Sustainable Agriculture and Rural Development in China: Past Experiences and Future Potential

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ABSTRACT To achieve sustainable development in developing countries, it is very important to search for their own path that can effectively deal with specific issues such as food shortage, rural poverty and environmental degradation. This paper is to examine the experiences, characteristics and effects of sustainable agriculture in China so that some useful conclusions can be drawn. We argue that food security and income generation must be incorporated into the goal system of

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sustainable development, and that high external-input is more feasible than low external-input in achieving sustainability in the developing countries especially with dense population. We argue for active initiation and effective intervention of government in implementing sustainable development strategy.

1. INTRODUCTION

As a new strategy, sustainable development has become part of the agricultural policy framework in many countries. Due to its complexity and the diversity of basic situations of various countries, however, the implementation especially in developing countries faces crucial problems such as food shortage, farmer poverty and severe environmental degradation. Except for the shortage of available economic resources for applying policy instruments to promote sustainable agriculture, the real difficulty for most developing countries is the lack of experiences with integrating sustainable agriculture and rural development, especially with the choices of the goals and appropriate strategic measures of sustainable agriculture policies.

China is the world's largest developing country, with only 0.09 hectare of arable land per capita. In 1991, grain output and GNP per capita were 378 Kg and 390 US$, respectively. For the purposes of increasing food output with

increasing population pressure, China has over the past three decades adopted yield increasing, external input requiring production technologies to complement its traditional organic production technologies and practices. This has made China the world's largest user of chemical fertilizers [Cheng *et al.*, 1992: 1128]. FAO-estimates indicate that fertilizer use per hectare of arable land in China is approximately equal to that of France, Germany, or Denmark [World Bank, 1992: table A.7]. China's efforts to increase food production and to meet other socio-economic objectives have certainly had destructive impacts on the environment such as serious soil erosion, increasing desertification, and intensifying environmental pollution. To address these problems, China has increasingly paid attention to practices of sustainable agriculture which suit its own national conditions since the beginning of the 1980s[1]. Although it is a gradual process in policy practice, the development of sustainable agriculture was originally characterised by the goals that integrate socio-economic benefits and ecological objectives, and comprehensive measures that combine rural transformation (in particular structural changes and poverty alleviation) with sustainable development. These characteristics, arising from the basic situations of China and differing from those of developed countries, have had significant effects on rural environment and development during the past decade.

Problems such as food shortage, rural poverty and degrading environmental base during agricultural development and rural transformation also are typical

for most other developing countries. In this article, the characteristics of sustainable agriculture in China are compared with those in developed countries so that some useful conclusions, in particular regarding the goals and strategic option choices of sustainable agriculture in LDCs, can be drawn. Next, the impact of sustainable agriculture practices on rural development in China is examined. In the last section of the paper, some strategic suggestions for dealing with remaining problems in China's sustainable agriculture are discussed. A special emphasis is given to the achievements of China's sustainable agriculture towards the goals of SARD and to suggesting some useful conclusions for other LDCs towards SARD.

2. THE CHARACTERISTICS OF SUSTAINABLE AGRICULTURE IN CHINA

The development of sustainable agriculture in China

The practices of sustainable development in China began by the end of the 1970s. From then it has undergone three successive phases. The first phase or "preparatory period" may be defined as the period from 1980 to 1983, characterised by academic preparation such as the classification of basic concepts and major functions of sustainable agriculture and the organization of scientific and technical personnel in order to start pilot research projects. The second phase, from 1983 to 1986, can be characterised as the period of intensive

experimentation and demonstration. By 1986, 300 experimental sites had been set up. The third phase, from 1987 up to the present, is the demonstration and extension period. This period is characterised by the strengthening of the demonstration farms or sites and massive extension. By 1990, about 29 sustainable agriculture pilot units had been set up at the county level (table 1), 138 at the township level and more than 1200 at the village or farm levels. These pilot units at various levels, the purpose of which is to carry out the experimentation and demonstration of sustainable agriculture programs, are scattered over all provinces and municipalities in Mainland China except for the Tibet Autonomous Region. It is likely that more and more areas at different levels will be incorporated into sustainable agriculture.

