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Proceedings of Postgraduate GP Education Workshop on

From Environmental To Sustainable Science

–thinking the shift and the role of Asian agricultural science–

2009年 大学院GP教育ワークショップ報告書
環境科学からサステイナビリティ学へ —アジアの農学の役割を考える—

January 12-13, 2009

Ibaraki University College of Agriculture

http://www.agr.ibaraki.ac.jp/

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"From Environmental to Sustainable Science:

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12th and 13th January, 2009

Kobushi-kaikan, College of Agriculture (Ami Campus),
Ibaraki University

Organizers

Ibaraki University, College of Agriculture
University of Tsukuba

Publication

Proceedings
Edited by Hiroyuki Ohta and Yoshinori Sato

Discussion recorded and printed by:
Tsukuba information lab (http://www.tilab.co.jp)

The publication of the Proceedings was supported by the Yuuji Ushiba donation.

Perspective of Sustainable Agriculture in Indonesia: Keep Growing in Harmony with Environment

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The nature of agricultural production system in Indonesia is very diverse from shifting cultivation to intensive food crop farming, from rainfed to intensive-irrigated paddy field, from vegetables mix farming to monoculture industrial plantations, from subsistence-small farming to commercial plantation. At present with about 230 million of population (2008), these systems have produced near to 100% domestic need of rice, maize and some typical commodities. Its also contribute to the international market of palm oil, rubber, cacao, coffee and other marketable products. Agriculture plays an important role as safety net which generates near to half of total employment and contributes about 20% of GDP, as well as very important contributor of merchandise exports.

Agriculture plays important roles in Indonesia and significantly contributes to its socio-economic and environmental development. Rapid paces of agricultural development in the last 4 decades – as well as commercialization, industrialization and urbanization– have led to significant changes in the agricultural production system. Indonesia now is facing the challenge of how to continue the agricultural development and economic growth required to improve quality of life and the basic needs of its growing population while on the other hand we have also to protect the environmental sustainability by reducing the pressure on its carrying capacity. hillslides, drought and flood in the lowland areas. Concerning to the present condition of agricultural practices in dealing with the needs to increase the productivity and at the same time to conserve the environment and natural resources, therefore we need to adjust our understanding and formulating the action strategy to develop better and sustainable agricultural practices in the future. The present status of agricultural condition and practices in Indonesia as well as some approach and action strategy will be briefly discussed.

Physically, biologically and culturally, Indonesia is recognized as one of the most diverse countries in the world, and it is outstandingly rich in plants and animals species. About 95% of the land surface of Indonesia is still covered by vegetation, either as tropical rain forest, woodland, mangrove, agricultural crops and grassland, which contain various indigenous varieties of flora and fauna, many of them are typical indigenous that never found in other place in the world.

Indonesia is considered an agricultural country, since more than 40% of the country's employments are still engaged in agriculture, either as land owners or farm laborers. Predominant characteristics of Indonesian farming systems are family based, small farm holdings, small capital, subsistence crops and traditional (non-mechanized) management.

Rice is the staple food for more than 90% of population; therefore paddy is the most important crop grown by farmers in Indonesia. Paddy is grown on flat lowland up to terraced middle-range altitude. Java Island is the main area for growing paddy, which comprises about 60% of total harvested area of the country. The other major areas of paddy fields are Bali, Lombok, west and southern part of Sumatra, and South Sulawesi. Blessing by the advantageous of tropical climate condition, a common feature of Indonesian farming activities is the fact that crops can be grown any time within a year. By using short growth period varieties, it is theoretically possible

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to make three crops a year in Indonesia. However, average cropping indexes of the country so far are still 1.8 and 1.2, respectively for irrigated and non-irrigated fields.

Farming system in Indonesia is diverse on commodities and ecosystems as well, which are basically can be categorized into four types, such as: (1) intensive wetland (lowland-irrigated) paddy field, (2) upland (rainfed-dryland) secondary crops field, (3) estate plantations (industrial crops), and (4) agro-forestry. Lowland and upland crops are predominantly practiced by common or individual farmers, while estate plantation and agro-forestry are industrial/ companies based management.

