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Analysis of Factors Influencing Farmer and Herdsman's Operating Behavior in Crop Production——A Case Study of the Typical Tibetan Counties (Cities)

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Abstract We select 204 panel data samples from fixed observation spots in China's rural areas (Nagqu County, Duilongdeqing County and Xigaze City in Tibet), and conduct systematic analysis of factors influencing farmer and herdsman's operating behavior in crop production, using regression estimation method of the linear model, mixed OLS model and the random effects model. The research shows that "the number of migrant workers", "the amount of household labor forces", "original value of fixed assets for production purpose at the end of year", "whether having agricultural machinery or not" and other household endowment factors, have a positive impact on total planting area of households, and theoretically, the endowment effect of internal factors predicted is valid; the product of "average food price" and "whether selling or not" has conspicuous impact, and the empirical results confirm that in external factors, the substitution effect of price is greater than the income effect.

Key words Farmers and herdsmen, Operating behavior, Influencing factors, Tibet

As to food crops in the Tibetan areas, the highland barley has the greatest distribution area, and the beans include peas, green beans, soybeans, *etc.*, but the distribution regions and growing area are limited. In addition, the food crops in the Tibetan areas include potatoes, corn and other minor cereals. As to the cash crops, rape is in the dominant position; peanuts and tobacco are only planted in southeastern Tibet; the beet is rarely planted, and many farmers and herdsmen use it as feed[1]. The crop production in Tibet develops by leaps and bounds. In 2010, the total grain yield in the Tibetan areas amounted to 920 000 t, an increase of 1.6% over 2009; in 2010, the growing area of crops was 240 020 hm^2, an increase of 4 950 hm^2 over 2009. However, some problems become increasingly prominent, such as the contradiction between the socio-economic development and ecological resources, problem of population growth and land dwindling, contradiction between the quantity and quality of agricultural products, contradiction between supply and demand of agricultural market, and resources abundance and deficiency contradiction, posing new challenges to the development of crop production in Tibet. Relative to the secondary and tertiary industries, the comparative benefit of agricultural production is relatively low, and the share of value added of the primary industry in the region's GDP declines ceaselessly. In 2010, the proportion of the primary industry in the Tibetan areas declined by 1.1% as against that in 2009. In view of increasingly food security issue and the weakening crop production, taking the typical farmers and herdsmen in the Tibetan areas as sample, we systematically research the influencing factors and influencing mechanism of the crop production and operating behavior, in order to provide reference for promoting continuous development of crop production in the Tibetan areas and ensure food security.

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1 Conceptual framework

In Development Microeconomics, Bardhan mentioned one farmers' production decision model under a perfectly competitive market condition. For the sake of simplicity, the model assumes the family size as two people, and the utility of two people is reflected by their consumption (c_1, c_2) and leisure (l_1, l_2). The function of household producing a certain kind of product is $F(L, A)$, where A is the area of farmland cultivated by household; L is rural household labor. In addition, p is the price of products yielded; w is labor wage (Assuming the labor of two family members is of the same nature). E_i^L is the time endowment of person i; E^A is the land endowment of household; r is the unit price of land. The equation of maximal household utility is as follows:

$$Maxu(c_1, c_2, l_1, l_2) \quad (1)$$

$$s.\ t.\ p(c_1 + c_2) + w(l_1 + l_2) \leqslant \Pi^*(w, r) + w(E^{L1} + E^{L2}) + rE^A \quad (2)$$

Since the utility function and production function are continuously differentiable, under the guarantee of the implicit function theorem, equation (1) and equation (2) mean that the optimal solution, namely, the production decision of rural households is the function of exogenous variables of E_1^L, E_2^L, E_3^L, E^A, p, w, and r. These exogenous variables can be divided into two categories: one is the internal factor of the family, namely the endowment factor, including labor endowment and land endowment; the other is external factor, namely the economic environment, including various types of p, w and r. Therefore, in order to further conduct empirical analysis of farmers' production decisions, we can carry out analysis from two angles of the internal and external factors. It is also the analysis method of

internal and external factors adopted by the majority of researches on factors influencing farmers' production decisions at present. Kong Xiangzhi believes that the internal factors affecting the economic behavior of rural household include arable land, capital and labor; the external factors include the development status of agricultural product markets and agricultural production materials markets, the development status of rural factor markets, specialization level of agricultural production, construction status of agricultural socialization service system, status of rural policy and its transparency, the penetration of the commercial and financial capital into agricultural and rural economy, and distance from the city[3]. Shi Qinghua holds that the variables of family characteristics that affect economic behavior of the rural household mainly include the basic information of family members (such as age, marriage, the maternity expectation of female adult in family, family decision-making mode, *etc.*), the farmland operation and utilization efficiency of rural households, human resources reserve and utilization efficiency of rural households, operating material capital reserve and use efficiency of rural households, income structure of rural households[4].