TABLE 1

RECENT DEVELOPMENT OF SUSTAINABLE AGRICULTURE PILOT UNITS IN CHINA

	Pilot Levels			Pilot area (million ha.)			Population
Year	County	Town	Village	Total area	arable land	Forest & grass land	(million)
1988	14	27	429	2.49	1.69	0.17	13.14
1990	29	138	1200	28.65	2.09	1.11	25.61

Source: The Ministry of Agriculture PRC; Sun, 1993: 1

China's sustainable agriculture can be characterized as a comprehensive agrosystem based on a multi-tiered and multi-purpose intensive management system and on successful experiences of agricultural practices (especially those of China's traditional organic farming). This agrosystem is designed and managed in accordance with ecological and eco-economic principles and systematic engineering methodology, and by applying advanced science and technology. Three principles are stressed in the concept: (1) the protection and conservation of natural resources and environment are the foundation for sustainable agricultural productivity; meanwhile, food security and income increase are pre-requisites for reducing pressure on the environment; (2) sustainable agriculture emphasises the relationships of components within the agroecosystem and the relationships between agroecosystem and its physical and socio-economic environment; (3) sustainable agriculture stresses that agricultural resources should be recycled and saved within the production system in order to reduce the negative impacts of external inputs and production wastes on the environment and to lower the production costs of agricultural products [Luo and Han, 1990: 303-6].

The implementation of eco-economic principles

As an important alternative for petroleum agriculture, the concept of sustainable agriculture was proposed first in U.S. in the early 1980 [Harwood, 1990: 3].

According to Parr *et al.* [1990: 52], a workable concept of sustainable agriculture is the low-input farming system that seeks to optimise the management and use of internal production inputs (*i.e.*, on-farm resources) in ways that provide acceptable levels of sustainable crop production yields and livestock production and that result in economically profitable returns. Low-input/sustainable agriculture emphasises such culture and management practices as crop rotations, recycling of animal manures, and conservation tillage to control soil erosion and nutrient losses and to maintain or enhance soil productivity. In developed countries sustainable agriculture implies many synonymous concepts or systems including biological, biodynamic, ecological, eco-biological, low-input, low-resources, organic, and regenerative agriculture, each urging low-chemical, resources- and energy-conserving, and resource-efficient farming methods and technologies. In fact, sustainable agriculture in North America mainly is a low-input farming system, while bio-dynamic agriculture is the dominant form of sustainable agriculture in West Europe.

Many aspects of sustainable agriculture in China, especially the overall goals and basic means of achieving the goals, are similar to those of sustainable agriculture in developed countries. Both types have a very definite holistic system orientation. Both are concerned with the long-term environmental /economic sustainability of the agricultural production system. Both give major attention to crop rotations and other soil-building practices. Both emphasise man

as an ally with nature, rather than man trying to conquer nature [Cheng *et al.*, 1992: 1135].

In some aspects, however, China's sustainable agriculture differs from that which has been practised in developed countries. These differences are to a large extent determined by the basic physical and socio-economic conditions of the country (see table 2). First of all, the ranking of goals is different. In developed countries, the priority of sustainable agriculture in most cases is given to the improvement of the ecological/environmental base even to some extent through sacrificing on output or economic objectives. This may appear to be possible in developed countries because of over-cultivation of soil, vast surplus of agricultural products and available resources for subsidizing farmers. Thus the economic objective of sustainable agriculture in developed countries may be only an *acceptable* level of sustainable crop yields and livestock production that results in economically profitable returns. Even if the crop yields from low-input farming systems are lower than from existing farming systems, the bottom line of objective is whether an *acceptable* net return can be obtained with the lower yield [Parr *et al.*, 1990: 53]. Some reports indicate that the yield or total income or profit of sustainability-oriented farms in America and Switzerland lower by 5%-17%, compared with existing agriculture [Sun, 1993: 49-50].

In China, however, with the prevalence of rural poverty and food shortages the emphasis is given to increasing output and raising income while maintaining

TABLE 2

A COMPARISON OF BASIC CONDITIONS BETWEEN CHINA AND OTHER SELECTED COUNTRIES (1989/90)

Countries	Per capita arable land (hectare)	Per capita GNP(US $)	Per capita food output (Kg)	Fertilizer use (Kg/ha)
China	0.09	370	323	262
India	0.20	350	225	69
Thailand	0.30	1420	452	37
U.S.A.	0.77	21790	1137	99
Netherlands	0.53	17320	992	642

Source: World Bank (1992: table 1 and A.7)

and improving the resource base. There is no country in the world which has a greater population pressure on land than China, either now or in the foreseeable future. According to the World Bank (see table 2), per capita food output in China was only 323 Kg in 1990. With continuing population growth, sustainable agriculture development, thus, must to meet the increasing demand for food, although certain food import is available; otherwise, environmental

degradation will intensify, and social security will be threatened because of insufficient food supply.

