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INTEGRATED RESOURCE MANAGEMENT AND SUSTAINABLE AGRICULTURE DEVELOPMENT IN THE RED SOIL AREA OF SOUTH CHINA

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EXECUTIVE SUMMARY

Background

The Red Soil Hills area of South China is a complex mixture of mountains, hills, paddy lands, rivers and lakes. The climate is favorable for agriculture in a sub-tropical to tropical environment and facilitates a diverse agricultural sector. Triple cropping on paddy lands is common-double rice followed by rapeseed or a green manure crop. Upland crops include tree fruits, tea and nuts. Pigs and poultry dominate livestock production. Fish production is important in lakes and streams. Forestry dominates the higher elevations and is an important component of the vegetation complex at lower elevations.

The red-and-yellow soil region covers parts of 10 provinces and autonomous regions and represents about 12% of the total area of China. While the climate is generally favorable for agriculture, periodic floods and droughts are important problems. Agricultural productivity has improved markedly in the last two decades. Forest cover has been doubled in the same period through an integrated Mountain-River-Lakes (MRL) program.

The Sustainable Agriculture Working Group (SAWG) focused its 2000 work plan on issues related to sustainable development of the Red Soil area. Chinese experts identified this area as having significant development potential provided that associated environmental management challenges are met to ensure sustainability. The SAWG selected Hunan and Jiangxi provinces as the focus for an extensive field study and an International Workshop on Integrated Resource Management and Sustainable Agriculture Development in the Red Soil Region in South China.
Agriculture and its interface with other sectors in these two provinces is characteristic of the red-and-yellow soil region, hence the choice as the location for the 2000 field tour and workshop.
The field tour and workshop format enabled SAWG members to interact with Chinese researchers, provincial and local government officials, program managers, farmers and technical specialists and with international experts.

The provinces of Jiangxi and Hunan are both essentially self contained watersheds wherein headwaters of all major streams originate within the provinces and discharge into Poyang and Dongting Lakes, respectively. These lakes flow into the Yangtze River. Recent policy change requires substantial diked portions of these lakes to be restored such that they will again play important roles in flood mitigation, migratory bird habitat and fisheries.
The economy and environment of the red soil region has changed markedly in the last two decades in response to policy changes and market opportunities. A number of important issues remain to be addressed to ensure sustainability of the agriculture sector into the future. These

include:

1. Excessive pesticide application rates, especially insecticides.
2. High rates of application of chemical fertilizers.
3. Burning of crop residues.
4. Land degradation through erosion, declining organic matter, industrial pollution and low water use efficiency.
5. Low levels of investment in applied research and technology transfer related to integrated crop and livestock production systems.
6. Limited storage and processing capacity to address market opportunities.
7. High level of government expenditure on grain storage, thereby limiting investment in other initiatives.
8. Economic, environmental and social problems associated with restoration of lakes.

Recommendations

1 ISSUE: Over use of pesticides and the need for a national strategy for Integrated Pest Management (IPM).

Background: During the past 10-20 years there has been a growing consensus that farmers generally apply more pesticides to grain, vegetable and fruit crops than they need for adequate pest control. This excessive use can:

- lead to the death or sickness of farmers;
- lower farm incomes because of the unnecessary expenditure on pesticides and days off sick;
- reduce fish production;
- Add to the need for costly water purification to meet drinking water standards.

Yet pesticide use has been increasing. In the case of rice it doubled in value terms between 1980 and 1997 (in constant prices), and now represents around 7% of the total material costs of rice production. Moreover, this is despite the clear evidence from local trials in China and nation wide programs in other Asian countries that an approach called integrated pest management (IPM) can decrease pesticide (especially insecticide) use two to three fold or more without lowering rice, cotton and other crop yields, raise farmers net incomes and health, and protect the environment. At national level the cost savings from the reduced pesticide use can be substantial, and for China could exceed 10 billion RMB.

The need for urgent action to stop the overuse of pesticides is supported by four other trends. First, the continued reduction in the area available for grain production, which leads to more intensive use of production inputs like fertilizers and pesticides, and greater likelihood of pest and disease outbreaks. Second, the reduction of direct funding of agricultural extension, which is forcing extension services to be self-funding and commonly leads to them placing too much emphasis on the sale of pesticides. Third, the conflicting role of government departments regarding the regulation, production and sale of pesticides. Fourth, the decline in rice prices which makes it important to maintain farm incomes by reducing the costs of production. Fifth, pesticides residues in foods are an increasing threat to the expansion of agricultural exports [and to compliance with WTO requirements].

Recommendation: China should develop a national strategy for IPM. The strategy should become part of the wider development strategies for eco-agriculture and safer foods. It should be consistent with policies to lower pesticide residue levels in foods, and backed up by stronger measures to ensure widespread compliance with such policies. The IPM strategy could initially be formulated for rice and major vegetable crops, and then extended to all crops receiving high pesticide applications. Two demonstration projects should be established to test the strategy and the main alternatives for its practical implementation including farmer participation and mass media approaches. These demonstrations should be developed in conjunction with provincial officials. It is recommended that these demonstrations be in Zhejiang and Jiangsu Provinces building on their experience with IPM, and the assessments that have been conducted in these provinces of the human health and other costs of excessive pesticide use.

***2 ISSUE*:** Effects of national food security policy on agricultural sustainability.

***Background*:** The national food security policy aims at achieving a level of 95% self-sufficiency in food grains. This policy is applied to provincial and local governments. Internal grain trade is restricted. This policy results in grain production in all areas in China, frequently on land not suitable for annual crop production.

The national food security policy results in large mandatory provincial and local government expenditures on food grain purchases and storage. This limits local and provincial government capacity to undertake other initiatives targeted at environmental, developmental and social programming such as infrastructure, poverty alleviation, education, applied research and technology demonstration.

Recent studies by the World Bank and the Trade and Environment Working Group of CCICED have made similar observations.

***Recommendation*:** The Government of China should review, on an urgent basis, the social, environmental and economic effects of its food grain security policy.

3 ISSUE: Skill levels of farmers and extension workers.

Background: Sustainable agriculture in a knowledge and technology market economy requires educated farmers and advisors. Skill levels of the majority of current farmers and extension workers are generally good for production matters, but limited for financial management and marketing. Also lacking in many cases is adequate understanding of the necessity for better environmental management of soil and water resources.

A World Bank "Agricultural Support Services" project has identified major weaknesses in support services, including extension services. Responsibilities and duties of many agricultural service personnel are largely administrative rather than educational and advisory. Studies of agricultural extension services suggest that the adaptation of agriculture to the market economy could be achieved most efficiently and quickly by additional training for extension workers.

Recommendation: The Government of China should undertake a concerted effort to improve

the skills of extension and farm service personnel with emphasis on marketing, financial management and environmental stewardship.

4 ISSUE: Sustainable Soil and Water Management

***Background*:** Despite the significant progress in developing the sloping lands of the Red Soil area with more appropriate soil management and diversified cropping systems and forestry, there are still major concerns with soil erosion, loss of organic matter and low water and fertilizer use efficiencies. Despite regional policies and laws that discourage burning of crop residues it is estimated that 70 to 80 percent of the crop residues continue to be burned in the region with only a small percentage being returned to the land, used for livestock feed or for non-food products.

Water use efficiencies of 20% or less are reported on paddy lands as are fertilizer nitrogen losses of 60%. These practices are not sustainable.