Based on the above research, we conduct systematic analysis of factors influencing the Tibetan farmer and herdsman's operating behavior in crop production, using the analytical framework of the internal and external factors. In order to analyze differences in farmer and herdsman's crop production and operating behaviors under the largely same external environmental conditions, we focus research on internal constraint mechanism of farmers and herdsmen, such as the age of the farmers and herdsmen, the years of education, labor conditions of farmers and herdsmen, wealth status of farmers and herdsmen, and the impact of family operation structure of farmers on crop production and operating behaviors. Certainly, we cannot objectively reveal the true situation of crop production and operating behaviors of farmers and herdsmen merely by simple analysis of internal factors, therefore, we introduce the price factor and the development status of rural social networks as external factors into quantitative analysis. At the same time, there is a number of crop production and operating behaviors of farmers and herdsmen, thus we select the total planting area of all crops grown by farmers and herdsmen as variables to be explained. The analysis of relationship between all kinds of factors and the total crop planting area of farmers and herdsmen can be shown in Fig. 1.

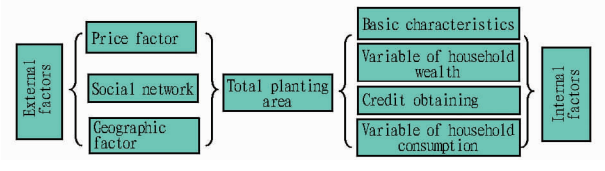

Fig. 1 Analysis of factors influencing farmer and herdsman's operating behavior in crop production

2 Variable explanation and descriptive statistical analysis

2.1 Variable explanation We select 204 panel data samples from fixed observation spots in China's rural areas (Nagqu County, Duilongdeqing County and Xigaze City in Tibet) in 2004, 2007 and 2008, and adopt "total planting area of farmers and herdsmen" as dependent variable, 14 variables as independent variables ("whether cadre or party member households", "the amount of household labor forces", "average years of schooling of households", "the number of migrant workers", "original value of fixed assets for production purpose at the end of year", "whether having agricultural machinery or not", "the product of average price of food and whether selling or not", "productive loans", "original value of having dwelling house at the end of year", "major food consumption all the year around", "dummy variable of the year 2007", "dummy variable of the year 2008", "dummy variable of Duilongdeqing County", and "dummy variable of Xigaze City"). Among them, "whether cadre or party member households", "the amount of household labor forces" and "the number of migrant workers" are variables of family characteristics; the variable of "average years of schooling of households" is obtained by first totalling the educational level of all family members and then calculating the average number, representing the human capital status of farmers and herdsmen; "original value of fixed assets for production purpose at the end of year", "whether having agricultural machinery or not" and "original value of having dwelling house at the end of year" reflect the wealth status of farmers and herdsmen; the variable of "the product of average price of food and whether selling or not" represents the market price factor; the variable of "productive loans" reflects borrowing loaning information of farmers and herdsmen; "major food consumption all the year around" reflects the consumer demand of rural households for major agricultural products; "dummy variable of the year 2007", "dummy variable of the year 2008" and "dummy variable of Duilongdeqing County", "dummy variable of Xigaze City" are the dummy variables of time and dummy variables of region set by this article. Using "the year 2004" and "Nagqu County" as reference respectively, we examine the differences in total planting area of rural households in different time and different regions.

