

# SUSTAINABLE RURAL LIVELIHOOD AND ECOLOGICAL SHELTER CONSTRUCTION IN UPPER REACHES OF CHANGJIANG RIVER —Case Study of Zhaotong of Yunnan Province

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**ABSTRACT:** Sustainable livelihood theory provides a comprehensive framework for understanding the interactions between livelihoods of peasant households and regional environment change in low-income areas. Based on field survey and 946 questionnaires from peasant household conducted in the case study area of Zhaotong, Yunnan Province, the paper has analyzed the basic characteristics of the rural livelihoods, including the asset base status, the income-generating activities, the energy consumption pattern, and the fertility behavior, in the upper reaches of the Changjiang (Yangtze) River. The micro-level findings show the conflicts among extensive agricultural development models, rural energy consumption structures heavily relying on biomass and the environment protection. The conversion of cropland to forest and grass program (CCFGP) has exerted an important influence on the livelihoods of the peasant households, but its design has given little considerations to their long-term livelihood sources, which will affect its sustainability to a great extent. From the perspective of sustainable livelihoods framework, the objectives that must be addressed in the ecological shelter construction in the upper reaches of the Changjiang River should include, first, facilitating access of peasant households to credit, technology and public services, second, encouraging the peasant households to adopt agricultural technology with environmental benefits and strengthen resources-conserving investments, and third, paying close attention to the rural energy problems and the long-term livelihood sources of the households with CCFGP. Given the weak asset base and difficulties of livelihood strategies shift, ecological shelter construction in the upper reaches of the Changjiang River will take a long time.

**KEY WORDS:** sustainable livelihood; ecological shelter construction; Zhaotong

CLC number: K901

Document code: A

Article ID: 1002-0063(2006)01-0032-09

## 1 INTRODUCTION

Ecological shelter construction (ESC) in the upper reaches of the Changjiang (Yangtze) River has been an important component of Development Program of Western China. In recent years, most of the literatures discussing the meanings and goals of ESC have been focused on the macro-level, and the scholars have conceptualized it as a comprehensive strategy to promote the sustainable development of regional economy, society and environment, in which forestry's construction and water and soil conservation are the key contents, while industry development and infrastructure construction

function as strong supports, and poverty alleviation as important guarantee (DENG, 2002; CHEN, 2002). This paper seeks to investigate the objectives and approaches of ESC from the micro-level, namely the perspective of the interactions between the livelihoods of peasant households and regional environmental change, to enrich people's understanding of this issue.

## 2 SUSTAINABLE LIVELIHOOD: FRAMEWORK FOR REGIONAL ENVIRONMENTAL CHANGE

The sustainable livelihood framework originates from the deepening of poverty attributes understanding in the

Received date: 2005-10-18

Foundation item: Under the auspices of the Fund Project of Ministry of Science and Technology of the People's Republic of China (No. 2005BA807B05)

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Another source is: WANG Wei-zhong, FAN Jie, SHENG Ke-rong, 2005. A comprehensive research on ecological shelter construction in Zhaotong of Yunnan Province[R]. Beijing: Institute of Geographical Sciences and Natural Resources Research. (in Chinese)

early 1990s, thanking to Sen, Chambers and Conway who not only studied income poverty but also put particular emphasis on development ability poverty or lack of ability to choose and finish the basic livelihood activities (ROBERTS and YANG, 2003). Meanwhile, the foundation of World Commission on Environment and Development reemphasizes the necessities of increasing the productivity of poor people's resources and creating more livelihood opportunities. Today, a lot of development organizations are using the sustainable livelihood method to design and carry out their development schemes.

Generally, a livelihood comprises the capabilities, assets (including both material and social resources) and strategies required for a means of living (Fig. 1). Livelihood strategy here refers to the activities that peasant households adopt in order to make a living, including agricultural intensification/extensification, livelihood diversification and migration, fertility behavior and energy consumption pattern. The ability to pursue different livelihood strategies is dependent on the assets that people have had in their possession, including natural resources such as land and trees, infrastructure and production tools, capital, and knowledge, skills and health status of the rural labors. Sustainable livelihoods method also emphasizes institutional environment analysis. The importance of institutions and organizations lies in that it determines the availability of different kinds of assets and provides the social fabric within which agriculture-environment interactions are conditioned. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resources base (SCOONES, 1998; KRANTZ, 2000).