Recognizing the important relationship of soil quality to productivity and universal principles of soil and water conservation, it is vital that more appropriate land management systems are developed for the Red Soil Region. Crop residues (mulches) are known to have many primary and secondary benefits under a wide range of climatic conditions, including: reduced erosion, reduced evaporation, improved water and nutrient use efficiency, improved weed control, increasing soil organic matter content and ultimately more stable and higher crop yields.

Recommendation: It is recommended that additional public investments be made to develop land management systems that make more appropriate and effective use of crop residues to improve soil and water conservation and nutrient use efficiency. Opportunities to use the surplus crop residues for commercial production of straw board (for construction material) or composts should be investigated. Applied research and demonstration projects would be valuable to facilitate transfer of appropriate technologies.

5 ISSUE: Improving the Client-Focus of Agricultural Research and Development

Background: There is a long history of accomplishments in Chinese agricultural science in national, university and provincial institutions. The remarkable increases in agricultural productivity in recent decades reflect that science effort. Research facilities are widely distributed geographically, thus facilitating response to regional problems and opportunities. Agricultural policies have been aimed at increasing output for a food deficit nation.

Much of the yield and output growth in Chinese agriculture has come at the expense of serious environmental degradation – soil erosion, salinization, grassland degradation, organic matter loss, desertification, pesticide and fertilizer pollution in soils and water and burning of crop residues. These environmental issues pose health hazards to farm workers, food safety concerns and deplete the agriculture resource base.

Public investment in agricultural research has decreased markedly in recent years. Coordination and cooperation across institutional boundaries is weak. The research philosophy or policy in many institutions tends to be relatively conservative and does not appear to have responded

appropriately to the needs of the market economy. Much of the research emphasis remains on higher yield while low value grain stocks grow, consumer demands for quality and variety increase and environmental considerations become paramount.

Many areas in southern and central China including the Red Soils area are blessed with rich soil and water resources and abundant human resources. There would appear to be an almost unlimited number of sustainable production system options available to farmers. These include various combinations of annual crops, ruminant and monogastric livestock, forestry, tree fruits and other perennial crops. The existing research institutions are not conducting sufficient applied research, technology demonstration and farmer participatory investigations needed to service those opportunities.

Field investigations by the SAWG suggest that production systems with the following components may be economically and environmentally sustainable and should be explored:

1. Ruminant livestock and forestry on upper slopes.
2. Integrated systems with annual crops, forestry and fruit trees, including rainfed systems, on lower slopes.
3. Forage and ruminant livestock production on restored flood plains in lakes.
4. Utilization of crop residue to increase organic matter content in all soils.

Recommendation: The Government of China should substantially increase its investment in agricultural research within a science strategy that emphasizes economic efficiency and environmental protection. This strategy should emphasize applied research, technology demonstration and farmer participatory investigations to enable farmers to participate more fully in the market economy while managing the environment in a responsible manner.

6 ISSUE: Restoration of lakes reclaimed from agriculture.

Background: The government of China has recognized that the many lakes in the middle reaches of the Yangtze River play an important role in seasonal flood management. Policies have been changed and actions have been taken to restore significant portions of lakes to enable their use in flood control and mitigation and to restore ecological functions of rivers and lakes. Lake restoration entails tremendous social and economic costs associated with displacement of people and changes to river and lake infrastructure. Substitute industries or means of livelihood for people displaced from lake bottom agriculture need to be developed, investment programs need to be re-directed from flood control infrastructure to restoration of ecological functions of the river system, capacity management of lakes is needed to solve seasonal shipping problems and technology development is needed to capitalize on production opportunities created by seasonal floods.

Recommendation: To meet the social, environmental and economic objectives of its "32-character principle" pertaining to lake restoration, the government of China should increase its investment in several areas:

1. Replacement housing and employment for people who are losing both housing and means of livelihood due to restoration of lakes.

2. Restoration of ecological functions of the rivers and lakes.
3. Research and associated technology demonstrations to develop economic opportunities in agriculture, forestry, tourism and acqaculture that take advantage of seasonal floods.

1 INTRODUCTION

Led by Prof. Honglie Sun, a member of Standing Committee of the National People's Congress and the academician of CAS, the CCICED Sustainable Agriculture Working Group (SAWG) conducted a field investigation on the sustainable agricultural development in Hunan and Jiangxi Provinces during 1-8 May, 2000.

In Hunan Province, the SAWG members visited the Bamboo garden in the red soil hilly-and-maintain region in Taojiang County, Taoyuan Agro-ecological Research Station of CAS, a demo project for cropping system reform in rice field in Taoyuan County, WWF demo project for wetland restoration in Hanshou County, the demo project for high-standard construction on basic farmland in Ziyang Division, and a national nursery base for good quality fruit and tea seedlings production in Wangcheng County. Besides the SAWG members, a group of local leaders and specialists also joined the field tour and guided related sites. They are Prof. Kelin Wang, deputy director of Changsha Institute of Agricultural Modernization of CAS, Prof. Kairong Wang, head of Taoyuan Agro-ecological research Station of CAS, Prof. Huang Huang, Dean of Plant Science and Technology College, Hunan Agricultural University, Dr. Guangchun Lei, Yangtze Programmer Leader, World Wild Fund For Nature, Mme Ximan Ou, Senior Agronomist and director of Soil and Fertilizer division, Agricultural Administration of Hunan, and etc. During the tour, Prof. Qiguo Zhao and Prof. Huang Huang made presentations on the Red and Yellow Soils in South China and the Cropping Systems in Hunan Province, respectively. After the field tour in Hunan, SAWG members attended a seminar on Integrated Resources Management and Sustainable Agriculture Development in Hunan Province chaired by Mr. Daomu Pang, Deputy governor of Hunan Province. Some high officials from Ministrations of Agriculture, Water Conservation, Forestry, Finance, Science and Technology, Planning Commission and Agriculture Office of the provincial government made presentations.

In Jiangxi Province, the SAWG members visited Qianyangzhou Ecological Research Station of CAS, Wentian orchard, Fuhai Ecological Agricultural Development Company, Liuliang Black Bone Chicken Farm, Yintan Red Soil Ecological Research Station, and Nieqiao Sustainable Agricultural Technical Extension Station of MRL Program. Besides the SAWG members, Prof. Zhenfu Wu, Deputy governor of Jiangxi Province, Qing Zhou, deputy of Science and Technology Commission, Prof. Guochen Wu, Director of Office of Jiangxi Provincial Committee for MRL Regional Development, Prof. Jiayong Li, head of Qianyanzhou Ecological Research Station of CAS, and Prof. Yuanqiu He, head of Yingtan Red Soil Ecological Research Station of CAS, and some others also joined the field tour and guided related sites. During the tour, Prof. Zhenfu Wu, Deputy governor of Jiangxi Province, made a special report on integrated resources management and sustainable agricultural development in Jiangxi Province.