2.2 Descriptive statistical analysis

2.2.1 Descriptive statistical analysis of growing area in different regions.

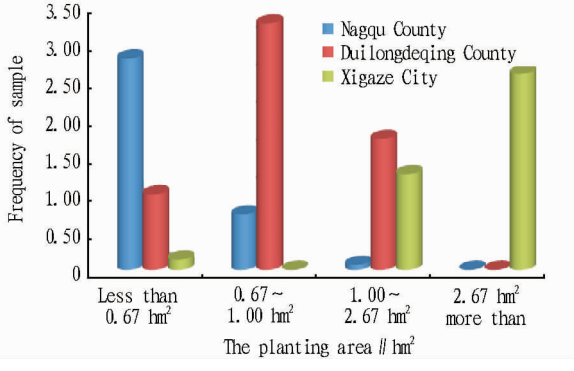

Fig. 2 Distribution of farmers' growing area surveyed in one city and two counties

Through Fig. 2, we can not only observe the changes in the planting area in Nagqu County , Duilongdeqing County and Xigaze City overall, but also see the distribution of different sizes of land parcel in each region. There is a sharp contrast between Nagqu County and Xigaze City. The planting scale of rural households in Nagqu County is generally below 1 hm^2; on the contrary, in Xigaze City, there are only two rural households with planting scale below 0.67 hm^2, and 48 rural households with large and medium-sized scale of 1 – 2.67 hm^2 and more than 2.67 hm^2. Although in Duilongdeqing County, there are no growers with scale more than 2.67 hm^2, the planting scale of growers in this region is mostly "1 – 2.67 hm^2", few with scale less than 0.67 hm^2. Therefore, through regional comparison, we find that Nagqu County is almost pure animal husbandry county, and its level of crop production is lower than that of Duilongdeqing County and Xigaze City; Xigaze City has the biggest scale and highest level of crop production. In the light of different crops, the average planting area of food crops in three regions is nearly 1.33 hm^2, and the maximum planting area of food crops is 4.43 hm^2.

2.2.2 Comparative analysis of growing area of different crops.

Table 1 The area of different crops planted by typical farmers and herdsmen hm^2

Variable	Number of samples	Mean	Standard deviation	Minimum	Maximum
Food crop	13.60	1.28	1.16	0.00	4.43
Wheat	12.80	0.72	0.34	0.13	1.87
Potato	11.07	0.09	0.05	0.01	0.27
Others	4.80	1.48	0.89	0.05	3.13
Non-food crop	13.60	0.11	0.10	0.00	0.67
Oil crop	10.07	0.09	0.06	0.03	0.40

The food crops that the farmers grow most are wheat and potato, and corn, soybean, rice and other food crops are planted rarely. There are 72 sample households planting other crops, and the planting area is large. The survey results show that the majority of them are highland barley and other barley crops. The area of non-food crops is very small, and the area of oil crops is relatively large. Through research, we find that many rural households plant rape and harvest rapeseed, for their own oil extraction and consumption.

2.2.3 Contingency analysis of growing area of wheat and regional variable.

Table 2 Contingency analysis of growing area of wheat and regional variable household

Growing area of wheat // hm^2	Region			
	Nagqu County	Duilongdeqing County	Xigaze City	Total
Less than 0.53	31	22	2	55
0.53 – 0.93	11	63	23	97
More than 0.93	2	5	33	40
Total	44	90	58	192

From the above table, there is prominent regional difference in the planting area of wheat overall, and the planting scale concentrates in 0.53 – 0.93 hm^2. Through the comparison of three regions, the rural households grow wheat most in Duilongdeqing County, least in Nagqu County. From the point of view of the planting scale, "less than 0.53 hm^2" and "0.53 to 0.93 hm^2" dominate Nagqu County and Duilongdeqing County, " less than 0.53 hm^2" is the majority in Nagqu County, and "0.53 to 0.93 hm^2" is the majority in Duilongdeqing County; "0.5 to 0.93 hm^2" and "0.93 hm^2 or more" preponderate in Xigaze City, thus the planting area of rural households in Xigaze City is large, with certain scale merit.

2.2.4 Contingency analysis of growing area of potato and regional variable.

Table 3 Contingency analysis of growing area of potato and regional variable household

Growing area of wheat // hm^2	Region			
	Nagqu County	Duilongdeqing County	Xigaze City	Total
Less than 0.07	16	0	5	21
0.07	4	53	34	91
More than 0.07	0	35	19	54
Total	20	88	58	166

From the table, we can find that there is prominent regional difference in the planting area of potato on the whole, and the planting scale less than 0.07 hm^2 is the majority, with not big operation scale. Through comparison of three regions, Duilongdeqing County has the greatest growing area of potato, followed by Xigaze City, Nagqu County with the smallest growing area of potato.

