Livelihood Capital and Livelihood Diversification for Different Farmers in Yuanjiang Dry-Hot River Valley

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Abstract Under the analytical framework of sustainable livelihoods, we establish the evaluation indicator system for farmers' livelihood capital, to evaluate the current livelihood capital and livelihood diversification for different farmers in the Dai nationality region of Xinping County in the Yuanjiang dry-hot river valley area, and discuss the relationship between livelihood capital and livelihood diversification. Studies have shown that the mode dominated by agriculture, supplemented by non-agricultural activities, combined with breeding, is the commonly used livelihood strategy for farmers in this region. As farmers change from pure agriculture to non-agriculture, their total livelihood capital and non-agricultural livelihood diversification index will increase, while agricultural livelihood diversification index will decrease. In the meantime, their livelihood activities gradually shift from agricultural to non-agricultural ones, which is mainly reflected in the combination of both agricultural and non-agricultural activities. Regression analysis on livelihood capital and livelihood diversification shows that natural and physical capital is the basis of realizing agricultural livelihood diversification. Farmers with rich natural and physical capital will prefer agricultural livelihood strategies. While financial and human capital is the driving force for farmers' transition from pure agriculture to non-agriculture.

Key words Livelihood capital, Livelihood diversification, Regression analysis, Yuanjiang dry-hot valley

1 Introduction

Livelihoods analysis has become a new perspective for the developing countries and regions to observe and research sustainable development of farmers' livelihood and sustainable use of natural resources in the ecologically fragile areas[1]. Farmers are the most important economic entities and the most basic decision-making units in the vast rural areas, and their livelihood capital is the basis of livelihood activities taken by them[2]. As the basis of farmers' livelihood structure, livelihood capital determines the choice of farmers' livelihood means and livelihood activities that may be taken[3]. Under different conditions of livelihood capital, farmers' livelihood activities show diversity and differences[4], reflected in the combination of agricultural and non-agricultural livelihood activities. Livelihood diversification is the strategy commonly taken by many developing countries and regions, and plays an important role in increasing livelihood capital and withstanding livelihood risks[5-6]. The studies of many scholars show that increasing farmers' livelihood capital, and improving farmers' non-agricultural employment ability and governmental assistance, are important tools to achieve livelihood diversification and prevent risks[7-10]. However, currently, most studies of livelihood capital focus on the assessment of different types of capital (*i.e.* natural, human, physical, financial and social capital), as well as analysis of the status of livelihood diversification, and lack quantitative analysis on the relationship between livelihood capital and livelihood diversification, thus unable to explain the intrinsic link between livelihood capital and agricultural or non-agricultural livelihood diversification. Therefore, taking Yuanjiang dry-hot river valley, a typical ecologically fragile area, for example, we analyze the current situation of farmers' livelihood capital, agricultural and non-agricultural livelihood diversification in the river valley of Xinping County. On this basis, we establish multiple regression model to explore the relationship between livelihood capital and agricultural or non-agricultural livelihood diversification, in order to provide a reference for the sustainable use and development of farmers' livelihood capital in the study area.

2 Overview of the study area and data sources

2.1 Overview of the study area Yuanjiang dry-hot river valley is located in the central and southern part of Yunnan Plateau, at the end of the Ailao mountains and Liuzhao mountains, with a total area of 2757 km^2. It has the landform deeply cut by river, and there are high steep mountains and deep valleys[11]. The dry-hot valley is mostly distributed in the Yuanjiang River basin below 1000 m-1400 m as well as the hilly terraces of its tributaries. Xinping County is in the eastern foothill of the middle Ailao Mountains, with a total area of 4223 km^2. The terrain, dominated by mountains, is high in the northwest but low in the southeast. The area of mountains is 4139.6 km^2, accounting for 98%, and the area of basin is 83.4 km^2, accounting for 2%. Affected by altitude differences, three kinds of three-dimensional climate zones (valley high-temperature zone; mid-warm temperate zone; alpine cold zone) are found, with the average annual temperature of 18.1℃ and annual rainfall of 869 mm. It is inhabited by many ethnic groups such as Yi, Dai, Hani, Lahu, Hui, Miao and Bai. In the valley area, Dai people's traditional livelihood is based on terraced rice planting and livestock breeding, supplemented by