After the field tour, On 9-10, May of 2000, an International Workshop on Integrated Resources Management and Sustainable Agriculture Development in the Red-and-Yellow Soil Region in South China was held in Nanchang. Co-Chairs of SAWG, Prof. Honglie Sun and Bernie Sonntag chaired the workshop. Mr. Huiguo Su, Secretary-general of Jiangxi Provincial Committee of the Chinese Communist Party, Prof. Kunmin Zhang, Secretary-general of CCICED, Mr. Dingming

Zou, Deputy Director General, Agricultural Department of Hunan Province, and Mr. Wally Redekop, Canadian International Development Agency made speeches in the opening session. Prof. Qiguo Zhao and other 13 international and domestic scholars and specialists made presentations on the general issues on sustainable agricultural development in Southern China, policy and sustainable agriculture, flood control, wetland restoration and alternative farming in Dongting Lake and Poyang Lake regions, and agricultural development and integrated resource management on the workshop. After the workshop, SAWG members and the other participants were invited to visit the Exhibition of Integrated Development of Mountain, River and Lake in Jiangxi Province.

2 GENERAL SITUATION OF THE RED-AND–YELLOW SOIL REGION IN SOUTHERN CHINA

2.1 RED-AND-YLLOW SOIL REGION IS THE IMPORTANT AGRICULTURE COMMODITY AND FOREIGN EXCHANGE EARNING BASE IN CHINA

The red-and-yellow soil region in Southern China ranges from the tropics and subtropics, including 619 counties or county level cities within 10 provinces or autonomous regions. It has 11.8% of the total area and 30% of the total population of the nation. The weather is normally wet and hot, and the resources of light, caloric and water are very rich in this region. It is the important base for the production of grains, cotton, oils, sugarcane, and some high quality and famous specialty with high potential of earning foreign exchange, such as tropical and subtropical cash trees, fruits, medicinal materials, and so on. It is obvious that the region plays an important role in the development of the national economy.

2.2 RED-AND-YELLOW SOIL REGION HAS THE HIGHEST POTENTIAL OF NATURAL PRODUCTIVITY IN CHINA

In favor of south-eastern monsoon, there are very rich water and caloric resources in the red-and-yellow soil region. It has a high potential of biological regenerating and soil renewing. And the multi-maturing and dimensional cropping systems are highly developed. The climatic production potential in the red-and-yellow soil region ranges from 46 t/hm^2.a to 54 t/hm^2.a with the average of 51 t/hm^2.a, and it is 1-2 times higher than that in North-eastern and Northern China. However, the present yield of the farming system is only 20% of the potentials.

2.3 RED-AND-YELLOW SOIL REGION HAS HUGE POTENTIAL IN THE DEVELOPMENT OF AGRICULTURE AND SOCIAL ECONOMY

There's high exploiting potential of land resources in the red-and-yellow soil region. There are 20-million hectares of non-exploited hill and mountain lands and 16-million hectares of low-hilly slopes, and around 30% of the area of waters, and the beach lands of river and lake are suitable for the exploitation as agriculture lands. There are also 33-million hectares of low yielding forest and 6.6-million hectares of bush and sparse woods. It could produce good results in increasing

wooden products and values in the red-and-yellow soil region by tapping the potentials of these lands. This region could also be constructed into the biggest base for the production of fast-growth forest in China.

2.4 RED-AND-YELLOW SOIL REGION IS AN IMPORTANT GATEWAY FOR CHINESE AGRICULTURE ENTERING INTO INTERNATIONAL MARKET

The region includes three booming economic areas, the delta of Yangtse River, the delta of Pearl River, and Hongkong and Macao. They are the channels for Chinese agriculture products entering into the international market. The agriculture in the red-and-yellow soil region is not only highly and mutually beneficial to that of northern China, but also can seek out experiences and ways in taking the lead in the international agricultural trade and fitting the global economic development.

2.5 Red-and-Yellow Soil Region has the zonal superiority in economic development with mutual benefit and promotion between hilly hinterland and the regions

Since the start of the "reform and opening" policy, there is a series significant changes in agricultural economic development in this region. First, the comprehensive agricultural productivity has markedly increased, and the yield of agricultural products has increased continually. Most of the agricultural goods that used to be deficient for quite a long term historically has now become balance basically in the supplying and requiring in domestic market. The market of agricultural goods has changed from "sellers' market " to "buyers' market". Second, agriculture production is going to break through the traditional model of "all round small-scale".. A batch of pillar industries that fit the market need and has regional characters is just taking place. Third, the processing industry of agricultural products has broken through the limitation among professions, regions and the systems of ownership. A batch of mainstay processing industries has sprung up. Forth, The selling business of agricultural goods has broken through the single circulation model of which formed in the planned economic system, and the market system with the character of multi-channels in selling and buying, multi-levels in structure, and multi–units in ownership has being formed. Fifth, the traditional fetter of the guiding ideology of "from agriculture to agriculture" (i.e. agriculture is just planting, and agricultural economy is just to make money from farmland) has been broken through in the management of agricultural economy. The construction of small-scale cities and towns in the countryside has become the new growing point in the economic development. Sixth, the deltas of Pearl River and Yangtse River, the south-eastern coastal region, the plains of Dongting Lake and Poyang Lake, the construction zone in the Yangtse River valley, and the border trading area along North Sea have become the centers of booming economy in the red-and-yellow soil region. It makes the region have the zonal superiority in economic development with mutual benefit and promotion between hilly hinterland and the coastal regions.

3.BASIC ISSUES ON SUSTAINABLE AGRICULTURAL DEVELOPMENT IN THE RED-AND-YELLOW SOIL REGION IN SOUTHERN CHINA

3.1 STRIKING CONTRADICTION BETWEEN POPULATION AND CULTIVATED LAND

In one hand, there are more hilly and mountain lands, and less of cultivated land. The average area of land per capita is 7.36 mu (0.424 hm^2), which is only half of the average nationally. The average area of cultivated land per capita is 0.93 mu (0.062 hm^2), which is also significantly less than the national average value, 1.42 mu (0.095 hm^2). In some counties, the average area of cultivated land per capita is even less to 0.7 mu (0.047 hm^2). The natural contradictory between population and cultivated land is very striking. In the other hand, this contradiction could be much more striking along with the development of the industrialization and urbanization of this region, since the occupying of the large quantity of arable lands (or even cultivated lands) by the newly sprung up industries has not yet been well controlled radically.

3.2 IRRATIONAL FARMING SYSTEM WITH LESS PLAY OF THE REGIONAL SUPERIORITY

In the red-and-yellow soil region, the areas of mountains (mostly are low and middle height mountain) and hills are up to 38% of the total area. The "valley agriculture model", of which grain production is the only important target, has been employed for a long time. So only about 20% of the total area in the region has been intensively used. About 80% of the labor force concentrated in the narrow valley farmlands. In some area, the arable valley land has been over-exploited. In the other hand, a large quantity of hilly and mountain lands still lies in a semi-waste situation in this region. The superiority of the forests that account for 35% of the total land area has far from being brought into play. The output value of the forest accounted only 6.17% of the total of agriculture in the region. While the output value of the farmland cropping reached to 51.54% of the total of agriculture. Abundance of grazing land and waters resources are not fully and effectively used in the region.

Also, the scale of high quality brand agriculture is still quite small. It is difficult to put the general agricultural goods into market. Some of the lower and middle grade goods or no brand agricultural products has no steady selling channel at all. In bumper year, the farmers usually have high yield of the products but low cash income because of the sharply decreasing price of the goods or overstocking or even deteriorating of the products. For the sake of market challenge, the labor force in the countryside has over-shifted to the second and third industry in some relatively developed areas. As a result, abundance of the cultivated farmland lies waste and agriculture becomes wilting in these areas. So, transferring an old agriculture model to a new model, and cultivating new economic growing point will be of great importance to the further social and economic development in this region.