Agricultural development in Indonesia has been in good pace during the last four decades, but however, the total production has not met the entire domestic demand of food and the majority of farmers still remain among the poorest citizens. Furthermore, increasing inputs of chemicals and fertilizers in most of agricultural production systems may pose a threat to the natural areas surrounding farmlands. Therefore, as we look for the future, the real challenge of agriculture is to continue increasing the production while in the same time to minimizing the environmental damage and conserving the resources, as well as reducing poverty, hunger and malnutrition.

Agricultural Production and Demographic related Issues

Indonesia is the fourth most populous nation in the world after China, India, and United States. Indonesian population is about 230 million presently (BPS, 2008) and is projected to grow about 1.4% per annum. However, higher population growth sometimes undermines the efforts to promote sustainable development. Fortunately, declining trend of population growth recently allows the country to increases their ability to invest in human development, combat poverty and protect environmental and build the base for future sustainable development. In the other hand, rapid urbanization and a growing number of mega-cities have been creating new demographic and urban environmental problems.

Indonesia experiences a rapid urbanization due to rapid growth of industrial sector instead of agricultural sector. Indonesian urban population was only 12 % in 1950's; it increased slowly to 16 % in 1960's and became 20% in 1980. But thereafter it was growing rapidly and now the urban population is almost 40% of the population (see Fig. 1). But, in term of employment, trend of total agricultural-engaged employment is decreasing whereas women employment in agriculture is increasing (see Fig. 2).

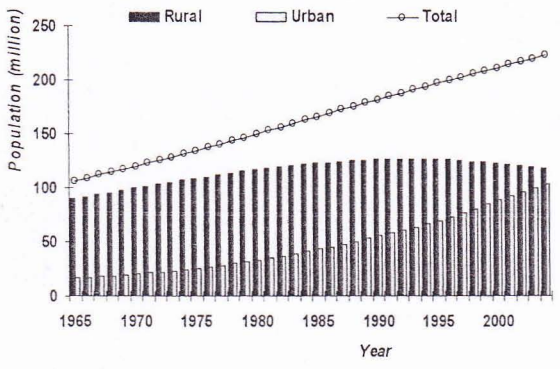

Fig. 1. Rural and urban population

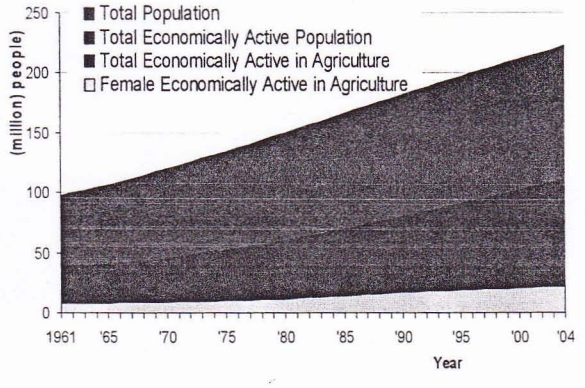

Fig. 2. Employment features of Indonesia

Within about 190 million hectares of the total area of Indonesia, there was no significant additional arable land and land under permanent crops during the 1960s to 1985 period, it was 26 million hectares. In the same period the population was increasing. So, it means the cultivated land per capita was decreasing. Amazingly, in that period the national food production was growing

in the best pace ever in the country history and the peak was in 1984-1986 where Indonesia reached self sufficiency in rice. In this era so called "green revolution", massive exploitation of land and excessive used of chemical fertilizer and pesticide has been practiced by most of the farmer due to increase the yield. Economic and population growth stimulant, however, have come at a significant consequence in environmental cost: rapid destruction of the natural forests to fulfill more arable land for food and permanent crops, as well as housing and industrial settlements. According to recent estimates, the annual rate of deforestation within the last two decades has reached unprecedented levels of over 1.9 million hectares per year (World Bank, 2008). As it is shown in Figure 3, the new permanent crop area (especially for estate plantations) has been increasing significantly since 1985. Meanwhile, growing population