The sustainable livelihoods theory provides a micro-level framework for understanding the interactions between livelihoods of peasant households and regional

environment change in low-income areas (SCHERR, 2000; SWINTON et al., 2003). The change of regional ecological environment is closely related to peasant households' livelihoods. Livelihood assets such as land, trees that farmers owned or shared with others are the direct components of natural ecosystem, and the process of asset accumulation such as soil and water conservation investments, forest plantation and more careful land husbandry is also that of environment improvement. When peasant households have more livelihood assets, they will be able to pursue more economic activities than crop agriculture, and the environmentally destructive activities such as overexploitation and deforestation will be alleviated and finally abandoned. Livelihood strategies have the direct influences on regional ecology and environment quality (XU, 2002). Migration for work, adoption of intensive agricultural technology and usage of clean and high quality energy could play positive roles in reducing the pressure of population growth on land and environment protection, while livelihoods unduly dependent on agriculture, extensive agricultural development and energy consumption pattern, and high fertility could only aggravate the man-land conflicts, which is exactly an immediate cause of the environmental problems in the upper reaches of the Changjiang River. Secure livelihoods thus become the key to sustainable utilization of natural resources and sustained success of the large environment improving programs launched by the government, and sustainable rural livelihoods should subsequently be the micro-level objective of the ecological shelter construction projects.

### 3 STUDY AREA AND DATA COLLECTION

Zhaotong is located in the upper reaches of the Changjiang River and the transitional zone from Yunnan-Guizhou Plateau to Sichuan Basin (Fig. 2). With

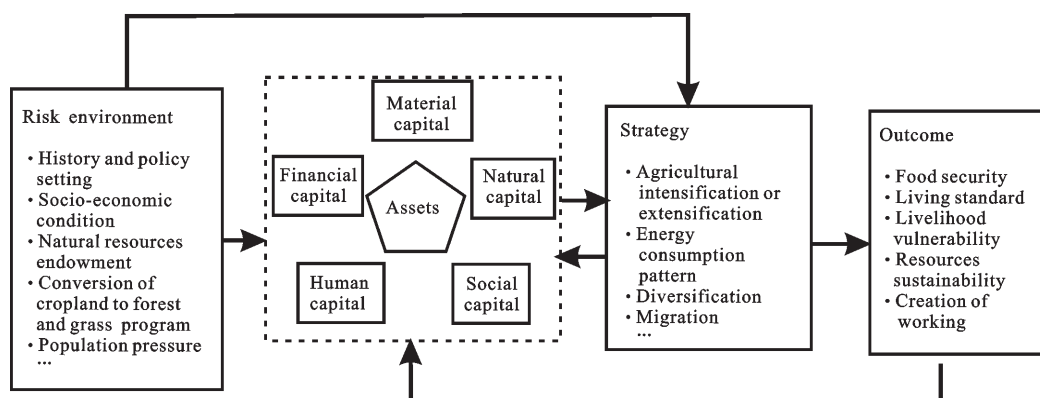


Fig. 1 Sustainable livelihoods framework

96% of its area being mountainous regions and 10% of its population ethnic minorities, Zhaotong is a typical low-income region of the western China. The topographical conditions of Zhaotong are very complicated. About 393 rivers within the territory including the Niulan River and the Daguan River pour from southwest to northeast into the Changjiang River and the Jinshajiang River. From the late 1950s, the natural forests have been depleted rapidly, and water and soil erosion area expanded. In 2002, the percentage of land affected by water and soil erosion reached 59.53%. Other natural disasters such as landslides, mud-rock flows, etc. also occurred extensively. Although its territorial area only accounts for 1.28% of the Changjiang River basin, Zhaotong, together with Dongchuan District of Kunming, is responsible for 10% of the sand deposit of it. Adverse natural environment and barren lands become the basic reason for widespread poverty in Zhaotong. The population living in absolute poverty was  $0.47 \times 10^6$ , or 9.8% of the total rural population in Zhaotong, accounting for 20% of the absolute poor of Yunnan Province. For lack of pillar industries and tax revenue sources, the local governments at all levels are suffering from finance deficiency and cannot invest in environment constructions on a large scale.