Received: December 15, 2015 Accepted: February 23, 2016
Supported by National Social Science Foundation (13BMZ059); Young Teacher Training Program in Yunnan University (XT412003).
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picking, fishing and hunting. Their cash income mainly relies on farming and breeding, and after the development of the hot zone, the modern agriculture characterized by sugarcane, tropical fruits and early winter vegetables is vigorously developed.

2.2 Data sources In this study, we use semi-structured interviews and questionnaires to collect data from the typical villages in Yuanjiang dry-hot river valley. Based on the criteria of economic development level, ethnic composition and religious beliefs, we select three Dai villages (Manle, Xinzhai and Modao) in the valley area, and collect a total of 287 valid questionnaires. The content of questionnaire is as follows: (i) natural capital, including the contracting area and per capita acreage of paddy field and dry land; (ii) human capital, including total family population, employees, labor force, number of students, school-age children, number of the elderly, education level, education and medical expenses; (iii) physical capital, including breeding, housing and number of machines per capita; (iv) financial capital, including planting income, breeding income, non-agricultural income and opportunities of access to credit; (v) social capital, including betrothal gift expenditure, participation in community rites, current agricultural and non-agricultural livelihood activities, and future livelihood plan.

3 Research methods

3.1 Calculation of livelihood capital (i) Selection of indicators. According to the classification of livelihood capital[12] under Sustainable Livelihood Approach Framework developed by DFID (Department for International Development) as well as previous quantitative researches on livelihood capital[13-14], we adjust the indicators based on field survey, and build the suitable measurement indicators on farmers' livelihood capital in Yuanjiang dry-hot valley (Table 1). (ii) Determination of weight. According to the survey data, we use entropy method[15] to perform weight assignment on each indicator based on normalizing the raw data, and the results are shown in Table 1. (iii) Calculation of livelihood capital. We use the normalized data and weights on various indicators to constitute a weighted composite standard model and calculate the total value of farmers' livelihood capital, and the results are shown in Table 2.

Table 1 Measuring indicators and weight for farmers' livelihood capital

Types of capital	Symbol	Weight	Measuring indicators	Symbol	Weight	Types of capital	Symbol	Weight	Measuring indicators	Symbol	Weight
Natural capital	N	0.298	Per capita paddy field area	N_1	0.127	Physical capital	P	0.208	Number of livestock and poultry	P_1	0.060
			Per capita dry land area	N_2	0.051				Types of housing	P_2	0.120
			Per capita acreage of paddy fields	N_3	0.083				The number of machines per capita	P_3	0.028
			Per capita acreage of dry land	N_4	0.037	Financial capital	F	0.224	Per capita household income	F_1	0.090
Human capital	H	0.210	Overall household labor capacity	H_1	0.061				Per capita net income	F_2	0.093
			Education level of adult labor	H_2	0.021				Bank loan	F_3	0.041
						Social capital	S	0.060	Leadership potential	S_1	0.024
			Investment in education	H_3	0.090				Betrothal gift expenditure	S_2	0.020
			Medical expenses	H_4	0.038				Participation in community activity	S_3	0.016

3.2 Calculation of livelihood diversification index We use agricultural livelihood diversification index and non-agricultural livelihood diversification index to measure. The type of livelihood activities that each family is engaged in is regarded as the agricultural livelihood diversification index[16]; the type of non-agricultural livelihood activities that each family is engaged in is regarded as the non-agricultural livelihood diversification index. Finally, we take the average of different farmers' agricultural livelihood diversification index and non-agricultural livelihood diversification index[17].

$$S = (S_1 + S_2 + S_3 + \cdots + S_i)/n \quad (1)$$

where S_i is the livelihood diversification index of farmer i; n is the number of samples; S is the livelihood diversification index of farmers in the study area.