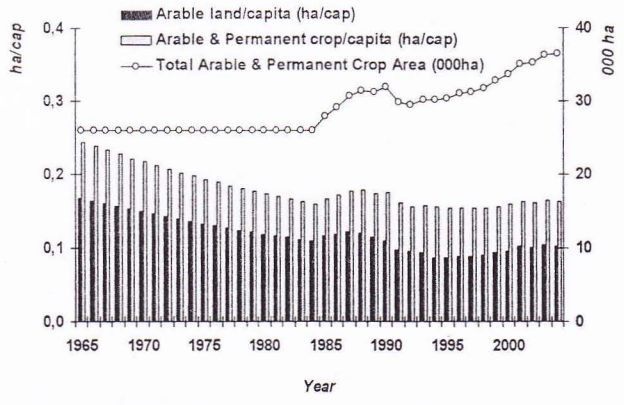

Fig. 3. Feature of arable land

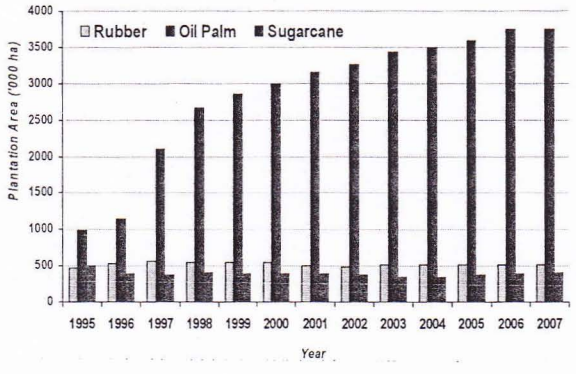

Fig. 4. Trend of plantation crops area

and rapid urbanization in fertile agricultural area (especially in Java and Bali) has converted agricultural field significantly. Now we have also harvested the side effect, this kind of practice might be caused about disharmony in the environmental balance and it has been contributing to the depreciation of the quality of agricultural environment and resources.

Agro-ecology and Land Utilization Features

Indonesia is archipelagic country which consists 5 main islands (Sumatera, Jawa, Kalimantan, Sulawesi and West Papua) and 2 smaller islands groups (Molucas and Nusa Tenggara). The total land area is more than 190 million ha. Based on the land utilization features, more than 30% (58 million ha) is recognized as agricultural land (lowland, upland, estate plantation, grassland, pond and dike), 60% is forest (permanent and industrial forests), and 3% is housing and settlement area (BPS, 2006). Based on soil, rainfall and length of growing period, five pragmatic agro-ecological zones are recognized in the country. Figure 5 shows the map of agro-ecological zones and Table 1 shows a rough estimation of land utilization in Indonesia (2006 condition).

Java Island, is the most fertile and suitable land in Indonesia for crops production. More than half of national food crops are harvested in Java. Paddy field, other food (secondary) crops and sugarcane plantations are the main agricultural activities in Java. Low coastal terrain at the northern part of Java island is the largest central of rice production in the country. The middle part of the island is mountainous with very fertile highland that mainly suitable for secondary food crops, vegetable, seasonal crops and highland plantations such as tea and coffee. Totally about quarter of Indonesia's land resources that suitable for food crops is located in Java, which only account for about 6.5% of the total land area of Indonesia.

Most lowland in Kalimantan, West Papua and the Eastern part of Sumatra are swampy, difficult to drain and mostly covered by thick organic and peat soil. Mangrove or swamps forests are common along the shores of alluvial lowlands of those areas. Therefore, most of lowland in those areas are virtually uninhabited and un-cultivated. In the other hand, upland soils such as