2.2.5 Contingency analysis of growing area of other food Crops and regional variable.

Overall, there are prominent regional differences in the planting area of other food crops, and it should be noted that in the survey sample data of Duilongdeqing County, there is no planting of " other crops", but in Duilongdeqing County, the highland barley is actually planted, so the data missing in this county is the problem of data survey. In Xigaze City, the planting scale of other food crops is relatively large, and the planting area of 81.03% of sample rural households is more than 1.07 hm^2. The scale of other food crops planted by 14 households in Nagqu County is smaller than 1.07 hm^2.

2.2.6 Contingency analysis of growing area of oil crop and regional variable.

Overall, there is prominent regional difference in the plant-

ing area of oil crops. There are the most growers in Duilongdeqing County, with the largest scale. The planting area of all sample farmers and herdsmen is more than 0.07 hm^2; the number of growing households in Nagqu County is more than that of the growing households in Xigaze City by 3, but the scale of operation is decentralized. The planting area of 45.71% of the sample farmers and herdsmen is less than 0.07 hm^2, and the planting area of 34.38% of the sample herdsmen in Xigaze City is 0.07 hm^2 or more.

Table 4 Contingency analysis of growing area of other food crops and regional variable household

Growing area of other food crops // hm^2	Region		
	Nagqu County	Xigaze City	Total
Less than 1.07	14	11	21
1.07 – 2	0	25	91
More than 2	0	22	54
Total	14	58	166

Table 5 Contingency analysis of growing area of oil crop and regional variable household

Growing area of oil crop // hm^2	Region			
	Nagqu County	Duilongdeqing County	Xigaze City	Total
Less than 0.07	16	0	0	16
0.07	14	48	21	83
More than 0.07	5	36	11	52
Total	35	84	32	151

3 Econometric analysis

We conduct econometric test of impact of 14 variables, and the econometric analysis model is as follows:

$$Y_{it} = a_i + \beta X_{it} + \varepsilon_{it} \quad (3)$$

Y_{it}, the farming production decision of farming and animal husbandry household i in year t, signifies the total planting area. X_{it} signifies the independent variable vector of farming and animal husbandry household i in year t, including the following independent variables: x_1 (whether farming and animal husbandry household i is cadre or party member household; x_2 (the amount of household labor forces of farming and animal husbandry household i; x_3 (average years of schooling of farming and animal husbandry household i; x_4 (the number of migrant workers in farming and animal husbandry household i; x_5 (farming and animal husbandry household i's original value of fixed assets for production purpose at the end of year); x_6 (whether farming and animal husbandry household i has agricultural machinery or not); x_7 (the product of average food price of farming and animal husbandry household i and whether selling or not); x_8 (productive loans of farming and animal husbandry household i); x_9 (original value of having dwelling house at the end of year owned by farming and animal husbandry household i); x_{10} (major food consumption all the year around of farming and animal husbandry household i); x_{11} (dummy variable of the year 2007); x_{12} (dummy variable of the year 2008); x_{13} (dummy variable of Duilongdeqing County); x_{14} (dummy variable of Xigaze City).

On the basis of 204 effective number of test in Nagqu County, Duilongdeqing County and Xigaze City, we carry out empirical econometric analysis of factors influencing farmer and herdsman's operating behavior in crop production using the above model, and the basic characteristics of corresponding observed values can be seen in Table 7. According to the foregoing discussion of research methods and variable selection, we adopt mixed OLS regression and random effects model for estimation, and the econometric estimate results show that the overall goodness of fit of the model is good. According to the estimated results model, we discuss the influencing factors of the two dependent variables below, respectively.

Table 6 Estimation results of mixed OLS and random effect of impact factors of the total planting area