3.3 Classification of farmers Based on field survey, questionnaire survey and small-scale seminars, we classify the farmers in the study area by learning from the previous research results[10, 16]. First, according to their participation in non-agricultural livelihood activities and non-agricultural income, farmers are divided into pure agricultural and non-agricultural ones. Second, according to the proportion of non-agricultural income to total income, the non-agricultural farmers are subdivided into agriculture-dominant type (non-agricultural income accounting for less than 50% of total income), non-agriculture-dominant type (non-agricultural income accounting for more than 50% but less than 90% of total income) and non-agricultural type (non-agricultural income accounting for more than 90% of total income).

3.4 Establishment of multiple regression model Multiple regression is regression analysis with more than one independent variable. It is used to quantify the influence of two or more independent variables on a dependent variable[18]. The multiple regression model is as follows:

$$y_a = \beta_0 + \beta_0 x_{1a} + \beta_2 X_{2a} + \cdots + \beta_k X_{ka} + \varepsilon_a \quad (2)$$

where $\beta_0, \beta_1 \cdots, \beta_k$ are the parameters to be determined; ε_a is the random variable.

The regression estimated equation is as follows:

$$\hat{y}_a = b_0 + b_0 x_{1a} + b_2 X_{2a} + \cdots + b_k X_{ka} + \varepsilon_a \quad (3)$$

where b_0 is a constant; $b_1, b_2, \cdots, b_k$ are partial regression coefficients, which are used in the context of multiple linear regression analysis and give the amount by which the dependent variable in-

creases when one independent variable is increased by one unit and all the other independent variables are held constant. In this study, with agricultural livelihood diversification index ($\hat{y}_1$) and non-agricultural livelihood diversification index ($\hat{y}_2$) as the dependent variables, natural capital, human capital, physical capital, financial capital and social capital as the independent variables, we establish the multiple linear regression model. X_1 represents natural capital; X_2 represents human capital; X_3 represents physical capital; X_4 represents financial capital; X_5 represents social capital; b_i represents partial regression coefficient.

4 Results and analysis

4.1 Different farmers' livelihood capital In terms of the livelihood capital index values, different types of farmers show a clear regularity (Table 2): non-agricultural farmers > agriculture-dominant farmers > pure agricultural farmers > non-agriculture-dominant farmers. The larger the value of human capital and financial capital, the lower the degree of agricultural livelihood diversification, the higher the non-agricultural degree; the larger the value of natural capital, the higher the degree of agricultural livelihood diversification, the lower the non-agricultural degree. From the proportion of farmers with different livelihood types to total samples, it can be found that currently the majority of farmers' livelihood strategies are still dependent on farming and breeding in the study area. Agriculture-dominant farmers occupy the largest proportion (47%), followed by pure agricultural farmers (35%), non-agriculture-dominant farmers (15%), and non-agricultural farmers (3%).

4.2 Livelihood diversification of farmers with different livelihood types In terms of livelihood diversification index for different farmers, it is in the order of non-agriculture-dominant farmers > agriculture-dominant farmers > pure agricultural farmers > non-agricultural farmers. Meanwhile, in the transition from pure agricultural to non-agricultural farmers, the agricultural livelihood diversification index decreases gradually, while the non-agricultural diversification index increases gradually; farmers' livelihood activities gradually shift from agricultural ones to non-agricultural ones. Specifically, pure agricultural farmers are exclusively engaged in agricultural livelihood activities; agriculture-dominant and non-agriculture-dominant farmers are engaged in both agricultural and non-agricultural livelihood activities; while non-agricultural farmers are only engaged in off-farm activities. In terms of the livelihood capital endowment of various types of farmers, as the farmers shift from pure agricultural to non-agricultural sectors, their livelihood capital is rising overall.