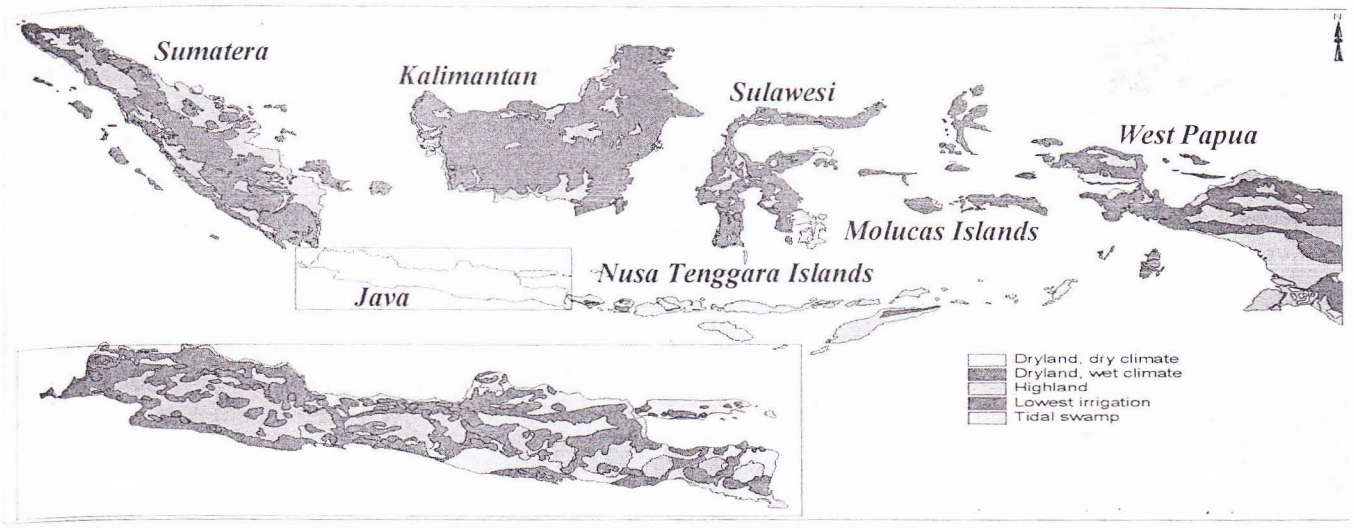

Fig. 5. Map of Agro-ecological zones in Indonesia

Table 1. A rough estimation of land utilization in Indonesia

No	Type of Land Utilization	Area (x 1000 ha.)	% of total land area
1	Permanent Forest	114,192	60.0
2	Wood land/agro-forestry	9,304	4,9
3	Estate plantation	18,490	9.7
4	Dry-land (upland & garden)	15,585	8.2
5	Temporary fallow land	11,342	6.0
6	Wetland (rice field)	7,886	4.1
7	Housing/settlement	5,686	3.0
8	Swamp/marsh-land	4,755	2.5
9	Grassland/meadows	2,432	1.3
10	Pond & Dike	779	0.4
	TOTAL LAND AREA	190,457	100.0

Data source: summarized from BPS and the Ministry of Agriculture (2006)

those in most of Borneo and Papua, are infertile, although they mostly have a cover of thick tropical rain forest vegetation. Estate (commercial) plantations such as oil palm, rubber, coconut and coffee are main agricultural activities in the areas, Sumatra in especially. Shifting cultivation which is mostly practicing 'slash and burning' activities in forest or woodland area is common among traditional local farmers in the islands. The smaller islands of Nusa Tenggara are less humid but rather barren, dry, and the landscape is predominated by savanna and steppes. The natural condition of this area has affected the way of living of the people, which cattle grazing are predominant activity there.

Fertilization Situation

Since the "Green Revolution" program launched in late 60's, application of chemical fertilizers was dramatically increased due to governmental encouragement to succeed the food self sufficiency goal. For decades farmers have been using straight fertilizers (N,P,K) in accordance with recommended composition. Fertilizers consumption in agricultural sector reached 5 times level of 1975 in 1990 and increased slightly afterwards. Since the economic crisis, in 1998 the government reduced the

Table 2. Utilization of agricultural machinery for rice cropping in Indonesia

Machine/Equipment	Total Unit	Unit Capacity	Working Time (hours/crop)	Total Covering Area (million ha/crop)
Hand Tractor (2W)	103,446	0.03-0.05 ha/hr	400 - 500	1.2 – 2.0
4W Tractor	4,017	0.06-0.12 ha/hr	400 - 800	0.15 – 0.25
Hand Sprayer	1,546,765	0.10-0.12 ha/hr	105	15 – 17
Power Sprayer	35,890	0.20-0.25 ha/hr	105	0.7 – 0.9
Pedal Thresher	313,732	0.07-0.10 ton/hr	180	0.9 – 1.2
Power Thresher	33,926	0.6-0.8 ton/hr	200	1 – 1.3
Rice Dryer	3,902	0.2 – 0.3 ton/hr	300	0.05 – 0.08
Rice Milling Unit	46,123	0.3 – 0.4 ton/hr	500	1.5 – 2.0

Data source: Summarized from BPS and the Ministry of Agriculture(2003)

subsidy of fertilizers and therefore the cost of agriculture input has increased; thus the farmers reduced the use of chemical fertilizers and start to improve the application methods and organic fertilizer become more favorable presently. While the economic crisis in industrial sector has not fully recovered yet, however agricultural estates have been intensified due to lift up the national income; fertilizers consumption for estate plantation therefore has been increasing since 2002. Figure 6 And 7 shows the total domestic consumption of agricultural fertilizers and its domestic retail price. The figures show that the retail price of fertilizers doubled since the 1998's economical crisis and the consumption was decreased at the time and then increasing again after year 2002.