Following the criteria that fieldwork should cover different geographical conditions, ten natural villages (Shoushan, Ganhai, Tiechang, etc.) in Daguan County and Ludian County were finally selected. A questionnaire survey of 1000 peasant households was conducted in August 2005, and 946 valid questionnaires were collected. Both qualitative and quantitative methods were involved in the survey. According to the physical geography conditions, the sampled households can be divided into two major categories, those living in mountainous regions (847 households) and those in flat districts (99 households). The flat district here is designated by a capital letter F. Households in mountainous regions were divided into three classes. About 293 households lived in river valley districts (designated by V) with an height of 1.2- 1.6km above sea level, 221 households lived in middle mountainous districts (M) which averages 1.6- 1.8km, and 333 households lived in high and cold mountainous districts (H) with an height of above 2.0km. In the whole sampled households, 196 were ethnic minorities, accounting for 20.7% and 56 participated in CCFGP, accounting for 6.94%. Using quartile method, the 946 households have been grouped into four equal-sized sets based on their total income per year : the

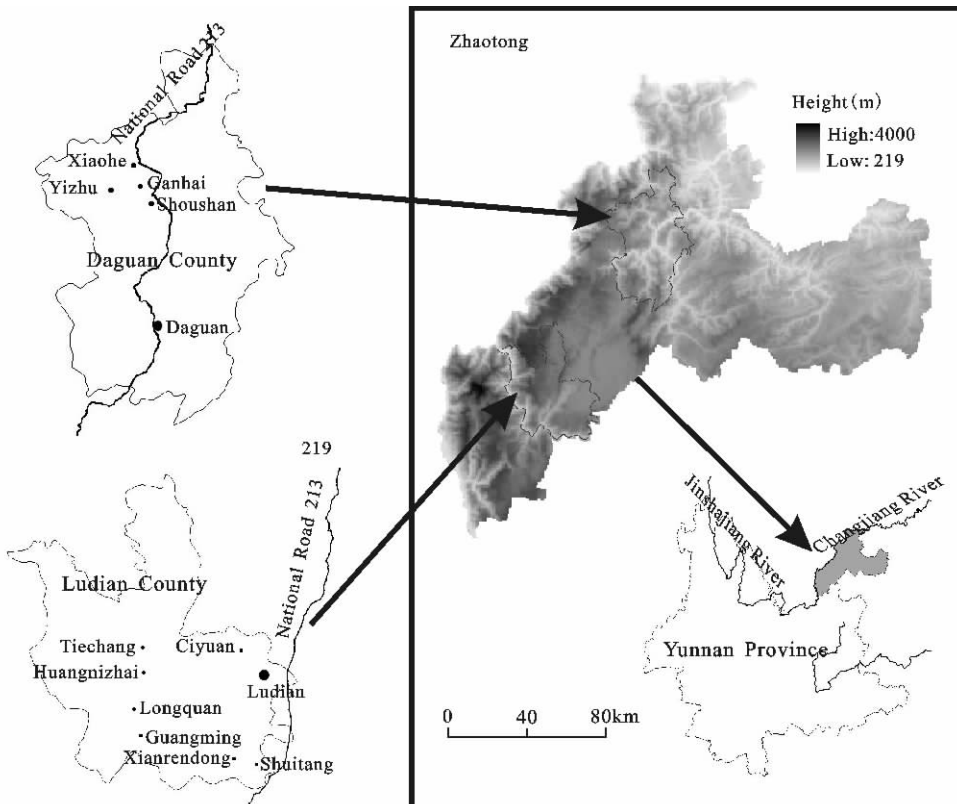


Fig. 2 Location of Zhaotong and study villages

In total income calculation, maize, rice and wheat are all 1.35 yuan(RMB)/kg, potato 0.36 yuan/kg, pig 7.00 yuan/kg, pork 9.20 yuan/kg according to recent market prices. The quartiles of those are 4100, 5891 and 9000 yuan, respectively.

highest income quartile ( ), the medium highest income quartile ( ), the medium lowest income quartile ( ), and the lowest income quartile ( ).