Table 2 Different farmers' livelihood capital and livelihood diversification index

The farmers with different livelihood types	Livelihood diversification index			Livelihood capital					Total	Share//%
	Agriculture	Non-agriculture	Total	*N*	*H*	*P*	*F*	*S*		
Pure agricultural farmers	3.778	0.000	3.778	0.992	0.571	0.650	0.632	0.174	3.019	35
Agricalture-dominant farmers	3.488	1.440	4.929	0.927	0.637	0.647	0.682	0.193	3.085	47
Non-agriculture-dominant farmers	3.095	1.857	4.952	0.833	0.651	0.640	0.690	0.192	3.006	15
Non-agricultural farmers	0.750	2.000	2.750	0.671	0.723	0.685	0.792	0.201	3.072	3

4.2.1 Livelihood diversification of pure agricultural farmers. For pure agricultural farmers, they are only engaged in agricultural livelihood activities, and depend on the planting of rice, vegetables, sugarcane and fruits as well as the breeding of pigs, cattle, chickens, ducks and geese. And planting is the main source of income, accounting for more than 80% of total income. There are some differences in the specific combination of livelihood activities between villages. In Manle Village, the planting of "rice + balsam pear + Capsicum frutescens + cowpea + banana" is combined with breeding. The farmers take the planting of balsam pear, Capsicum frutescens, cowpea and banana as the main source of cash income. In terms of breeding, each household generally raises a pig and some poultry to meet their living needs. In Xinzhai Village, "rice + corn + sugarcane + breeding (cattle, pigs, poultry, etc.)" is regarded as the main livelihood combination mode, and some farmers combine vegetables with fruits. Currently, farmers there primarily rely on sugarcane cultivation and breeding for cash income. In Modao Village, pure agricultural farmers' livelihood combination mode is "rice + sugarcane + corn + breeding (pigs, cattle, poultry)". Some farmers start to plant banana, mango and orange, and take sugarcane, corn and breeding as the main source of income. In general, pure agricultural farmers take "farming + breeding" supplemented by other livelihood strategies as their livelihood mode.

4.2.2 Livelihood diversification of agriculture-dominant farmers. Agriculture-dominant farmers are engaged in both agricultural and non-agricultural livelihood activities, but rely primarily on agricultural ones. They account for 47% of the total surveyed farmers. In Manle Village, farmers who plant rice, balsam pear, Capsicum frutescens, cowpea, banana and towel gourd account for 94.7%, 57.7%, 52.6%, 63.2%, 5.2% and 10.5% respectively, while farmers who raise cattle, pigs and poultry account for 21%, 15.8% and 47.4% respectively. In Xinzhai Village, farmers who plant rice, sugarcane, corn and fruits account for 95.8%, 83.3%, 66.7% and 16.7% respectively, while farmers who raise pigs, cattle, poultry and fish account for 79.2%, 50%, 33.3% and 4.1% respectively. In Modao Village, farmers who plant rice, sugarcane, corn and vegetables account for 100%, 100%, 100% and 5.2% respectively, while farmers who raise cattle, pigs and poultry account for 42%, 94.7% and 57.8% respective-

ly. The non-agricultural livelihood activities mainly include temporary labor, trading and wage work. Most of the farmers are migrant workers, and there are also farmers doing odd jobs in the surrounding regions.

4.2.3 Livelihood diversification of non-agriculture-dominant farmers. Non-agriculture-dominant farmers are both engaged in agricultural and non-agricultural livelihood activities, but mainly rely on off-farm ones. Its agricultural livelihoods are similar to those of the former two categories of farmers, but its agricultural livelihood diversification degree (3.095) is lower than that of agriculture-dominant farmers (3.488) and that of pure agricultural farmers (3.778). There are altogether 43 non-agriculture-dominant farmers, of whom 43 planting rice, 6 planting balsam pear, 4 planting Capsicum frutescens, 4 planting cowpea, 32 planting sugarcane, 28 planting corn, 24 raising pigs, 10 raising cattle and 12 raising poultry. The non-agricultural livelihood diversification degree for non-agriculture-dominant farmers (1.857) is higher than that for agriculture-dominant ones (1.44). The non-agricultural livelihood activities mainly include temporary labor, trading and business services. In terms of temporary labor, there are nearly 20 farmers working in the local factories such as Dahongshan iron ore plant, Bada iron ore plant and Gasa sugar mill; there are 10 working in other provinces and 6 doing odd jobs in the surrounding regions. At the same time, there are also some farmers engaged in other non-agricultural activities (6 engaged in the service work, 6 in the wage work, 6 in mechanical diggers, 3 in the construction industry and 3 doing business).

