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How Does Family Factor Endowment Change Affect Farmers' Production Decision-making: An Empirical Analysis based on National Rural Fixed Observation Point Data in 2004~2013

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Abstract: By using data from national rural fixed point in 2004-2013, this paper constructs farmers planting structure decision-making model and production factors input decision-making model to analyze the influence of family factor endowment on farmers' production decision-making. The study shows the following results: The factors such as the area of circulation cultivated land, the number of cultivated lands, the age of labor force, government subsidies and productive fixed assets owned by the family have a significant positive influence on farmers' planting decision, while the area of cultivated land, the number of agricultural labor force, household disposable income and agricultural operating income have a significant negative influence on it. Under the same conditions, farmers with the advantages of labor factor endowment first consider the full use of household labor resources, and farmers with the advantages of land and capital factor endowment will increase the investment in agricultural workers, agricultural machinery and material means of production. This article argues that with the continuous promotion of land rights and the regulation of farmland circulation, the profit-driven feature of capital will inevitably stimulate farmers' investment in agricultural production, and the future worries about "who will go in for farming" and "how to farm " will naturally subsides.

Keywords: Family factor endowment; Planting structure decision-making; Production factors input; Rural fixed point.

1. Introduction

The transformation of agricultural production structure is currently an important and urgent task in the transformation of China's agricultural development mode. With the deepening of China's rural reform and the continuous improvement of agricultural structure adjustment policies, the structure of agricultural production has also undergone profound changes [1]. The "No. 1 Document" of the Central Government has repeatedly emphasized the basic formation of a modern agricultural production structure and regional layout that is adapted to market demand and matched with resource endowments. At present, the core of the supply-side structural reform of agriculture is to optimize the allocation of agricultural resources and solve the dilemma of difficult agricultural restructuring and difficult income generation for farmers [2]. Factor endowment theory tells us that, in general, farmers, as rational economic agents, will allocate household resources reasonably according to their factor endowments in the pursuit of utility maximisation. In recent years, along with rapid urbanisation and rising income from non-farm employment, changes in the household factor endowments of farmers in terms of land, labour and capital have all been evident [3].At the same time, the structural status of agricultural production reflects the mix of agricultural production and is influenced by macro factors such as science and technology, population size, market demand, government regulation and control [4].In fact, these factors are ultimately implemented at the level of the farmer and have an impact on agricultural production decisions through the farmer's production decisions. In other words, agricultural production decisions are in fact the concentrated expression of many micro-farmers' production decisions. Exploring the impact of changes in household factor endowments on farmers' production decisions will help to further enrich our understanding of the restructuring and upgrading of agricultural production, as well as to formulate targeted policy measures based on changes in the factor endowments of agricultural operators, so as to promote the structural transformation of agricultural production in China in an orderly manner while increasing agricultural business incomes.

A review of the literature reveals that studies have analysed in depth the impact of labour factor endowment, capital factor endowment and land factor endowment on the production of farm households. Taking labour factor endowment as an example, some scholars believe that ageing and part-time labour affects the output efficiency of agricultural production and the development of the agricultural economy [5-6], and that part-time labour reduces the human input of agricultural production or even leads to land abandonment [7-8], while some studies show that the effects of ageing, part-time labour and feminisation of labour on the efficiency of agricultural production are not significant [9-10], and that part-time households have an optimal allocation of household Part-time households optimise the allocation of labour [11], which is conducive to land transfer and the promotion of moderate agricultural scale operations [12-13].Similarly, most of the studies on the impact of land and capital endowments on the production decisions of farmers are also controversial. It can be said that the conclusions reached by scholars based on different perspectives, using different sample data and different methods are inconsistent, and most of the existing studies have analysed the impact of a single factor endowment on the production operations of farmers. In fact, the decision of household agricultural production is not only influenced by one type of factor endowment, but also the

optimal decision based on a comprehensive consideration of all household factor endowments. Therefore, it is necessary to analyse how changes in household factor endowments affect the production decision of farmers in a comprehensive manner by integrating the factor endowments of land, labour and capital.