#### 4 RURAL LIVELIHOOD AND ITS IMPACTS ON ECOLOGICAL ENVIRONMENT

##### 4.1 Asset Status and Implication on ESC

Land, livestock, and labors are the main livelihood assets of the peasant households in the study area (Table 1). For the sample as a whole (946 households), the cultivated land ownership per household was relatively high and averaged 0.26ha. Unfortunately, the water conservancy conditions were poor, with non-irrigated farmland comprising 89%. Most of the study areas, except the flat district of Ciyuan Village, are suffering from heavy losses of topsoil as a result of water and wind erosion. Land productivity, especially that on the steep slope in middle or high mountainous districts, is very low. So, although the cultivated land owned by the households living in high and cold mountainous districts were 0.222ha higher than those owned by the households in river valley districts respectively, there existed small differences in land holdings across the income ranges. Livestock holding is a distinct mark for doing better in rural Zhaotong. Peasant households in the lowest income quartile had 0.21 head of cattle, 0.38 goats and 1.87 pigs on average, while those in the highest income quartile had 0.64 cattle, 1.56 goats and 3.54 pigs. Households in the river valley districts and high mountainous districts had relatively more livestock holdings, showing that development of animal husbandry industry is influenced mainly by availability of credit and feed and accessibility of markets. Labor are relatively abundant, with each household having 3.12 persons employed on average. Total income was positively related to household size. Households in the top quartile had 3.83 labors on average, while the bottom

quartile averaged 2.14 labors. But the years of labors' education were fewer, and there were minor differences among the income ranges. As a whole, the asset base of households in the upper reaches of the Changjiang River is very weak, and the man-environment conflict is serious.

More importantly, because the development of local production material markets is lagged behind, the peasant households could not get access to necessary credit and technology. For example, micro credit projects have been proved to be an effective way to resolve the difficulties of households' livelihoods, but the number of the branch outlets of Agricultural Bank of China, which has recently been adjusting its development strategy in rural China, was reduced from the peak of 59 to 2 in the year 2004 in Zhaotong, resulting in the loss of institutions operating micro-lending. When the households were asked, "what are the most urgent things that you want the government to help you to do (three items at most)?", 52% of households replied they would want the government to provide production capital, 35% would want agricultural technology, 32% want education for their children, and 22% want means of agricultural production. Given these difficulties, the accumulation process of livelihood assets in the upper reaches of the Changjiang River will be very slow, and ecological shelter construction should also be regarded as a long-term task.

##### 4.2 Household's Livelihood Strategies and Their Environmental Impacts

###### 4.2.1 Income generating activity

Overall, agriculture is the main livelihoods activity and income source of peasant households. Crops (wheat, maize, buckwheat, potatoes and corn) and livestock (cattle, goats and pigs) provided 68% of the total income on average. Especially for households in the low-income quartile, the percentage of agriculture was up to 94%

Table 1 Asset composition of peasant household in 2004

		Cultivated land (ha)			Forest-land (ha)	Livestock (head)			Labor	
		Irrigated	Dry	Paddy		Cattle	Goat	Pig	Number	Year of education
Income quartile		0.004	0.23	0.005	0.113	0.21	0.38	1.87	2.14	4.92
		0.017	0.21	0.017	0.110	0.35	0.60	2.91	3.32	4.89
		0.016	0.21	0.018	0.092	0.51	0.85	3.06	3.45	5.13
		0.013	0.26	0.026	0.125	0.64	1.56	3.54	3.83	5.12
Geographic condition	F	0.019	0.13	0.076	-	0.57	-	0.36	3.21	4.32
	V	0.009	0.19	0.002	0.003	0.45	0.51	4.01	3.01	5.32
	M	-	0.20	-	0.023	0.17	0.36	2.46	3.52	4.84
	H	0.025	0.37	0.025	0.293	0.54	1.71	3.41	2.97	4.73
Average		0.012	0.23	0.017	0.110	0.43	0.84	3.05	3.12	4.98



(Table 2). But because the soil productivity is very low, most peasant households had to resort to agricultural extensification to ensure their own food security. Statistics show that when the families were asked "do you think that ecological environment is important?", 36% of families replied that ecological environment is very important, 43% replied important. But when families were asked "have you taken into account the environment impacts when you selected economic activities?", 56% said they occasionally considered the environment impacts, 27% said not at all. The extensive management of natural resources forms the basic reason why the regional ecological environment has been severely degraded.