4.2.4 Livelihood diversification of non-agricultural farmers. For non-agricultural farmers, their off-farm income accounts for more than 90% of total income and some of these farmers are not completely divorced from agricultural activities. They lease all or most of the land, and plant rice and vegetables and raise chickens, ducks and geese to meet their basic living needs. The non-agricultural livelihood diversification index (2.00) is higher than that of the other three types of farmers, and their non-agricultural livelihood activities mainly include doing business, working in local factories and working in other provinces. There are a total of 9 non-agricultural farmers, 3 of whom do business (selling clothes), 4 work in local factory (Dahongshan iron ore plant), and 2 work in other provinces.

4.3 Regression analysis of livelihood capital and livelihood diversification

4.3.1 Regression analysis of livelihood capital and agricultural livelihood diversification. In SPSS 20.0, agricultural livelihood diversification is input into Dependent list, and the five kinds of livelihood capital are input into Independent column. The stepwise method is used for regression simulation, and the results are shown in Table 3. Based on the regression results, we establish the regression equation of livelihood capital and agricultural livelihood diversification:

$$\hat{y}_1 = 0.758 + 2.049X_1 + 3.479X_3$$

The output results show that VIF of independent variables is less than 5.0, indicating that the collinearity is not very clear for the independent variables of the regression equation. Among five independent variables, natural capital shows the largest impact on agricultural livelihood diversification, with the correlation coefficient of 0.288, followed by physical capital, with the correlation coefficient of 0.245. In specific, families with more natural and physical capital, their agricultural livelihood diversification index is higher. Natural capital is the basis for achieving agricultural livelihood diversification. In the study area, the area of paddy field is large in the basin, and farmers have many opportunities to choose agricultural livelihood activities, which helps to improve their livelihood diversification level. In terms of physical capital, income from raising livestock and poultry occupies an important position, meanwhile the popularity of agricultural machinery has played an important role in improving the efficiency of agricultural production. Thus, natural capital and physical capital is the basis for achieving agricultural livelihood diversification, and farmers with rich natural and physical capital are more willing to choose agricultural livelihood activities in their choice of livelihood strategies.

4.3.2 Regression analysis of livelihood capital and non-agricultural livelihood diversification. In theory, the non-agricultural livelihood diversification is affected by natural capital, human capital, physical capital, financial capital and social capital, and all five independent variables are input into the independent variable column in the modeling process. The stepwise method is used for regression. Independent variables with no significant regression coefficient are excluded from the regression model, and thus the regression coefficient of the independent variables entering the regression model reaches the significant levels[18]. The regression results are shown in Table 4. Based on the regression results, we establish the regression equation of livelihood capital and non-agricultural livelihood diversification:

$$\hat{y}_2 = 0.256 - 0.846X_1 + 1.62X_2 + 0.592X_4$$

Table 3 Regression results

Model	Explanatory variables	*B*	*Std. Error*	*Beta*	*t*	*Sig*	Correlation	Partial	*VIF*
1	(Constant)	1.773	0.420		4.225	0.000			
	Natural capital X_1	2.240	0.593	0.288	3.777	0.000	0.288	0.288	1.000
2	(Constant)	0.758	0.542		1.397	0.164			
	Natural capital X_1	2.049	0.584	0.263	3.509	0.001	0.288	0.270	1.013
	Physical capital X_3	3.479	1.216	0.215	2.861	0.005	0.245	0.223	1.013