3.3 ECOLOGICAL FRAGILITY, LAND DEGRADATION, ENVIRONMENTAL POLLUTION, AND THE STRIKING CONTRADICTION BETWEEN THE EXPLOITATION OF RESOURCES AND SUSTAINABLE AGRICULTURE DEVELOPMENT.

For the high temperature and moist weather in the region, it is fast in decomposing of the soil organic matter, strong in mineral weathering and soil leaching. The soils are usually acidic with low CEC and low capacity of nutrient holding. The native fertility of the soil is usually quite low. The comprehensive fertility index for most of the ploughed red soils is in the middle or low levels. The middle and low yielding area accounts for 68% of the total cultivated farmlands. It is commonly short of organic matter and nitrogen in the soils. All of the upland soils and 60% of

the wetland soils are short of phosphorous, and 50%-80% of the ploughed soils are lack of the nutrient elements of potassium, boron, molybdenum, or zinc, and so on. Especially in the recent years, the content of soil organic matter decreased markedly for the merely heavy application of chemical fertilizer and less production and application of organic manure in agriculture. Taking Hunan for instance, 28% of the ploughed soils appeared significant reduction in organic matter content. In the full red-and-yellow soil region, there is more than 100 millions mu (6.67 hm^2) of ploughed soils of which have been acidified, gleyed, or polluted. Soil fertility degradation is becoming the obstructive factor for sustainable agriculture development in the region, while the fund need for the reformation of the middle and low yielding soils lack seriously in the region.

In vast hill and mountain area, it is very serious in soil erosion and ecological degeneration for the improper resource exploitation. For instance, in the central area of Hunan Province and western area of Guizhou Province, there is very strong water loss and soil erosion for the low rate of forest coverage and irrational forest component.

The situation of the irrigation equipment being out of date or damaged is also quite popular. In some area, the actual storage capacity of the existing reservoirs and ponds or pools is only about 50% of the designed capacity. Over 70% of the irrigation ditches have serious seepage. The losses of water resources in the transferring process are estimated to 90% or more. Water use efficiency is quite low. For the aged and low functioned irrigation works, the natural capacity in withstanding drought and flood is getting lower and lower, and the drought and flood damages in agriculture is going bigger and bigger in the whole region.

In the higher-level intensive farming areas, there is an extensive pollution of chemical fertilizers and pesticides in the farmlands. According to a investigation made in Hunan Province, the areas of soils polluted by pesticides, fertilizers, and the waste emissions of industries are accounted to 79.2 million mu (5.28 million hectares). In more than 70% of the section of the four rivers, Xiang, Zi, Yuan, and Li, water quality cannot fit the national water standard for fishery. Recently, the technologies and equipment employed by most of the industrial and mining enterprises are quite backward in this region. There are high in power consumption, low in efficiency, and heavy in environment pollution in the enterprises, especially for those small- and middle-scale town and township enterprises. The pollution of countryside and agriculture environment made by the town and township enterprises has touched an unbearable level. Seeing from the whole region, the higher in economic developing level, the heavier in resource and environment destroying. It shows that recent economic development is mostly relies on the sacrifice of environment and natural resources. This makes us think deeply and draws our high attention.

3.4 UNBALANCED ECONOMIC LEVEL, RELATIVELY UNDEVELOPED AGRICULTURE AND DISTINCTLY DIFFERENCE ON INCOME OF FARMERS

In hinterland, for the backward status in industrialized management and market construction, and also for the unformed market management scheme and work mechanism, the contradiction between the large amount of mini-production and the variation market is very prominent. All the facts such as unprosperous need, unsmooth circulating, fall of prices of some agricultural products, especially some staple products such as rice, and of livestock products and dry and fresh fruits influenced the increase of the famers' income and producing activity. For the rapid

development of the river-sided and coastal areas, large amount of labors and capital of hinterland flowed to this areas, and this enlarged the unbalanced status between the two areas.

4 SUGGESTIONS ON THE SUSTAINABLE AGRICULTURE DEVELOPMENT IN RED-AND-YELLOW SOIL REGION IN SOUTHERN CHINA

4.1 EXERT THE PREDOMINANCE OF THE RESOURCES IN RED SOIL AREAS AND PROMOTE THE SUSTAINABLE DEVELOPMENT OF THE REGIONAL AGRICULTURE

In the red and yellow soil area of south china, there is do the problem of flimsy ecosystem, but there is also have the integrated resources advantage. For the regional overall economic development, much attention should be paid to the ecological value, and market methods should be also used to measure the economic value of the ecological construction, and to keep the balance between ecological value and economic value. The resources advantage should be transformed to the economic advantage by developing a large amount of industries of which have their unique regional characters. So, we suggest finding high quality and unique brand agricultural products base combining the treatment of the natural catchments and mini valley (river basin). Based on the various natural geographical landscape and biodiversity, a large amount of regional unique agricultural production and management model should be developed such as ecological tour and sightseeing agriculture, green food agriculture, agroforest, planting-grazing-forest combining farming system, and agricultural products processing et. al. At present, small-scale cities and towns building in the countryside should be enhanced. Much attention should be paid to the labor-denseness industries, such as silkworm feeding and agricultural products processing to make full use of the labor resources and promote the labor in countryside to obtain full-time employment. Scot system should be adjusted to improve the development of the unique agriculture.

4.2 PROPERLY UTILIZE THE RESOURCES AND ENHANCE THE CONSTRUCTION OF ECOLOGICAL ENVIRONMENT

(1) Pay attention to the use of hilly land and develop sustainable agriculture

In this region, except that mountain covers 30%, hilly and slope lands cover about 40%, which is about 350 million mu (23.3 million hm^2). The economic pattern of this region should stress on the integrated development of the natural resources. And thus, a sustainable agricultural forest system needs to be built up. In recent years, tree planting has been paid attention to and the forest cover ratio in a majority of regions has obviously increased. For example, the forest cover ratio has increased to 50% from 30% in Hunan province, and it has been up to 53.3% from 21% in Jiangxi province. It is a common problem that the quality of the tree species is not good, and the economic benefit is quite low. The ratio of economic tree species is low and the ecological and economic values have not been properly united. Much attention should be paid to the polymorphism of the vegetation structure in hill mount area and ecological and economic values must be united organically. We suggest that an ecological economic model should be

established. The ecological economic model could include some sub-models, such as the economic forest combining with ecological one, forest combining with agriculture, forest combining with pasture and so on. At the same time, forest products should be processed comprehensively and the economic and social benefits in exploiting the red soil hill should be improved. According to the experiences of Taoyuan County in Hunan province and Qianyanzhou in Jiangxi province, it is benefit to improve the production potential in hill regions and to get high benefits both in ecological and economic value by compounding conifer and broadleaf, trees and grasses, and constructing agriculture and forest combined ecosystem, such as forest-agriculture, forest-herd, forest-fruit, forest-bamboo, forest-tea combined systems. In Taojiang county of Hunan Province, people make full use of the abundant resources in hill region and develop bamboo processing industry. The output value from bamboo industry had reached to 0.6 billion yuan in 1999. And this increased the income per farmer by 475 yuan, which is about 23.5% in the pure income. In this cases, resource utilization, environmental protection, and economic development has been united organically.

In exploiting and developing the hill slope land resources, people should pay attention to make the rainfall as agriculture water resource and to conserve the water and soil.