Relatively, the livelihood strategies are more diversified for households in level ground and river valley districts (Table 2). Households in the flat districts have the tradition of doing business, so the income from non-farm self-employment occupied a high proportion. In the income structure of households of river valley districts, livestock breeding and waged work exceeded farming. So the conflicts between rural livelihoods and ecological environment in the two districts are relatively weak. However, the livelihood-environment conflict is acute in middle mountainous district and high mountainous district, owing to the fact that households there get less income from other activities than agriculture. The peasant

Table 2 Income structure of household in 2004 (yuan)

		Income from self-employment			Wages	Transfer	Total income
		Farming	Livestock	Non-farm			
Income quartile		1312.78	1234.49	51.02	268.80	58.67	2715.30
		2069.49	1841.78	143.39	754.72	87.58	5004.09
		2937.72	3141.53	401.60	1414.44	11.06	7318.59
		3915.30	3181.29	1099.84	4045.17	1097.13	13512.97
Geographic condition	F	4543.33	1022.72	1993.23	625.25	1597.98	10734.04
	V	2294.02	2627.89	624.67	3231.46	245.03	9043.17
	M	1869.69	2104.76	14.16	1489.94	59.42	5568.74
	H	2635.99	2787.62	154.85	752.25	217.18	6557.98
Average		2551.76	2395.82	430.49	1682.93	333.99	7264.32

households want urgently to increase their income through livelihoods diversification and intensive land management. When they were asked "which activities do you think can most improve your living standard (select 3 items at most)", 58% of households selected raising more livestock, 52% selected strengthening land investments, 41% selected migration for work. But the pursuit of these livelihood strategies was also heavily restrained by the weak livelihood assets base. For lack of production capital and technology, and with the improvement of agriculture input prices, peasant households had little ability to maneuver for activities such as land improving investments, livestock breeding in barns, etc. Restricted by labors' quality, 78% of the population migrated away for temporary jobs were engaged in simple manual works, and the monthly income averaged only 300 yuan (RMB). The increase of income from local waged jobs was closely related to the massive government's investments in roads, power station, etc. after implementing of the Development Program of Western China in 1999, and there is no strong evidence to support that such a trend will continue for a long time.

4.2.2 Rural energy consumption pattern

Rural household expenditure on energy consumption per

capita was 90.65 yuan in 2004, accounting for 5%- 7% of the annual total income. The ecological environment impacts of peasant households' energy consumption pattern were manifested in two aspects in Zhaotong. That is, two-thirds of the straw production were used for cooking fuel, resulting in declines in soil nutrients and fertility, and half of the fuel wood consumption was obtained through over-exploitation, resulting in ecology destruction and water loss. The fuel wood and straw consumption in 2004 amounted to 913.07kg of standard coal equivalent (ce), or 44.29% of domestic energy consumption. This proportion was up to 69.62% and 81.97% for peasant households in the lowest quartile and high mountainous regions respectively (Table 3). Because there is an abundant coal endowment in Zhaotong, coal constituted the principal part of domestic energy consumption for the sample as a whole, mainly used for cooking, flue-curing tobacco and pig-feed heating. But with the enforcement of the national policy of closing small coalmines and improvement of transport costs, the coal price in markets rose from 120 to 150 yuan/t in 2004 to 300 yuan/t in 2005. It will increase the dependence on biomass energy of rural households, especially those with low income and those distant from markets.