Another important goal of sustainable agriculture development in China is income generation. In 1990, per capita GNP in China was only US $370. Net income per capita of farm households was about US $130. Rural poverty not only indicates agricultural backwardness, but also is one of the main causes of environmental degradation. For example, during the period 1981-83, 225 counties in China were below the poverty level, *i.e.* having an annual average per capita income of less than 200 yuan (about US $100) and a per capita grain production of only 200 kg per year. All of these counties are located in the serious soil erosion regions in China [Wen, 1993: 77]. Therefore, sustainable agriculture in China should evidently contribute to income generation at the farm household level. Otherwise, its viability will disappear because of the lack of participation by farmers. The focus of sustainable agriculture in China on income generation, to a large extent guarantees the integration of economic objectives at the farm household level with the food security and ecological objectives at the national or policy-maker level.

A second difference of sustainable agriculture between China and developed countries lies in the strategy and industrial organization of sustainable agriculture. Because of the limited land resources (0.09 hectare of arable land per capita), China's strategy for promoting sustainability in agriculture focuses

on a broad structural adjustment of the agroecosystem and an optimization of regional resource allocation. It takes into consideration not only horizontal development of each sector (*e.g.* cropping, forestry, animal husbandry and fishery), but also the vertical relations between planting, breeding and agro-processing in order to ensure a harmonious development of the entire system in which each sector promotes a higher and more comprehensive efficiency in other sectors. Accordingly, a broad scope of industrial organization becomes an obvious characteristics of China's sustainable agriculture, in which economic integration through the creation of industrial links increases the agricultural productivity and product value, and improves the profitability of sustainable agriculture. In developed countries, however, the macro strategy of sustainable agriculture usually focuses on some specific environmental problems or projects and on the legislation of agricultural environmental protection, rather than broad structural adjustment of the agroecosystem. As a result, industrial organization of sustainable agriculture is mainly confined to crop planting and breeding with a focus on soil conservation and improvement.

A third significant difference of sustainable agriculture in China is the intensive input system. Unlike developed countries, China emphasises the necessity of external input use in agriculture. Consequently, appropriate chemical fertilizer and pesticide use are not excluded from the input systems (see table 2), and extensive use of modern science and techniques is made in

sustainable agriculture. A fundamental reason for the relatively low emphasis on reduced chemical fertilizer use in China is the much smaller current margin of difference between the nutritional need and/or economic demand for food and the capacity to produce food in China compared to most Western countries [Cheng *et al.*, 1992: 1136]. Compared with developed countries, in most agricultural areas of China, higher marginal output of external input can be obtained because of insufficient agricultural input. As shown in table 3, for example, the marginal output of chemical fertilizer input in wheat production is 9.60 on the average over the country during the period from 1983 to 1987, which implies a great potential of increasing output with increasing external input. Thus in China, sustainable agriculture may be characterised as *intensive* (or *high-input*) sustainable agriculture[2]. However, the most important form of sustainable agriculture in developed countries is called *low-input* agriculture or *low-input* sustainable agriculture. Thus in West Europe and North America, most of the relevant literature discourages the use of agro-chemicals and fossil fuels, and advocates greater reliance on animal and green manure, leaf mulch and crop residues so as to lower the risk of farmer management, to reduce pollution and to improve soil quality [Hulse, 1991: 546].

Finally, sustainable development in China is characterised by effective initiation and intervention by the government. The government was the initial and primary moving force underlying the recent thrust toward sustainable

TABLE 3

ESTIMATES OF MARGINAL OUTPUT OF MAIN INPUT FACTORS IN WHEAT PRODUCTION IN CHINA 1983-1987

Factors	Country	Northern area	Middle & lower reach areas of Youngze River	Southern & Southwestern areas	Western area
Labour	4.69	9.65	10.85	10.19	12.70
Fertilizer	9.60	8.10	9.62	8.99	9.87
Others*	7.79	6.71	20.05	8.99	9.91

* machine, irrigation, pesticide, etc.