Independent variable	Mixed OLS			Random effect		
Indicator	Coef.	t	P > |t|	Coef.	z	P > |z|
Constant term	−1.811 887	−1.16	0.246	2.468 143	1.47	0.143
Whether cadre or party member household	−3.651 398	−3.44	0.001	−1.577 653	−1.86	0.064
The amount of household labor forces	2.492 078	7.94	0.000	1.546 86	5.42	0.000
Average years of schooling	0.097 662 8	0.57	0.571	−0.132 670 9	−0.90	0.370
The number of migrant workers	0.771 264 9	1.43	0.153	0.171 926 6	0.58	0.564
Original value of fixed assets for production purpose at the end of year	0.000 011 5	2.62	0.010	3.08e −06	0.90	0.368
Whether having agricultural machinery or not	3.532 937	3.34	0.001	1.988 695	2.48	0.013
The product of average price of food and whether selling or not	2.486 315	2.58	0.011	3.909 147	6.12	0.000
Productive loans	0.000 804 5	5.86	0.000	0.000 360 2	3.68	0.000
Original value of having dwelling house at the end of year	2.11e −06	0.32	0.752	6.95e −06	1.54	0.124
Major food consumption all the year around	0.000 539 5	2.17	0.031	0.000 255 2	1.45	0.147
Whether 2007 or not	−0.519 105 3	−0.52	0.604	−0.3634 298	−0.75	0.454
Whether 2008 or not	−0.584 057 5	−0.59	0.553	−0.364 0872	−0.76	0.446
Duilongdeqing County	−3.369 995	−1.95	0.053	−0.868 94	−0.45	0.652
Xigaze City	14.276 18	8.70	0.000	25.095 44	11.42	0.000

As shown in Table 6, the 6 variables ("whether cadre or party member households", "the amount of household labor forces", "whether having agricultural machinery or not", "the product of average price of food and whether selling or not",

" productive loans" , and " dummy variable of Xigaze") are significant at the 0.05 level in methods of OLS and random effect; the variable of " original value of fixed assets for production purpose at the end of year" is significant in OLS estimate, but not significant in random effect estimate; the impact of " average years of schooling " , " the number of migrant workers" , " original value of having dwelling house at the end of year" , " whether the year 2007 or not" , " whether the year 2008 or not" , " Duilongdeqing County" and other variables on total planting area is not significant at the 0.05 level.

From the independent variables of " family characteristics" , " whether cadre or party member households" and " the amount of household labor forces" correspond to family endowment in the theoretical analysis; " whether cadre or party member households" has a prominent negative effect on total planting area, indicating that due to official duties, the time and energy of civil servant households are occupied, and the civil servant households also get income from non-agricultural industries, reducing the behavior of crop production accordingly; the impact of " the amount of household labor forces" is positive, because the income effect is positive, and with improvement in the endowment, the family will promote production level. The impact of " the number of migrant workers" is not conspicuous, needing to combine " the amount of household labor forces" for explanation: in the existing rural family structure, the high remuneration of labor forces is generally from non-agricultural production, therefore, half of the young labor forces work outside home, and they are isolated from agricultural production, having no effect on the planting area; apart from the young labor forces, the elderly, women and children become the main force of agricultural labor, and the number of this part of labor forces is directly related with " the amount of household labor forces" , thereby showing high conspicuity. The impact of " average years of schooling" is not prominent, and the reason is as follows: in the case of shortage of per capita arable land and outdated technology, technology and education do not constitute direct productivity, and there is no prominent difference between high-quality labor forces and pure physical labor forces in labor-intensive agricultural production.

In terms of " family assets" , " whether having farm machinery or not" and " original value of fixed assets for production purpose at the end of year" , have obvious positive impact on the planting area of farmers and herdsmen, indicating that in the current agricultural production, although the high-quality labor forces cannot obtain enough factor returns, the productive capital get smaller per capita arable land area needed by the scale returns, so that the productive capital put into agricultural production is effective and the benefits outweigh the costs. In the production pattern based on the elderly, women and children, the productive assets can effectively reduce the labor intensity and improve labor efficiency, forming complement to the lack of young labor force. In the current proportional relationship of resource endowment between human and land in China, the effective substituting of agricultural machinery and productive assets in the agricultural production for the young labor force has become increasingly evident.

The impact of " original value of having dwelling house at the end of year" on agricultural production is not obvious, and there are many reasons. In general, the effect of wealth including houses, can exert impact on production and consumption decision-making of economic individuals, but such neo-classical theory has assumed premise: the existence of a sound financial market, can carry out evaluation, mortgage lease and sale of all assets with low costs. In rural areas, the real estate is generally free houses with few migrant residents, and lease and sale are even rare. The lack and weakness of rural financial institutions is long-standing problem, and the valuation and mortgage of land and rural houses are still far from being able to carried out smoothly, therefore the wealth effect of rural real estate is far from apparent. For changes in this situation, we need to overhaul China's rural financial system and land system.