Table 3 Energy consumption structure of peasant household in 2004 (kgce)

		Straw	Coal	Biogas	Electricity	Fuel wood	Leaf and grass	Total
Income quartile		241.14	537.59	8.12	27.93	1169.40	69.56	2053.74
		409.67	1001.62	16.24	46.54	319.48	44.87	1838.43
		392.29	1308.83	48.03	65.16	302.95	4.86	2122.13
		323.55	1516.34	48.34	93.09	531.41	3.78	2516.51
Geographic condition	F	205.52	2233.06	16.25	55.85	0.00	89.21	2599.89
	V	411.74	1338.04	72.16	83.78	94.73	3.57	2004.01
	M	548.11	1282.20	40.36	65.16	65.93	17.15	2018.92
	H	164.94	369.01	0.00	37.24	1513.86	0.00	2085.05
Average		335.14	1077.55	40.54	55.85	55.85	30.15	2117.17

Notes: 1. The standard coal equivalent coefficients for straw, coal, electricity, fuel wood, leaf and grass are 0.485kgce/kg, 0.714kgce/kg, 0.404kgce/kWh, 0.571kgce/kg, 0.361kgce/kg; 2. An 8m<sup>3</sup> biogas plant can produce 400m<sup>3</sup> biogas per year, which roughly amounts to 800kgce

The pressure on ecological environment protection will therefore be intensified. Development of biogas, which includes the rebuilding of an animal barn, a toilet and a kitchen besides the construction of a biogas plant, is an effective way to improve peasant households' livelihoods. The total investment in the construction of a biogas plant with a volume of 6- 8m<sup>3</sup> is about 3000 yuan, but the subsidy provided by the national government is only 1000 yuan. For lack of investment, biogas development has made little progress, and the proportions of biogas users in each income quartile, different geographic locations and ethnic groups were all very low.

#### 4.2.3 Fertility behavior

In the environment that livelihood assets are poor and agriculture dominates income sources, high fertility rates become an important means for peasant households to improve their welfare and reduce the risks. For the whole sample, each household had 4.58 persons on average, while in the top income quartile each household had 5.12 persons. Population growth has diminished the per capita resources. To satisfy their basic necessities of food and fuels, the peasant households were forced to expand farming into marginal lands, leading to deforestation and further degradation of the vulnerable ecological environments. The downward spiral between population growth and environment degradation was formed. When the households were asked about "what are the main reasons for local environment problems (select 2 items at most)?", 53.27% selected the item of rapid population growth, 42.28% selected agriculture expansion into marginal lands, 36.15% selected over-exploitation for fuel woods. Fortunately, with the enforcement of family planning policy, particularly the increase of children raising costs, the fertility attitude of the peasant households in the study areas was changing. When asked "if the government takes away the birth control, would you like to have more children?", most (76%) of the house-

holds answered no. But the study areas had a very young population, the people under the age of 24 accounting for 43.82%. The population size will be further enlarged over time, which will increase the pressure on natural resources.

#### 4.3 Livelihood and Sustainability of Conversion of Cropland to Forest and Grass Program

Conversion of Cropland to Forest and Grass Program (CCFGP), as one of the main campaigns launched by Chinese government to protect ecological environment, has exerted an important influence on the peasant households' livelihoods in the upper reaches of the Changjiang River. On one hand, the program changed the land use pattern of the participating households. There are 56 households participating in the program in the whole sampled households, and the average cropland area converted into forest per household was 0.072 ha, or 10% of the total cultivated land. The change of land management practices has played a positive role in ecological environment construction. About 32% of households sampled in the area where CCFGP was carried out replied that the environment quality has been improved obviously after CCFGP, and 50% replied there was some improvement. On the other hand, the program caused a direct increase in the rural household income at least in a short time. First, the subsidies of the government are more substantial. Before CCFGP, the total income from cultivated land per hectare was 1575 yuan on average, while the household could obtain a net income of 3900 yuan in the form of grain and cash subsidies from 1ha converted land after participating in the program. Second, CCFGP expanded the space and time for farmers to engage in off-farm or non-farm activities. Calculated on the assumption that 300 man-hour can be saved for 1ha converted land per annum and the income from off-farm jobs per man-hour is 10 yuan, household could increase

their net income by 3000 yuan for 1ha converted land per annum.