(2) Stabilize the food production and adjust the cropping systems

Based on stabilizing the potential of food production and guaranteeing the food safety system, the planting systems must be adjusted. In this region, the stable increase of food must be guaranteed. In the ploughed soils (which is accounted to 20% of the total land areas), the base farmland area (26 million mu in Jiangxi province, 32 million mu in Hunan province and 36 million mu in Guangdong province) must be ensured. Meanwhile, the grain planting area must be stabilized and the cropping index should be further improved. For ensuring the balance of the food production in the region, the middle and low yielding farmlands should be reformed, and water and nutrients must have a balance. Also, the funds for agriculture science and technique research and extension must be increased in order to dredging up grain production potentials. For the improvement of the farmland quality and production potential, we suggest that collect the technique and funds to reform the middle and low yielding soil that has been listed in the base farmland. According to the experience of Ziyang Division, Hunan province, after the reformation of the deep mud farmland by engineering, not only the yield of double cropping rice can increase up to 944kg/mu from 520kg/mu, increasing 81.5%, but also can earn extra 680 yuan per mu by the development of winter farming. Both the economic and social benefit is obvious.

In adjusting the farming systems, the market needs must be taken into consideration and the planting crops must be adjusted according to the fact of the farmland soils. In current conditions, the sum of the food is relatively overmuch but the high quality rice is insufficiency, so the grain species structure should be adjusted to increase the competition power of the food products. For example, in Hunan and Jiangxi, the planting area of low quality early indica rice has been decreased (decreased 3 million mu in each province this year), while the area of high quality middle and late rice has been increased and the area of "double rice and three cropping system" has been decreased too.

In the new market conditions, the farmers must be led and organized to develop the water-dry rotating multi-maturing system and enhance the upland agriculture economic development. By

adjusting the farming systems, the three-dimensional agriculture, precision agriculture, famous brand-high quality-speciality agriculture should have further developed, and the high quality and pollution-free green agricultural base should also be built energetically. It should pay attention to develop the high quality brand agriculture. The areas of cash crops and pasture should be increased properly. The yields of high quality muscle-type pigs, grass-feeding domestic animals, and fishes should be further increase. For the increase of agriculture extra value the income of the farmers, the integrated system for agricultural products processing should be developed. The conditions of ploughed land wasting must be forbidden. It is also improper to change the rice producing fields economic development area or for trees and fruits cultivating in a large quantity.

(3) Improve the soil quality and enhance the environmental construction

In recent years, though the total area of afforestation has been increased, the situation of water loss and soil erosion has not been changed radically. In some regions, it still appears "green in a distant view, while water and soil erosion in a close shot". One of the primary reasons lie in the fact is that the afforestation quality is poor, and the young forest has low function in protecting the ecosystem. For example, in Hunan province, the deserted mount has disappeared in 1993, and virescence has been basically accomplished in 1997, the ratio of the forest area reached 57.1% in 1999, and the forest cover rate reached 52.1%. While, there is large in the rate of conifer and less in broadleaf; large in timber and less in eco-protection forest; large in young trees and less in maturing forest; large in unitary forest and less in mixed forest. The components of the forest are not good enough, and the eco-protection function is usually poor. The current elusion area in Hunan province is 470 thousand kilometre squares, and the amount of eroded soil is accounted up to 170million tons per year, which it has increased about 1 time since 1949. In this condition, the quality of forestation should be improved firstly. In hilly slope lands, contour planting, grass and shrubbery covering should be adopted. It has been proved that adopting nitrogen-fixing plants into the contour hedgerow system in the hilly slopes can not only prevent water and soil from erosion, but also increase the concentration of N and K contents in soil and the use efficiency of phosphate fertilizer. It just kills many birds with one stone. We suggest the relevant department to extend this technology in hilly region.

Here, pollution caused by the emissions of industries, especially from the town and township industries is very serious. Pollution caused by fertilizers and pesticides is also increased continually. In some areas, it is even difficult to produce pure agriculture products. As to the serious polluted farmlands, agricultural ecological engineering projects should be processed. By adjusting the farmland planting structure, the approach of poisonous masses that transferred through food chain can be cut. We suggest that the government should take the adjustment of farmland planting structure in polluted area as a special work when it makes the farming system adjustment. To ensure food safe, the grain and vegetable crops in polluted farmlands must be changed to cash crops, which can't be taken into the dishes.

For the reformation and protection of the ecosystem integratedly, stalk burning must be forbidden. It should be recommended that the stalks be returned to the farmland directly or feeding animals and then return the excrements into the field. The inorganic fertilizers and organic manure should be used in combination in the development of Chinese agriculture.

4.3 ADJUST THE AGRO-INDUSTRY STRUCTURE AND INCREASE THE FARMER'S INCOME

(1) Develop "food-grass" and "forest-grass" agro-forest system, extend grazing areas; promote the development of grain-saving and grass-feeding livestock husbandry

It is an important orientation to develop the grain-saving and grass-feeding livestock husbandry and fishery in the adjustment of agricultural structure in the red soil region. The techniques of which feed animals on crop stalks, especially on green manure, and then to return animal excrements to the field must be extended, while the yield of grassland in agro-forest systems should also be enhanced. According to the experience from Taoyuan county, a benefit of 10,000 RMB per mu per year could be obtained by corn and pasturage planting and cattle raising in the red hilly land. In De'an county of Jiangxi province, 6000 native chicken have been raised by one family in a bush and sparse hill, and the annually benefit for the family is more than 20,000 RMB. According to an investigation, raising ruminants can not only increase the economical benefit, but also improve the ecological structure in the red soil, bush and sparse hilly region, and this eco-ecological model should be developed gradually in the similar regions.

(2) To spread actively the ecological agricultural models of which can develop sustainably, while summarizing experiences in the models

Recently, a great deal of experiences in the treatment and exploitation of red soils are accumulated, and a set of eco-agricultural models and the relevant technologies are summarized by many institutes under the central or local government or academy, including the six agricultural experiment stations of the CAS. These include the cropping-forest-livestock-fishery three-dimensional model in hilly areas, the high yielding technology and sustainable farming system model, and the water and soil preservation and exploitation model, and so on. These models are distributed in different areas of which represent different regional types and include different technology systems. Many of the models have been changed into productivity, for example, the pig-methane-fruit mode adopted in the hilly region of Jiangxi province, and have promoted the development of agriculture in the vast red soil hilly areas. It is suggested to establish an extending network, which is led by the local government, and combining with some institutes and the farmers, to spread and apply the maturing eco-economic models and their relevant technologies in the different red soil regions.

(3) To develop mixed farming and enhance competition of agricultural products in the market

Through adjusting agricultural structure, to change the "valley agriculture" model into a high efficiency, extensive and sustainable three-dimensional farming model which with the potentials in the development of cropping, forest, livestock, and fishery synthetically. Under new models, all resources could be optimized in space and time, and the backbone industries in mixed farming including tea-fruit, mulberry-silkworm, bamboo-wood, stockbreeding and fishery, could be well established. As a result, the superiority of resource and region will change into the advantage of economy and sustainable development.

Through developing variety and coordinating nutrition, the quantity and quality of agricultural products would be improved continually. Meanwhile, under the condition of entering WTO, the cost of agriculture production should be further reduced. A deep processing of agricultural product should be considered in order to increase the extra values and comparative advantage of agriculture, and to actively join the new competition in the world agriculture market.