Source: Chen and Zhang 1990: 8-9

agriculture in China, beginning during the late 1970s. Since 1985, sustainable agriculture has been incorporated into agricultural and rural development planning of every province and region. In 1989, special departments of the Ministry of Agriculture (MA) and the State Environmental Protection Agency (SEPA) were identified to carry out experimentation and extension. With government support, specific markets (green label) have been created for some outputs of sustainable agriculture in China. Sustainable agriculture practices in developed countries, to a large extent, are spontaneous and scattered activities

of researchers and farmers. In the U.S., for example, significant initiatives in the private sector (*e.g.*, by the Rodale Institute) preceded by decades government promotion of sustainable agriculture that started in the mid-1980s [Cheng *et al.*, 1992: 1135].

The foregoing comparison of sustainable agriculture between China and developed countries has been summarised in table 4.

Contribution of China's sustainable agriculture towards the goals of SARD: some experiences

There has been a debate about the socio-economic viability of low-input sustainable agriculture even in developed countries. Ruttan [1991: 572] has proposed that the strategy of sustainable development should be changed from the "preventist" that urges the reduction of fossil fuel use, the intensity of agricultural production and biomass burning to the "adaptionist" that implies moving as rapidly as possible to design and put in place the institutions needed to remove the constraints that intensification of agricultural production are currently imposing on sustainable increases in agricultural production. When Crosson [1991: 552] discusses sustainable agriculture in North America, he defines it as a production system "which meets demand for food and fibre into the indefinite future at economic, environmental, and social costs which do not imperil the per capita welfare of present or future generations."

TABLE 4

A COMPARISON OF SUSTAINABLE AGRICULTURE (SA) BETWEEN CHINA AND DEVELOPED COUNTRIES

Items	SA in Developed Countries	SA in China
1. Emphases of goals	Protecting environment and maintaining resource base with acceptable yield or return	Integration of raising yield & income, and improving ecological & social impacts
2. Strategic options	Environmental protection planning through specific projects and legislation	Broad structural adjustment of agroecosystem & optimization of regional resource allocation
3. Industrial organization	Cropping & breeding focusing on soil conservation and water resource protection	Integrated development of cropping, forestry, animal husbandry,fishery,processing & environmental engineering
4. Input use	Low-input, self-maintaining system with more emphasis on reduced chemicals use	Intensive use of modern techniques & labour, less emphasis on reduced chemicals use
5. Development and organization	Spontaneous and scattered activities of researchers and farmers; sluggish promotion by government	Government initiates, supports, and directly intervenes

As for most developing countries, low output never becomes a feasible option for achieving sustainable agricultural development because of its adverse effects

on farmers' incomes and food security. For that reason, the Den Bosch Declaration has developed the concept of sustainable agriculture and rural development (SARD), implying that environmental quality and ecological balances lost their predominant position in the goals of sustainable development. Because "underdevelopment, poverty and the social inequalities of the rural world" are recognised as the "root of the problem" of unsustainable use of land, the essential goals of SARD are defined as "food security"; "employment and income generation in rural areas, particularly to eradicate poverty", and "natural resource conservation and environmental protection". The Declaration also highlighted several "fundamental changes and adjustments" needed to achieve these goals: a greater role in the design and implementation of development projects for farmers and local farm-based organizations; the need for a plurality of institutions and new forms of cooperation among government, NGO, and rural leaders in decision-making; clearer rights to land and other natural resources; new investments in natural resource conservation; and, changes in macro-economic and agricultural policies [FAO, 1991: 1-9; Benbrook, 1991: 581-3].

From the analysis of its characteristics in the previous section, it follows that China's sustainable agriculture is rather close to the FAO-concept of SARD. Most importantly, the emphasis of essential goals in China's sustainable agriculture is similar to that of SARD. Furthermore, broad industrial

organization in China, in fact, has combined sustainable agriculture and rural development. Thus it can be concluded that China's sustainable agriculture is a good example of actual implementation of SARD in the world.