In terms of " household borrowing" , " productive loans" have obvious positive impact on the planting area, indicating that the capital plays a significant role in promoting agricultural production. Of course, the path of this impact is diverse. It may be used for agricultural machinery and productive assets, and it may also be used for in living-oriented consumer spending, even for emergency and so on. In any case, the wealth effect will help to resist the risk of production and life, and expand production possibility curve in production decisions, so that rural households can choose a higher production level. From this point to infer, if the rural financial market and real estate system are perfect, " original value of having dwelling house at the end of year" can also have positive effects on agricultural production.

In terms of " household consumption" , " major food consumption all the year around" has obvious positive impact on the planting area in the OLS estimation, but the positive impact of it is not obvious in random effect estimation. Grain, as the farmers' product, is also one of consumer goods, therefore, rural households have " the endowment effect" on food production and consumption. On one hand, increase in food consumption would make farmers need to and willing to increase production and planting; on the other hand, if the return from non-agricultural industries increases or the relative prices of grain lower, engaging in non-agricultural industries can get more money to buy food, and this moment, increase in food consumption might reduce the planting area. It indicates that increase in food consumption has multi-path impact on the planting area, and depends on the relative prices of different products. In measuring and estimation, there is instability in its sign and significance.

In terms of " price factor" , " the product of average price of food and whether selling or not" has prominent positive effect on the planting area, indicating that increase in returns expected exerts obvious impact on the production behavior of farmers. The expectation way of rural households is just the empirical estimation of the price in the previous period; the time point of data is only three years, making it difficult to effectively estimate the formation mechanism of more complex price expecta-

tion in multi-period distributed lag model, but the effective impact of the conduction of market prices on production behavior still exists. We can also use the substitution effect and the income effect to explain the mechanism of action of this variable. According to the substitution effect, after the food prices increase, farmers will shift to agricultural production, therefore, it will increase the growing area. However, according to the income effect, when food prices rise, the income of farmers will increase, therefore, they are likely to further enjoy their leisure, thereby reducing crop acreage. From the empirical results, the substitution effect is greater than the income effect, and thus the crop acreage increased.

In terms of " external social networks and geographic factors" , " whether in 2007" , " whether in 2008" , " Duilongdeqing County" and other variables have inconspicuous impact on the total planting area, indicating that for the three regions overall, the environmental changes over the past few years are not large, and the climate, environment and other external factors are not the main factors influencing the planting area; " dummy variable of Xigaze City" has significant positive impact on the planting area. In comparison with Nagqu County, in Xigaze City, different endowments of per capita arable land and geographical environment determine that the planting area is bigger after controlling a series of variables, and such regional differences are prominent.

4 Conclusions

This paper conducts systematic analysis of the basic characteristics and influencing factors of typical farmer and herdsman's operating behavior in crop production in the Tibetan areas, using the sampling survey data from fixed observation spot in rural areas of the Ministry of Agriculture. In general, we draw the following conclusions.

First, the factors representing the basic characteristics of rural households, " whether cadre or party member household" and " the amount of household labor forces" have obvious impact on the planting area. Cadres, as an alternative career, reduce the planting area, and abundant labor forces will naturally increase the planting area.

Second, young labor forces and highly educated labor forces cannot obtain scale returns in the small-scale production, and these labor forces flow out and depart from agriculture in a large number, thus variables of " the number of migrant workers" and " the average level of education" , have little effect on the planting area.

Third, the benefit of " original value of fixed assets for production purpose at the end of year" , " whether having agricultural machinery or not" (as the substitute of labor), is greater than the cost in the existing per capita arable land area, and the two variables have significant positive impact on the planting area.

Fourth, since " household borrowing" expands the production possibility curve and farmers' ability to resist risks, the planting area is increased, but due to unsound financial markets and constraints of the current land system, " the original value of the farmers' houses" can not provide financing, having inconspicuous impact on the planting area.

Fifth, " the product of average price of food and whether selling or not" representing the market price, has significant impact on the planting area, indicating that in farmers' expectation of the price in the next period, the price in the previous period has a quite remarkable effect.

Sixth, " major food consumption all the year around" has multi-path impact on the planting area, and it is vulnerable to the impact of the relative price of food, thus the total effects of it on the planting area is uncertain.

Seventh, in dummy variables, due to resource endowment and other factors, there is an obvious difference between Xigaze City and Nagqu County; there is no obvious regional difference between Duilongdeqing County and Nagqu County; the time variables of the year 2007 and 2008 also have no obvious effects.

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