Dependent Variable: agricultural livelihood diversification

The output results (Table 4) show that financial capital has the greatest impact on non-agricultural livelihood diversification, with the correlation coefficient of 0.182, followed by natural capital, with the correlation coefficient of −0.120; human capital has the weakest impact, with the correlation coefficient of 0.159. Financial capital is the basis for farmers to engage in the non-agricultural livelihood activities which quickly increase farmers' family wealth, so that they have sufficient funds for housing construction, vehicle purchase and labor education input. There is a negative correlation between non-agricultural livelihood diversification and natural capital, and further analysis shows that for farmers engaged in non-agricultural livelihood activities, most of their land has been leased, and the crop planting area is small. Human capital (i.e. education level of adult labor) and the adequacy of financial capital also have important impact on non-agricultural activities, which are actually the driving force for farmers to shift from pure agriculture to non-agriculture.

Table 4 Regression results

Model	Explanatory variables	*B*	*Std. Error*	*Beta*	Correlation	Partial	*VIF*
1	(Constant)	0.635	0.268				
	Financial capital X_4	0.431	0.185	0.182	0.182	0.182	1.000
2	(Constant)	1.068	0.318				
	Financial capital X_4	0.580	0.193	0.245	0.182	0.234	1.113
	Natural capital X_1	−0.936	0.385	−0.198	−0.120	−0.190	1.113
3	(Constant)	0.256	0.515				
	Financial capital X_4	0.592	0.191	0.250	0.182	0.241	1.114
	Natural capital X_1	−0.846	0.384	−0.179	−0.120	−0.174	1.128
	Human capital X_2	1.650	0.828	0.154	0.159	0.158	1.019

Dependent Variable: non-agricultural livelihood diversification

5 Conclusions

Studies have shown that the mode dominated by agriculture, supplemented by non-agricultural activities, combined with breeding, is the commonly used livelihood strategy for farmers in the study area. As farmers change from pure agriculture to non-agriculture, their total livelihood capital and non-agricultural livelihood diversification index will increase, while agricultural livelihood diversification index will decrease. In the meantime, their livelihood activities gradually shift from agricultural to non-agricultural ones, which is mainly reflected in the combination of both agricultural and non-agricultural activities. Regression analysis on livelihood capital and livelihood diversification shows that natural and physical capital is the basis of realizing agricultural livelihood diversification. Farmers with rich natural and physical capital are more willing to choose agricultural livelihood strategies. While financial and human capital is the driving force for farmers' transition from pure agriculture to non-agriculture.

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(To page 26)

element for promoting urbanization. In the process of urbanization abroad, there is also a massive population transfer, and many countries have already finished this process. Britain is the first country where rural population flows to the town and the transfer scale is the largest. However, rapid urbanization has many drawbacks. Therefore, British people reaches the consensus of urban and rural planning on "the movement of garden city"[11]. Mass transfer started in the westward movement of population in the United States, and reached its peak at the end of the 19th century when the industrial revolution was completed. The strategy the United States took is the path of agricultural modernization, intensive management implement and urban village establishment[12]. There is a special historical background and also a complex reality condition for the labor transfer in the transition period of modern development in China. Along with China's urbanization, the transfer of rural labor also brings many problems, such as a large number of hollow villages, hampering the development of rural society. However, from the above analysis we can see that the "hollow village" is accompanied with the whole process of urbanization development. We'd better realize that "hollow village" is not immutable and frozen, and it will be with the evolution of the continuous development of urbanization. The key is that the government should take reasonable and timely measures at different stages to guide the development of "hollow village". At present, the regional economic and social development is not balanced in China, and the stage of urbanization is also different. The government should formulate corresponding policies based on different stages of urbanization, and adjust measures to local conditions. In a word, the local government should adjust policy in time according to the dynamic process of urbanization development.

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(From page 21)

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