Farm Works and Mechanization

Human and animal remain predominant power sources of farm works in Indonesian. Mechanization is a 'luxurious' matter for mostly Indonesian farmers. However, in some 'well-developed' area (i.e. parts of Java, Sumatera and Sulawesi) farm mechanization has been applied; but it still has a narrow meaning and limited on such as utilization of hand tractor for land preparation, or utilization of power thresher and rice milling unit (RMU) for post-harvest handling. Utilization of 4-wheel tractor, power sprayer, cultivator, and other machinery are merely found in bigger commercial estate plantations, such as oil palm, sugarcane or some industrial crops plantations. Table 2 shows the official data of amount of major agricultural machinery utilized in Indonesian paddy fields and their working capacities (estimated calculation). The facts clearly revealed that mechanization is only applied not more than 20% of total paddy field activities in Indonesia.

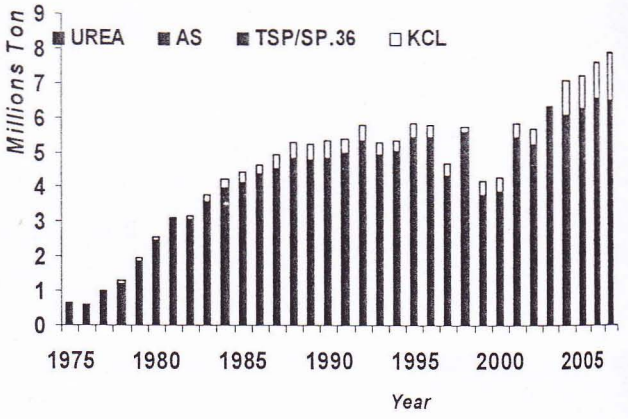

Fig. 6. Domestic consumption of fertilizers

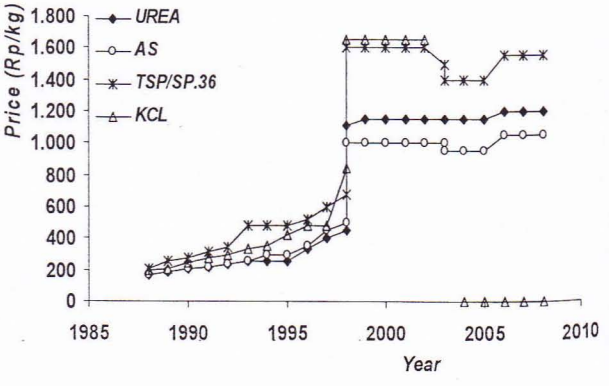

Fig. 7. Domestic retail price iof fertilizers

Challenge of Agriculture in Indonesia: Present and Future

Agricultural development in Indonesia has been in a good pace during the last decades. However, the total production has not met the entire domestic demand of food and the majority of farmers still remain among the poorest citizens. The intensive and extensive programs have been able to increase the production of food, fiber, and bio-fuel material recently. Rapid development of agriculture (especially on commercial estate plantation) may places serious burden on the environment, although there has been little documentation about it.

Agriculture is the dominant land use, the largest consumer of water and one of the main contributor of groundwater and surface water pollution as well as the powerful emitter of greenhouse gases (GHGs). Furthermore, increasing inputs of chemicals and fertilizers may pose a threat to the natural areas surrounding farmlands. Therefore, as we look for the future, the real challenge of agriculture is to continue increasing the production while in the same time to minimizing the environmental damage and conserving the resources, as well as reducing poverty, hunger and malnutrition.

Despite diversity in agroecological condition in Indonesian agriculture, it is useful to distinguish between the agricultural problem related to intensive-irrigated area and those related to extensive rainfed farming area. Productivity has grown fastest in intensive-irrigated area because of the increase use of modern inputs, such as: irrigation water, chemical input of fertilizer and pesticides, high-yielded variety and machineries. However, this system has associated with some environmental problems, i.e.: deterioration of water and soil qualities, micronutrient deficiencies and soil toxicities, weather and pest related vulnerability, and lost of indigenous (traditional) varieties.