4.4 TO PAY ATTENTION TO THE DEVELOPMENT OF SCIENCE AND TECHNOLOGY AND TO ADJUST RELEVANT POLICIES

(1) To strengthen the input for science and technology and enhance the scientific and technological shares in agricultural development

In order to achieve scientific and technological development in agriculture, the potential of biology, environment, time and space on agricultural science and technology must be exploited. Much valuable experiences of which have been accumulated by many areas should be well summarized and extended earnestly.

With deepening systemic reformation of science and technology in the countryside, the input for science and technology must be increased continuously so that the input in science and technology will be up to more than 0.5~0.7% of total output value of agricultural production.

Spreading system of agricultural science and technology should be perfected. The technological group in agricultural research and extension should be stabilised, and the scientific and technological achievements should be transferred to the countryside, farmers and the front of agricultural production rapidly. The policy of "to provide science and education basis for promoting agriculture development" should be further pushed on practice in order to increase the contribution of science and technology in agricultural economy development. The contribution of science and technology in agricultural development should reach to a level of more than 50% of the total increasing of agriculture in this region within a short term.

(2) To adjust agricultural policy, push on the development of the countryside roundly

The purpose of adjusting countryside policy is to impel roundly the development of countryside economy. Presently, besides of enhancement the self-organisation ability of the farmers, the agriculture policies, including the goods price policy, the agriculture production material price policy, and the policies for encouraging the transfer of science and technology to productivity, must be adjusted and perfected.

The action body in promoting the development of sustainable agriculture are the governments in different ranks. So, the governments in each rank should play the roles of adjuster and guide in making policies, laws and regulations.

Much attention should be paid to the establishment and enforcement of the policies that are benefit to strength the research, popularization and extension of agriculture science and technology, and the stabilization of the agricultural sci-technology teams.

The economical organisation model of "company + base + farmer", and the farmers professional association should be fostered and developed widely, and the agricultural production-selling-service industry systems should be established and perfected in order to ensure the increasing of farmer's benefits.

(3) To organise sci-tech research, solve the key science and technology issues of which affect the development of regional sustainable agriculture

In order to promote the development of agriculture and environment sustainably in the red-and-yellow soil hilly region of Southern China, it is suggested to establish the following research programmes and put the issues of overall importance on study:

- Food safety policy and technologic countermeasure in the hilly and mountain region of Southern China
- Strategy of comprehensive exploitation of natural resources and sustainable agriculture development in the hilly and mountain region of Southern China
- Developing models and relevant technological systems of comprehensive exploitation of natural resources and sustainable agriculture development in the hilly and mountain region of Southern China, including the follows:
  1) The sustainable national economy development models in different social-economic areas and natural ecological landscape regions.
  2) Sustainable planting and the relevant key technology systems. To exploit the exist land resource properly, to adjust farming system according to the market guidance, and to develop speciality agriculture in order to further enhance the production benefit and realise agriculture development sustainably, all of these are the important tasks for economic development in red and yellow soil region of southern China.
  3) Comprehensive control system of degraded environment, Such as comprehensive control of soil erosion, re-generating fertility of degraded soil, synthetic control of water resource, and pollution control system, and so on.
- The monitoring systems of comprehensive exploitation and environmental construction in the hilly and mountain region of southern China, including:
  1) The located monitoring system of water loss and soil erosion,
  2) The monitoring system of soil fertility,
  3) The monitoring system of the regional water resource and the fluctuation of drought and flooding in space and time,
  4) The monitoring system of soil pollution
- Suggestions on the experiment and demonstration of comprehensive exploitation and environmental construction in the hilly and mountain region of southern China,

According to the current situation of the countryside economy development, three experimental and demonstrational areas for complex agro-ecological economy development should be set up, and hence be used as the models for demonstration and extension. The first experimental and demonstration base is the one of taking off poverty and bring to wealth. It could be arranged in the poor mountain area (western of guangxi, center of Yunnan, northern west of Guizhou). By establishing comprehensive development base of high-yielding, high-quality, and speciality agriculture products, guide the people to get rid of poverty and become rich. The second experimental and demonstration base is the one of high-quality, high-yielding, and high-efficiency, three-dimensional agriculture development. It could be established in the areas which people simply have adequate food and clothing (center of Zhejiang, south-east and south of Jiangxi, north and center of Hunan). By establishing of the demo base to promote the countryside economy increasing to a higher level. The third experimental and demonstration base is the one of green-food production, foreign exchange earning, and environment protection complex. It could be arranged in the economic rather developed areas (east of Guangdong, south of Fujian, and the delta of Pearl River). By building up the demo base to further promote the development of economy sustainably.

4.5 BRIEF SUMMARY

There is a grand potential of agricultural production in the red soil hill and mountain area of Southern China. Taking a comprehensive view of the general situation, we must establish a high-efficiency, intensive, and sustainable development agriculture system gradually; must take a great consideration into the coordination among population increase (P), natural resource exploitation (R), eco-environment protection (E) and agricultural economy development sustainably (S). Based on the balance of food supplying and demanding in the whole region, the foreign exchange earning agriculture, which is with the regional characters of tropics and subtropics, including grains, cash crops, cash forests, fruits, livestock and fishery industries must be developed continually. It should take the way in the development of agricultural industry, and finally accomplish the sustainable and co-ordinate development of agriculture and social economy in the whole red and yellow soil region of Southern China.

5. PROBLEMS AND RECOMMENDATIONS ON RETURNING LAND RECLAIMED FROM LAKES AND RESTORING ECOLOGY ON THE MIDDLE REACHES OF THE YANGTZE RIVER

5.1 BACKGROUND

Historically, large-scaled reclamation of land from lakes and erection of embankments reduced sharply the areas of lakes along the middle reaches of the Yangtze River, lowered the natural flood storing capacities of the river, thus increasing the risk of floods and losses from the disasters. Since the beginning of the 1990s, frequent floods show that the cumulative effect of the damage to the ecological environment has become very evident, so much so that it has gone beyond the limit bearable by the natural ecological environment.

After the serious 1998 floods, the State Council formulated a “32-character principle”: that is, sealing up the mountains to cultivate trees, returning land reclaimed from forests, returning land reclaimed from lakes, levelling embankments to divert floods, work relief, building towns for displaced people, reinforcing trunk levees and dredging the river course. This principle has tied floods and ecological problems of the Yangtze River to sustainable development. It has no doubt laid a basic framework for thoroughly ending the flood scourge of the Yangtze.

According to the result of a questionnaire survey of 2,700 households conducted by the China Youth Development Fund and the World Natural Fund, there is some popular support for returning land reclaimed from lakes in the area. More than half of the households surveyed said that reclaiming land from lakes had more disadvantages than advantages and expressed their support for the state policy of returning land reclaimed from lakes. However, there are still obstacles to voluntary storing of floods and returning land reclaimed from lakes. Due to the government’s decision to strictly guard against floods and defend the levees to the last, local people underestimated the risk of floods and the anti-flood capability of embankments. More than half of the households surveyed showed no knowledge about safety towers and safety platforms inside the flood storing embankments and three quarters of the households surveyed did not know there was a precautionary and alarm system inside the embankments. Most

households (85%) showed worries about storing floods and they worried more about not enough compensation by the government than about no compensation at all. Over 80% of the households held that life would become insecure after returning land reclaimed from lakes. It cannot rely on administrative measures only to return land reclaimed from lakes. There should be economic means. Over half of the people showed a desire for economic compensation for returning land reclaimed from lakes and over 80% showed a desire for housing subsidies for building towns for displaced people.