But most of the program participants were worried about their livelihoods after 5-8 years when the payment of subsidies expires. First, the program has decreased farmers' self-sufficiency in food. When asked about "if the subsidy payment expires, would the grain production be self-sufficient?", 75% of households replied no. Food security of the participating households constitutes the main risk of CCFGP. Second, though the economic forests, after the growth period of 3 years, could generate more income than cropping if managed well, the proportion of economic forest is very low relative to the ecological forests in the study area. As 71% of households surveyed said, it is difficult to anticipate whether forestry could bring steady income after the program is ended. Third, it is also worth noting that the rise in domestic grain price will become a potential threat to the fodder supply and hence the animal and poultry industry development. Once the fodder price goes up, it would block the households to adopt the barn-feeding livestock development mode that the government has always advocated, and livestock foraging on pasture would only tension the pressure on rangeland. Finally, although after CCFGP, the participating households has to differently extent diversified their livelihood sources, and many surplus labors were transferred into animal and poultry husbandry industries or migrated away for temporary waged jobs, the consideration of creating more off-farm opportunities in the program design was obviously insufficient. As many scholars have pointed out, the sustainability of CCFGP depends on the food security and income increase of participating households, besides the continuation of national policy (DONG and ZHONG, 2005; XU et al., 2004). If this is not the case in the upper reaches of the Changjiang River, there is a risk that once the payment of subsidies expires, short term expedient returns will be preferred over long term (if somewhat larger) returns and the land use changes achieved will be reversed.

## 5 KEY POINT OF ESC: FROM SUSTAINABLE LIVELIHOOD PERSPECTIVE

### 5.1 Strengthening Livelihood Asset Base of Peasant Household

ESC in the upper reaches of the Changjiang River should firstly improve the institutional arrangements and enhance the access by the households to credits, technology and other public services. Micro-credit is an effective way to provide the households with necessary capital to

pursue more profitable activities. On one hand, micro-lending organizations should be appointed and credit sources be guaranteed. The Rural Credit Cooperatives, as the only financial institution with branch outlets extending to most villages after the change of rural financial landscape, can act as the micro-lending organization. And the credit used for micro-lending should be provided by the government in the form of anti-poverty funds rather than collected by Rural Credit Cooperatives. On the other hand, the households involved in the micro finance programs should also be trained in appropriate cropping and animal husbandry technology as well as non-farm techniques. Availability and usage of modern inputs is the key factor to lasting growth of rural economy (SCHULTZ, 1963). So the development and promotion of appropriate technology can enable the farmers to make advantages of existing or emerging economic opportunities.

Infrastructure construction is another important aspect of strengthening livelihood assets. The government should encourage and induce the households to investing in cultivated land, besides the endeavors to build large water conservancy facilities, road networks and electronic grids, etc. through programs of work for food. Especially in the areas affected heavily by soil erosion, conversion of slop land into terrace is crucial to the production increase of crops. A large body of literature has revealed the positive linkage between security of tenure over the land and investment in land improvements by peasant households. So the imperative for the Chinese government is to ensure that farmers' rights over the CCFGP land are well defined and protected, so as to form an institutional environment in favor of resources-improving investments.

### 5.2 Improving Strategy of Household's Livelihood

Contributing to re-establishing human-natural harmony, ecological agriculture is a small agricultural system that is ecologically self-sustained, economically viable, and aesthetically pleasing, which seeks to optimize skills and technology to achieve long-term stability of the agricultural systems, environmental protection and food safety. In ecological agriculture systems, locally available organic inputs are being promoted to complement or substitute for expensive purchased fertilizers, thus lightening the burden of peasant households and improving the soil fertility. Ecological agriculture development in the upper reaches of the Changjiang River could be integrated into biogas construction programs. And several food chain production models, such as "pig-biogas-grain/fruit", "pig-biogas-vegetable", "cattle-biogas-pig-grain/

grass", etc. could be extensively adopted. Migration is a direct way to diversify households' livelihoods and reduce the pressure of population growth on natural resources. There exist multiple opportunities for governments and non-government organizations to help the rural residents to go out to work as temporary laborers. They could provide training to the migrants, particularly to those in the lowest income quartile and in high mountainous districts as well as those graduated from high or junior middle school. Focus of training could be aimed at the industries with higher income, such as housekeeping, food and beverage, hotel, health care, building, and machine repair. In addition, the government should strengthen the organization and management of migrants, and ensure their legal rights.