On the other hand, in absence of adequate increase of productivity in the less-productive rainfed agricultural area, farmers need to reduce fallows and expand into new area. Sometimes they open a new fragile area with inappropriate land clearing method which caused pressure on the properties of natural resources and lead to the degradation of environmental quality. Some major problems associated with extensive farming are: loss of biodiversity, air pollution caused by slash & burn land opening, erosion, hillslides, drought and flood in the lowland areas.

Concerning to the present condition of agricultural practices in dealing with the needs to increase the productivity and at the same time to conserve the environment and natural resources, we need to adjust our understanding and formulating the action strategy to develop better and sustainable agricultural practices in the future. A sustainable approach of agriculture in Indonesia is necessary to keep growing the productivity (to fulfill human need) whereas in the same time it has to be in harmony with environment (to maintain environmental balance). The approach strategy may consist some aspects, such as: (1) Production and management practices (precision input, appropriate technologies and mechanization, mix cropping system, diversify output, waste recycle etc); (2) Socio-economic (scale of production, capital and purchasing ability, efficiency & productivity, food safety & security, infrastructures); (3) Policy and institutional drivers (fair trade, investment, competition, eco-labeling, incentives, R&D); (4) Socio-cultural (local wisdom & indigenous knowledge, formal education, community education, consumer awareness, etc); (5) Regional and International networking and cooperation. Further more, a sustainable agricultural system has to always take into account three dimensions of sustainability: economy, social and ecology.

Agricultural activities basically can contribute both positive and negative effect to the environment. It is vary significantly as a function of the type of production and management system. Environmental issues related to agricultural production and management practices include water quality and use; use and management of agricultural inputs (nutrients, pesticides, and energy); land use and management, soil quality; biodiversity; climate; and air quality. Bio-cyclo farming system (integrated farming system) might be one of the most reasonable approach to be disseminated to address the above mentioned issues.

Bio-cyclo farming or integrated farming (IFS) system has been applied in many areas of Indonesia. The

dissemination of the IFS practices in Indonesia are promoted and supported by universities and governmental institutions, as well as by the NGO and private companies through their CSR programs. Some learning centers were established to educate and disseminate the technologies to farmers and other related stakeholders.

As an agricultural good practices system, IFS can give multiplying effects, to the farmers, rural community as well as to the rural environment. Economically, the benefits of IFS may reduce the cost of farm production as well as to increase the value of farm products. Therefore, economically IFS will increase net income for the farmers. In social point of view, IFS can produce wider employment opportunity. In wider scale, IFS contribute to the promotion of agricultural sustainability and decreasing agricultural vulnerability. The using of local matters as agricultural inputs will decrease dependency to external inputs. Environmental deterioration will be decreased by recycling and reusing waste. By decreasing agricultural vulnerability, agricultural system will be more sustainable and thus will be more ability to support the need of the growing population.

Concluding Remarks

Agricultural development in Indonesia has been in good pace during the last four decades to chase the need of the growing population. However, yet the total production has not met the entire domestic demand of food and the majority of farmers still remain among the poorest citizens. Furthermore, high dependency on chemicals in many production systems may pose a threat to the nature surrounding farmlands. Therefore, as we look for the future, the real challenge of agriculture is to continue increasing the production while in the same time to minimizing the environmental damage and conserving the resources, as well as reducing poverty, hunger and malnutrition.

Concerning to the present condition of agricultural practices in Indonesia (as well as in many countries in Asia), we need to adjust our understanding and formulating the action strategy to develop better and sustainable agricultural practices in the future. A sustainable approach of agriculture is necessary to keep growing the productivity to fulfill human need whereas in the same time it has to be in harmony with environment to conserve the resources and maintain the environmental balance.

Bio-cyclo farming or integrated farming (IFS) system might be one of the best approaches to be implemented in practice of sustainable agricultural production and management system. IFS can give multiplying effects - economically, socially and environmentally – to the farmers, rural community as well as to the rural environment.

When it be carried out in a sustainable manner, agriculture surely can be expected to: (1) conserve the natural resource and protect the degradation of soil, water, and air quality; (2) contribute to the economic and social well-being; (3) ensure a safe and high-quality supply food and other agricultural products; (4) safeguard the livelihood and well-being of farmers, agricultural workers and their families.

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