Study shows that the transformation of the embankment economy should be carried out in conjunction with the building of towns for displaced people and priority should be given to returning embankment land reclaimed from lakes belonging to the common people before the reclaimed areas for flood retention are returned and lake outlets to the river are restored. At the same time, there must be an economic compensation policy for flood retention areas to display their functions and develop substitute industries. The construction of major embankments should proceed side by side with urbanization and industrialization and promote the return and transformation of land reclaimed from lakes for flood retention and for cultivation by common people and the development of substitute industries so that the Yangtze River will truly be restored to a “river of life” and display its roles in promoting sustainable development of the whole catchment area for the benefit of future generations.

5.2 MAIN VIEWS

(1) Lowering of flood storing capacities of lakes, increase in the losses from disasters, environmental pollution and other serious economic, social and ecological consequences.

The terrain of the middle reaches of the Yangtze River is relatively flat and prone to floods. The steady expansion of embankments and agricultural production has caused worsening problems. First of all, the unprecedented reclaiming and production activities around embankments have disrupted the stable ecological relations between the river and lakes, leading to deterioration of lakes and drastic shrinking of flood regulation and storage capacity and narrowing of flood diversion channels. This, plus the serious water loss and soil erosion on the upper reaches of the river due to destruction of forests, has caused silting-and changes of stream courses on the lower reaches, making flood threats more and more serious. In the 1990s, the areas affected and stricken by floods in Hunan, Hubei and Jiangxi increased by 4-6 times as compared with the 1950s. The direct consequences of frequent floods and increase in severity of floods are rapid increases in economic losses. As the social and economic level has risen steadily in the river basin, the losses in the stricken areas have risen year by year and so has the cost of disaster prevention and relief. The expansion in the scale of embankments has not only increased the economic losses inside the embankments but also posed increasing threats to the cities and towns along the middle reaches of the river. In addition, it has also caused a series of ecological problems, especially the building of embankments, which reduced the areas of wetland and caused the reduction of biodiversity. The extensive pollution from agriculture and spotty industrial pollution have made water quality of the river and lakes worse and lakes eutrophic.

(2) The comprehensive control of floods in the Yangtze River basin requires that the middle

reach areas should maintain a considerable capacity of flood regulation and storage, making the return of land reclaimed from lakes inevitable.

Experience from other parts of the world shows that it is essential to adopt comprehensive measures to control floods of large rivers. There must be flood retarding measures on the upper reaches, flood regulation and storage measures on the middle reaches and flood discharge measures on the lower reaches. There should be a combination of engineering measures, ecological construction and social and economic development. Generally speaking, the upper reaches of the river should mainly adopt such measures as planting trees and grass to increase the water containing capacity and building reservoirs in areas above the mountain foot to increase the flood regulation and storage capacity. When water flows into the middle reaches, the speed drops drastically and the flood discharge capability is reduced. Excessive floods would form lakes due to difficulty for water to be discharged in time. The drastic reduction in speed results in sedimentation. Thus the flood regulation and storage capacity of the middle reaches of the river is a crucial factor affecting the flood disaster and its magnitude. After the water flows to the lower reaches of the river, the main factor affecting a flood is the discharge capacity. The river course control and flood discharge capacity are important factors in reducing flood disasters.

The severe flood that occurred in the middle reaches of the Yangtze River in 1998 was caused, apart from abnormal weather conditions, directly by the denuding of forests on the upper reaches of the river and land reclamation from lakes on the middle reaches. The indiscriminate felling of trees on the upper reaches has reduced the water containing capacity of the vegetation, resulting in serious soil erosion and worsening the silting up of the river courses and lakes on the middle and lower reaches, thus weakening the flood discharge and storage capacities of the river. The reclamation of land from lakes on the middle reaches has reduced the holding capacity of lakes and hence its flood storage capacity, aggravating flood disasters. The 30% reduction in the holding capacity of Dongting Lake from 1949-1984 was attributed to silting up and 70% was attributed to land reclamation from the lake and the shrinking of the cross-section of the outlet at Chenglingji. The return of land reclaimed from lakes is, therefore, an important means to enhance the flood storage capacity of lakes and restore the ecological functions of the Yangtze River. It must be pointed out that the current scale of returning the land reclaimed from lakes as planned is not enough to solve the problem of inadequate flood storage capacity of the middle reaches of the river. It is, therefore, necessary to increase the land to be returned on the one hand and to fully establish the flood storage functions of the flood retention areas on the other.

(3) Anti-flood and relief policies and measures over the past 50 years have failed to control the continued development of the flood retention areas. Control of the flood disasters on the middle reaches of the river has been plunged into a freak cycle of “the more reinforcement is made, the more dangerous it has become; and the more dangerous it is, the greater efforts are made to reinforce”.

The history of water conservancy construction and flood disasters in Hunan, Hubei and Jiangxi on the middle reaches of the Yangtze River shows that although investment in water conservancy projects has increased, irrigation capacity and employment have increased steadily, the areas hit and affected by floods have assumed a trend of increase rather than being reduced. Neither has it been reduced in the flood-prone areas. What accounts for this is the increase in drainage and irrigation power, which, though, has increased the flood discharge capacity of part of the

embankments, has raised the water levels of the outer river and outer lake, thus increasing the risk of floods on the whole flood plain. And once the water levels of the outer river and outer lakes reach a certain height, it is difficult for embankments to display their flood discharge capacity.

For a long time, the main means to fight floods on the Yangtze River was to heighten and reinforce the trunk levees. However, the efforts have not made the levees secure. The Yangtze River has become a "suspension river" on the middle reaches. The 1998 flood level was 4-18 meters higher than the ground level on the banks. The height difference between the inside and outside of the river, has accumulated tremendous flood potential. These, plus the sand layer in the river course and below the levees, make it easier for piping to occur in some sections when there are hydrodynamic conditions. The higher the levees are raised, the bigger the risks of the occurrence of piping. Even if all the anti-flood levees were built with reinforced concrete, there are still risks like the 1998 Jiujiang Levee, which collapsed altogether as it, was hollowed out at the bottom. Besides, although dredging of the river course is part of the "32-character"principle, sand removal is banned in many sections of the trunk river course of the river and that has made the dredging of the river seemingly a "forbidden area".

(4) With significant resources and geographical advantages, the middle reaches of the Yangtze River should actively develop a flood type economy and wetland associated industries.

The areas along the middle reaches of the Yangtze River enjoy the advantages of rich wetland resources. The geographical advantage is that it is located in the middle of the golden waterway and the Yangtze River Industrial Belt. Its advantage industries should, apart from serving the heavy and chemical industries belt, develop a flood-associated economy, especially the four major wetland industries, namely, aquatic breeding, wetland breeding and processing, ecological tourism and seasonal grassland husbandry, in order to achieve multiple utilization of wetland. Starting from 1983, the embankment economy began to shift from mainly grain and cotton production to diversified agricultural products, giving shape to an economy characteristic of embankment land on the middle reaches of the river, which has also acquired the characteristics and trend of diversity. But economic activity is low and it needs adjustment at an accelerated speed in order to change in an all-round manner the industrial structure from mainly featuring plant culture. In this sense, the development of wetland industries may obviously lessen the pressure due to the return of land reclaimed from lakes, help transfer rural surplus labor, increase the income of local people and thus promote the return of land reclaimed from lakes.