If we revisit the previous analysis of China's sustainable agriculture and its characteristics, some useful experiences could be wrapped up for the implementation of SARD in developing countries. First of all, the determination of the goals regarding SARD should depend on a country's physical and socio-economic situations as evinced by the ratio of population to land, the level and manner of agricultural production, the living standard of farmers, the phase of rural transformation and the available economic resources. For many developing countries, the most crucial problems are a chronic shortage of food and rural poverty. Meeting the increasing demand for food supply and improving farmer's income must be incorporated into the goal system of sustainable development. With increasing population pressure, developing countries can't afford to rely on low input agriculture [Hulse, 1991: 546]. Thus LEISA is not feasible in areas with high population pressure; HEISA is a better alternative. Secondly, sustainable agriculture should be incorporated into the entire rural transformation process. Rural industrialization and urbanization in developing countries will change the location and magnitude of ecological or environmental problems in the future. These impacts and changes should be taken into consideration in the choice of structure design and measures to achieve sustainable agriculture, rather

than be ignored or avoided. Widely industrial organization especially processing and environmental engineering industry development in China's sustainable agriculture supplies useful experiences to realise this objective [Qu *et al.*, 1988]. Finally, active initiation and effective intervention by the government is another important aspect. In developed countries, it has been suggested that the innovation and application of technologies and other changes in farmer's behaviour related to sustainability can be induced by means of market forces. Sustainable development, however, in most cases deals with externalities of economic activities and will not be realised without effective government intervention. Especially in developing countries, because of limited economic resources and environmental ignorance of farmers, government initialization in particular through direct intervention is necessary for sustainable development in agriculture.

3. IMPACT OF SUSTAINABLE AGRICULTURE ON RURAL DEVELOPMENT IN CHINA

Economic and environmental effects

Since the late 1970s, the number of pilot units of sustainable agriculture has reached to near 1400 and the number of sustainable agriculture households in the country is going up, too. For example, in Sichuan Province alone, there are at least 10 thousand such households. Furthermore, most of the nation's

provinces, municipalities and autonomous regions are continuing to expand demonstration units and scale. At the moment, 5% of rural labours are involved in sustainable agriculture practices [Sun, 1993: 1]. The pilot projects have been successful in most areas. Four villages of China won the top prize of the global environmental project award from the UNEP between 1987 and 1991 for their outstanding achievements in sustainable agriculture development.

The introduction of sustainable agriculture practices during the last decade has had significant impacts on agricultural environment and rural development. The most important effect, however, is that sustainable development has become the dominant strategy of agricultural modernization and rural transformation for the entire country. Successful agricultural structure adjustment from the beginning of the 1980s, for instance, is largely a result of the strategic transition towards sustainable agriculture. During the adjustment, cultivation practices of a number of environmentally sensitive lands such as marginal lands, steep lands and wetland has changed from cropping to forestry or grass. Mono-planting of grain in farming which had led to serious soil erosion and nutrient depletion has been replaced by a diversified structure of cropping which has a wider range of ecological suitability. Recently, 46 million hectares of land with serious soil erosion, i.e. one third of total land areas in China, has been placed under a program of conservation which to a great extent consists of the technical systems of sustainable agriculture. Preliminary results of pilot areas in the Loess Plateau

indicate that with structural changes from cropping to planting trees, shrubs and grasses, the soil erosion rate has been reduced by 70-80% and the cost-benefit ratio has reached 1:2-10 [Wen, 1993: 80]. With increasing output and economic benefits, the ecological instability of agricultural production in China is being controlled.

A second important effect is the fact that more labour can be involved in sustainable agriculture. According to available survey information, the use rate of labourers in pilot areas has been raised by 10-20% [Zhang *et al.*, 1992: 79]. Although the creation of employment opportunities will depend to a large extent on non-agricultural development and urbanization, the potential of sustainable agriculture for absorbing more surplus labours will be of great significance for rural development.

Another significant effect of sustainable development is the emergence of an "ecological market". The production of ecological products which contain little chemical residues has been included into the sustainable agriculture programme; and more and more production bases have been established in areas least polluted by industry. In addition, more and more ecological products with a "green label" have emerged in markets. Some ecological products such as tea, vegetable and fruits have been exported abroad. Thus, ecological products with a higher economic value are recognised as a new way to realise sustainability, especially in relatively developed areas.

