

Under the first term of President Yudhoyono, the revitalization program showed remarkable progress. Rice production increased considerably as a result of improved varieties of rice, timely supply of agricultural inputs such as certified seeds and agrochemicals, better harvest and post-harvest technologies and facilities, including improvement in market facilities. Such favorable atmosphere has led to more vibrant activities in the rural economy, and higher motivation of farmers to cultivate rice farm more intensively. After waiting for 24 years – and for the second time in 2008 – national rice production was able to meet domestic demand, a feat that was sustained until the following year (Anonymous 2008).

However, government efforts that led to the attainment of the country's rice self-sufficiency should be sustained. One big issue that has not been adequately addressed is the conversion of agricultural land for other purposes. Mariyono (2008) reported that the rate of land agricultural conversion in Java, which is the rice bowl of Indonesia, is relatively high. Rice self sufficiency that has been achieved could not be sustained if the rate of agricultural land conversion is left unchecked.

CONCLUDING REMARKS

It is remarkable that Indonesia's agricultural sector, particularly rice, has been dynamically up-and-down. Agricultural development has been heavily influenced by institutional and political changes and later, by global concerns of environmental protection and sustainable development.

When agriculture received attention from the government, the sector was able to substantially contribute to economic growth. This occurred under the New Order through intensification programs, which coincided with promotion of the Green Revolution. Agrochemical-intensive technologies played a significant role during this era. Irrigation infrastructures were improved and areas of irrigated land were expanded. High yielding varieties of rice were released, which were supported by high levels of subsidized agrochemical use. Productivity of rice increased dramatically, Indonesia achieved rice self-sufficiency, and the country experienced significant economic growth. However, this development came at a high cost; the government allocated huge amounts of resources for the efforts.

Moreover, these intensive programs became less relevant with the growing concern over issues of environmental degradation and how it was compromising sustainable development. Indonesian agricultural policy shifted from the chemical-intensive programs to more environmentally sound practices. A number of problematic pesticides were banned, fertilizer use was rationalized, and local governments and farmers were empowered to take a bigger role in their own development.

The government has realized that agriculture was the only sector that showed resilience during the economic crisis, while other sectors such as manufacturing and banking faltered and even collapsed. The current administration has been paying closer attention to the agricultural sector through its revitalization program. As a result, rice agriculture has become more vibrant, and Indonesia once again achieved its target of self-sufficiency in rice.

An important implication that can be gleaned here is that attention should be paid continuously to agriculture because strong linkages between agriculture and economic development still apply in Indonesian economy. Facts show that significant declines in overall economic performance, to some extent, resulted from political neglect of the agricultural sector. In contrast, high performance of overall economy occurred when the agricultural sector was given the attention it deserved.

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