(5) The current plan of returning land reclaimed from lakes cannot solve the problem of flood prevention on the middle reaches of the river.

According to the first phase of the program, the middle reaches of the Yangtze River (including Anhui Province) will break down embankments to let off floods, return land reclaimed from lakes and build towns for displaced people. The state has arranged 3.5 billion yuan to be used to knock down (restore) 525 embankments, build 910 villages and towns to settle 950,000 displaced people. After completion, the middle and lower reaches of the Yangtze River will increase flood storage areas by 1,530 km^2 and divert floods by 8.7 billion m^3 when big floods occur. But still it cannot solve the inadequacy of flood storage capacity on the middle reaches. For instance, if a flood like that of 1954, which had 102.3 billion m^3 in excess, occurs, the flood

storage capacity increased due to the return of land reclaimed at present would mean nothing but trying to put out a burning carload of faggots with a cup of water. In 1998, due to the break of embankments, the river regulated and stored more than 10 billion m^3 of water. If a flood like the one in 1998 occurs again, the trunk levee of the river will not only have to bear the pressure like that of 1998 but also have to seek a way out for 1.3 billion m^3 of water (assume that the land returning work is all completed). Furthermore, according to the 1999 flood situation, the maximum flow of the river at Yichang was only 57,600 m^3. According to the 1999 data from the Ministry of Water Resources, the peak flow that occurs once in five years was 60,300 m^3/s. The 1999 flood at Yichang was of normal level. But already, the level of the trunk river was the second highest since the founding of the country and the maximum level at Dongting Lake was already 3m above the warning level. It is, therefore, necessary to intensify the management of the flood storage area, gradually restore the outlets of lakes to the river in order to increase the flood storage capacity.

5.3 MAJOR RECOMMENDATIONS

(1) In returning the embankment land reclaimed by the local people, priority should be given to key areas that have a major impact on the prevention and control of floods, that is, the embankments on the islet and beaches built by the people on the main course of the river and the common embankments of the people on the outlet of lakes to the river, especially those that were broken in 1998 and 1999. All these should be restored to their original state and the people living there should be moved to other places.

Levelling the embankments and returning land reclaimed from lakes involve the life of several hundred thousand people. If these problems cannot be resolved from the roots, the policy of leveling the embankments to let off floods and returning land reclaimed from lakes could not be put in place. At present, China has already achieved initial results in “leveling the embankments to let off floods, returning land reclaimed from lakes and building towns for displaced people”, basically solving the problem of “moving out”, but the problems of the income and compensation of people that have returned land reclaimed from lakes still remain and the people moving out cannot feel secure. It is, therefore, necessary to combine the work with the building of towns for displaced people, which is a prerequisite for implementing the policy of returning land reclaimed from lakes.

(2) To restore the outlets of lakes to the river to raise the capacity of lakes to regulate the flow of the river and solve the problem of disruption of shipping during summer flood season and during winter season (way out for water).

Before 1949, there were more than 30 lakes linking with the Yangtze River from Datong upstream. But, with the implementation of reclamation and breeding projects toward the end of the 1950s and the building of sluice gates, the outlets of most of the lakes to the river were blocked. Now only Dongting Lake and Poyang Lake have outlets to the river. The lake surface area with outlet to the river has been reduced by 10595km^2, 61.4% of the original lake surface area. The Yangtze River has more and more become an “artificial canal”. Although the flood storage and land reclamation projects once played an important role in grain production on the middle reaches of the river, now it seems that the loss has outweighed the gain in terms of economic results and ecological cost. It is, therefore, necessary to return the reclaimed land and

restore the lake outlets to the river. Despite the fact that no common understanding of the problem has been achieved, the 1998 summer floods and the 1999 spring disruption of shipping service show that it is of crucial importance to restore the ecological functions of the lakes to maintain this “mother river”. Its significance and results are far more important than returning the general land reclaimed from lakes by the people. It is, therefore, necessary to do the feasibility study well.

In the process of restoring the lake outlets to the river, it is, first of all, necessary to fix the proportion of lake outlets to the river according to the needs and cost and work out the sequential order. Then, it is necessary to select proper areas for experiments and demonstration according to the actual conditions of different areas and spread the successful experience.

(3) To improve the management of the flood retention areas and economic compensation policies to promote the development of industries that will substitute for plant culture (industrial structure adjustments).

Due to population expansion and accumulation of social wealth, the flood retention areas on the middle reaches of the river have not been used actively since 1954. The current flood storage areas are in fact not real flood storage areas at all. This has made active flood storing over-scrupulous while passive flood storing entails heavy losses. For a large river, the construction of flood storage area on the middle reaches is an indispensable and important means to prevent and mitigate floods. Under the current conditions, major adjustments should be made in the development of the flood storage areas.

The construction of flood storage areas must be combined with the adjustment of the internal agricultural structure and the development of substitute industries and the management of the areas must be strengthened. Within agriculture, it is necessary to adjust the product mix, change the cropping system, such as reducing the sowing areas of long-grained nonglutinous rice, increasing the sowing areas for feed and forage crops to avoid the overlapping of rice harvesting and flood seasons. The development of substitute industries should follow multiple models according to the characteristics of different embankments, such as developing forestry and forest product processing, aquatic breeding and developing such new industries as breeding and processing of unique products and ecological tourism, which should be spread through demonstration and training and other ways.

(4) To adjust the investment structure in the middle reaches of the Yangtze River and end the policies of stressing the heightening and reinforcing of the levee to the neglect of the restoration of the ecological functions of the river (adjustment of investment structure).

In the 1990s, frequent floods have shown that the persistent implementation of the investment structure in water conservancy projects has plunged the flood prevention and control work into the queer cycle of “the more reinforcement is made, the more dangerous it has become; and the more dangerous it becomes, the more reinforcement is made”. There have been no corresponding adjustments in the investment structure in the anti-flood projects. Such investment will make flood prevention and restoration of ecology even more complicated, brewing tremendous hidden ecological dangers.

(5) To carry out experiments and demonstration in returning land reclaimed from lakes and the development of substitute industries to promote rapid development of four major wetland-associated industries.

The return of land reclaimed from lakes and the development of substitute industries affects an extensive area and a large population. It involves strict policies. There is little experience at home and abroad to borrow or apply. It is, therefore, necessary to carry out experiments and demonstrations and, through summing up experience and lessons, improve step by step the technical system and policy system concerning the returning of land reclaimed from lakes and the development of substitute industries.

The value of wetland has been underestimated for a long time. The turning of wetland into farmland has been the long pursuit in the utilization of wetland. Experience in the reclamation of wetland over the past dozens of years show that the value of wetland is not confined to grain and aquatic production. The wetland and its diversity have made it possible to develop aquatic breeding, ecological tourism, unique plant culture and breeding, grassland husbandry, forestry and forest products processing, which should form a cluster of wetland-associated industries, making the transformation of general popular embankment land, flood storage embankments and key embankments and the development of substitute industries part of a chain operation that use the floods of the Yangtze River as a precious resource.

The goal of taking the initiative to let floods into the embankments instead of shutting them out as in the past and making floods something beneficial rather than a scourge should be realized.