Economic benefit improvement and higher income generation are feasible in most pilot areas of sustainable agriculture. In China, the important options adopted in sustainable agriculture are not low external input but rationally intensive external input use and industrial diversity of agro-eco-system. Intensive input use has resulted in high agricultural output and improved food security which have, to some extent, alleviated the pressure of population growth on environmental resources. Industrial structure adjustment according to eco-economic principles not only has maintained natural resource base but also has significantly increased income, income diversity and income stability. According to McLaughlin [1993: 103], in Dingxi County, Gansu Province, the elasticity of income with respect to soil conservation practices (terrace and biological methods) was 0.76 during the period from 1982 to 1986. An evaluation of integrated eco-economic benefits of two typical pilot areas of sustainable agriculture (at the county level and the village level) indicates that , with ecological improvement, the economic benefit has increased considerably (see table 5).

With the implementation of sustainable agriculture programmes, more advanced or top techniques have been applied to agricultural production. The increasing demand for new technologies is likely to lead to further technical transformation in agriculture. So far, new micro techniques such as genic engineering and ferment engineering, and macro ecological engineering

TABLE 5

THE INTEGRATED EVALUATION OF SUSTAINABLE AGRICULTURE IN WENXI COUNTY AND CHUANZIYING VILLAGE

	Wenxi County			Chuanziying Village		
Index of Benefits	**1983**	**1986**	**1989**	**1982**	**1986**	**1990**
Ecological benefit	0.072	0.292	0.815	0.107	0.526	0.689
Economic benefit	0.275	0.409	0.760	0.000	0.467	0.881
Social benefit	0.018	0.482	0.538	0.000	0.492	0.976
Integrated benefit[b]	0.148	0.398	0.763	0.046	0.474	0.832

[a] The indices of ecological, economic and social benefits are derived from the development of different indicators of ecological, economic and social benefits.

[b] Integrated benefit index $I = w_1P_1 + w_2P_2 + w_3P_3$. Where: P_1, P_2 and P_3 are the indices of ecological benefit, economic benefit and social benefit, respectively; and w_1, w_2 and w_3 are the weights of P_1, P_2 and P_3. See Zhang et al. (1992) for more details.

Source: Zhang *et al.*, (1992)

designing are being applied to sustainable agriculture.

The discussion above only is an exploratory analysis of sustainable agriculture development in China. A more systematic evaluation at the national level should concentrate on its long-term impacts as well.

Remaining Problems in China's sustainable agriculture

Despite these successes, however, there exist a number of problems that are affecting and will affect agricultural sustainability in the near future. First of all, the immense and still increasing population pressure is intensifying the friction between population and resources. Although the population increase has been controlled since the beginning of the 1970s, the population growth rate is still 1.4%. Population projections for 2000 and 2025 amount to 1.3 and 1.5 billion, respectively [Lu, 1992: 3]. Soil over-cultivation and marginal land development will become major problems in realising sustainability, especially in the south and northwest of China. According to estimates of the Chinese Academy of Sciences in 1989, the area in which the food demand of the population exceeds the carrying capacity of land resources occupies 38% of the total area of China. It comprises 22% of the total arable land area and 27% of the total population [Hu and Wang, 1989: 136].

The second problem is the accelerating rural industrialization that can result in environmental pollution, in particular of water resources. As a major component of rural transformation, rural industry has increased by 28.5% annually from 1978 to 1993 and its output value equals 37% and 70% of social total output value and rural social output value, respectively, in 1993. However, pollution arising from rural industrialization has had serious impacts on the agricultural resource base. In 1989, 1.83 billion tons of waste water was

produced and spilled out, only 16.3% of which had been treated according to the criteria issued by the state, because of limited equipment and funds. The experiences of U.S. and Japan indicate that, as a rule, effective treatment of environmental pollution begins when GNP per capita reaches about 4000--11000 US $ [Ye and Peng, 1992: 2]. Assuming China's development will follow a similar pattern, this would imply that more intensive pollution arising from rural industry will be inevitable for a considerable period, because GNP per capita in China is only 390 US $ in 1991. Furthermore, the scattered distribution of rural industry with little relations with agricultural product processing, and the more readily diffusion of its pollution to arable land, will lead to relatively more serious and direct environmental damage to soil and water resources.