### 5.3 Taking Measure to Satisfy Energy Demand of Household

Rural energy construction should be strategically regarded as an important component of ESC in the upper reaches of the Changjiang River. On one hand, coal is of great significance in improving peasant households' energy consumption structure and hence the ecological environmental quality, so the national policy of closing small coal mines should not be rigidly uniformed across regions. In the low-income western regions, the governments should foster some small township and village owned coal mines that are scientifically managed in order to mitigate the negative effects of biomass burning. And effective measures should also be taken to ensure that farmers could get coal from local small coal mines. On the other hand, with the introduction of CCFGP and the enforcement of closing hillsides to facilitate afforestation, peasant households are in urgent need of a new kind of energy as a replacement of coal and firewood. Biogas, a regenerative biological energy with relative small investment and rapid returns, has more promising prospect compared to electricity and liquefied petroleum gas. The central government should provide more financial subsidies to biogas plant, and regard it as a priority in rural energy construction.

Given the regional disparity of resources, environment and transport conditions, 3 models of rural energy development could be proposed. The first is developing biogas as the principal energy source and coal as the complementary. This mode is mainly applied to the river valley districts, middle mountainous districts and flat districts. For these districts, crop agriculture dominates the households' livelihoods and the crop residuals are abundant. Meanwhile, because of the relative low altitude, biogas plant can work for a year-round time. The second

is developing coal as principal energy and firewood as subsidiary. The mode is most suitable for the regions where coal is abundant or traffic is convenient. The third model is developing firewood as principal energy and coal as complementary. This model could be applied to the high and cold mountainous districts. Along with firewood plantation, the fuel-saving stoves should be promoted.

### 5.4 Ensuring Livelihood Security of Household Participating in CCFGP

Livelihood security of CCFGP participants is key to the sustainability of the program. If the achievements of CCFGP are to be continued after the subsidy payment expires, the food security and income sources of the participants must be carefully addressed, so as to protect peasant households' long-term livelihood. Some proposals are as follows: to promote agricultural technology with environmental benefits to ensure the food security; to introduce the tree species featured short cycle and higher output value, and to quicken the development of bamboo and fruit processing industries to increase the household income; to foster and develop labor markets to facilitate the transition of the surplus labors to non-farm activities.

Transfer payments can internalize the externality benefits of environmental protection and hence provide households economic incentives for conservation management or investment. At present, CCFGP and other environmental protection investments come mainly from national debt fund and budgetary allocation. The forest ecological benefit compensation scheme across the whole drainage area of the Changjiang River therefore should be established as soon as possible through collecting fees from those enterprises and individuals in the lower reaches according to the principle of whoever benefits pays. Institutional challenges that must be addressed include fair negotiation of terms of trade, adapt mechanisms for payment transfers, credible and low cost monitoring and fair payment distribution (SCHERR, 2000).

## 6 CONCLUSIONS

The results of field survey and data analysis have revealed the basic characteristics of peasant households' livelihoods and their environmental impacts in the upper reaches of the Changjiang River. The asset base including land and livestock was weak, and the households lacked access to modern production factors such as capital, technology, etc. In order to make a living, the households were forced to raise more children and over-ex-



exploit the natural resources for food and fuel necessities. Also there is the fact that extensive agriculture dominated the household income generating activities, and biomass remained a principle energy source. In nature, the conflict between economic development and environment protection is caused to a great extent by the heavy reliance of the households' livelihoods on natural resources, or the conflict between livelihoods and environment. To combat environmental degradation, the CCFGP was introduced by the central government in 1999, which has improved the environment quality. Although the CCFGP participants were satisfied with the subsidy policies, their long-term livelihood sources did not get enough attention, which will influence the sustainability of the program. At the micro-level, the livelihoods of peasant households must be addressed in ESC in the upper reaches of the Changjiang River. First is to develop micro credit to enhance the access of the households to capital, technology and other public services. Second is to ensure secure land tenure to induce the households to making necessary investments for resources conservation and improvement. Finally, the governments should pay close attention to the problems related to rural energy consumption and the long-term livelihoods of CCFGP participants. Given the weak asset base and difficulties of livelihood strategies shift, it is safe to conclude that ecological shelter construction in the upper reaches of the Changjiang River will be a long-term task.

## ACKNOWLEDGMENTS

I would like to thank Zhaotong Municipal Government, Dagan County Government and Ludian County Government for their help in the fieldwork and questionnaire surveys.

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