Instable economic policy is another problem affecting sustainable development of agriculture. The rather scattered and small-scale land use limits the optimization of the eco-economic structure and the collective activities that are necessary for resource conservation and ecological projects. China's fluctuating price policy affects the stability and sustainability of the agroecosystem. Investments have increasingly been shifted from agriculture to non-agricultural sectors, because of significant differences in benefits between the two sectors arising form policies that depress relative prices of agriculture. The current system of land property rights frustrates farmers' incentives to conserve or protect land resources [Qu *et al.*, 1988]. In addition, the policy of lagged

urbanization that retains labour on over-cultivated land increases population and employment pressures on the environment and resources.

4. MAIN CONCLUSIONS AND RECOMMENDATIONS

Sustainable agriculture in China differs in a number of respects form sustainable agricultural practices in developed countries. These differences arise from China's deviating basic physical and socio-economic conditions, such as the huge population pressure, the long history of farming, the primary phase of agricultural development, and the household management of very small-scale land units. Important characteristics of sustainable agriculture in China include the relatively high emphasis on the goals of food security and income generation, the diversified structure of agroecosystem and the wider industrial organization, the intensive input use, and the effective initiation and intervention by the government. Thus, sustainable agriculture in China is close the concept of sustainable agriculture and rural development (SARD) proposed by the FAO, and may serve as a good example of actual implementation of SARD.

During the last decades, the upsurge of sustainable agriculture has had significant effects on the agricultural environment and on rural development in China. Sustainable development has become the main strategy of agricultural and rural transformation. The agricultural structure has been transformed

accordingly. The integrated system of techniques in sustainable agriculture resulted in innovation and application of new techniques, and is likely to result in further transformation of agricultural and biological technology in near future. The emergence of an ecological product market, such as the market for "green label" products, implies the development of efficiently functioning markets in natural resources and environmental services over the country. To some extent the intensive use of labour in sustainable agriculture is alleviating the employment pressure caused by the increasing population in rural areas. Furthermore, in most sustainable agriculture programmes, from the county level to the village level, output and farmers' incomes have increased simultaneously with the improvement and maintaining of resource base and environmental quality.

Some problems, however, are affecting the realisation of sustainable agricultural development. Perhaps most important of these are the immerse and increasing population size that intensifies land use and pressure on the environment, the accelerating rural industrialization that may lead to increasing pollution of soil and water, and the unstable economic policies that threaten the stability of the agroecosystem.

In order to deal with these problems, appropriate adjustments of strategy and policy are needed. Opening the road in which rural surplus labour can be shifted to non-agricultural sectors and urban areas is a great potential for alleviating

population and employment pressure on land resources. It is suggested that rural industry distribution should be concentrated more and that the development of small to medium size cities or towns be given priority. Meanwhile, the innovation and application of new techniques of pollution prevention and treatment should be stressed. Providing the necessary economic incentives to farmers towards sustainability and stabilizing the structure and functions of the agroecosystem should be the objectives of economic policy reform. With market reform and price liberalization, prices that are important for maintaining resource base and agroecosystem stability should be protected by the government, so that serious fluctuations of the agroecosystem arising from inevitable market changes can be avoided to a great extent; on the other hand, ecological markets or "green food" markets should be promoted so that effectively functioning markets that maintain natural resources and environment can be further developed. Sustainable development also requires investments and credit availability for vast numbers of small farmers. Thus, state investment and credit policies directed towards sustainable agriculture are needed. Finally, land property rights and land use policy should be reformed further so that effective and secure land rights can be established, which will stimulate farmers' enthusiasm for maintaining resources and sustainable development.

Notes

1. The alternative to the existing farming system sine the end of the 1970s was originally called "ecological agriculture" in China. because its concept and contents are different from that of ecological agriculture in developed countries, more and more agricultural scientists and economists have denoted "ecological agriculture' in China as "sustainable agriculture" [Cheng and Taylor, 1992: 1127; Lu, 1992: 1]
2. A similar conclusion has been drawn from the study on Africa by Van Keulen and Breman [1990: 177-97]. They argue that input use in Sahel countries can alleviate soil mining and stimulate the sustainability of agriculture. Thus a new concept-high external input sustainable agriculture (HEISA) is proposed, compared to low external input sustainable agriculture (LEISA).

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