There is no doubt that changes in household factor endowments do exist and are becoming stronger, but whether they can have a substantial impact on farmers' production decisions depends on the extent to which changes in household factor endowments affect farmers' decisions on cropping structure and factor input decisions. So, how do changes in household factor endowments affect farmers' production decisions in China's agricultural production and management conditions? To what extent do household factor endowments influence farm households' decisions on cropping structure? How will the impact on farmers' production factor input decisions be reflected? It is difficult to draw scientific conclusions through qualitative analysis alone, and requires empirical testing through normative econometric analysis. In view of this, this study attempts to use data from 2004 to 2013 from fixed rural observation sites across China to study farm households' production decisions, focusing on the impact of changes in household factor endowments on farm households' decisions on cropping structure and farm households' decisions on production factor inputs.

2. Analytical framework

Farmers' production decision-making behaviour depends on the cost-benefit comparison of agricultural production and is mainly influenced by factors such as household factor endowment, the price of agricultural production materials and the price of agricultural products. Farmers, as rational economic agents, not only consider the structure of household production, but also constantly adjust their production factor input behaviour according to the actual situation. In other words, in addition to deciding what to plant and how much to plant, farmers also need to decide how to plant, i.e. how to rationalise production resources. Therefore, in general, farmers' production decisions include two aspects: on the one hand, farmers' decisions on planting structure, including the choice of crop types and planting areas; on the other hand, farmers' decisions on production factor inputs, including the choice of factor input types, factor input quantities and factor input times. Some scholars have carefully analysed the production decision-making behaviour of farmers from different perspectives and using different methods, and concluded that farmers' production decisions are influenced by internal factors such as household population, labour force quantity, labour force literacy, household arable land area, number of arable plots and household agricultural income, as well as external factors such as natural endowment conditions, traditional habits, costs and benefits of agricultural extension, macro policies and market prices [4, 14-15]. The present study focuses on land, labour and household income. This study focuses on the influence of three major types of household factor endowments, namely land, labour and capital, on the production decisions of farm households, while other influencing factors are not specifically analysed for the time being.

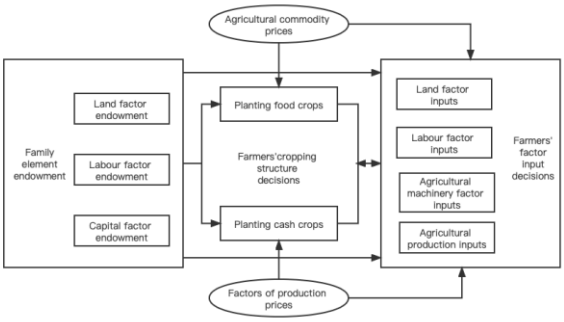


Figure 1. The impact of household factor endowments on the production decisions of farm households

2.1. Impact of household factor endowments on farming structure decisions

Schultz suggests that farmers, as rational smallholders, are profit maximisers, able to take every opportunity to respond positively and quickly to household production decisions [Schultz uses the cases of Guatemala and India in his book Transforming Traditional Agriculture to argue specifically that traditional smallholder production is "efficient"]. The study of many scholars has also shown that traditional smallholder production is "efficient". Numerous studies have also shown that it is common for farmers to make decisions about the structure of their cropping based on the characteristics of their household's factor endowments, and that farmers' decisions about 'what' and 'how much' to grow necessarily take into account their household's strengths and weaknesses in terms of their factor endowments of land, labour and capital (see Figure 1). (see Figure 1). The reasons for this include the heterogeneity of productive and human resources and the endowment of labour factors such as age, gender, education level and part-time employment [6,11,16], the endowment of land factors such as the scale of land operations, the direct production value of farmland and fractionalised land titles [17], and the endowment of agricultural capital factors such as household income from labour and government subsidies [18]. These studies show that farm households' cropping structure decisions are constrained by household factor endowments. For households with different factor endowments of land, labour and capital, the differences in factor endowments are likely to make farming structure decisions significantly different. Thus, farming structure decisions need to constantly create conditions for the relaxation of factor endowment constraints.

2.2. Influence of household factor endowments on farm households' factor input decisions

Factor endowment theory suggests that farmers will allocate household resources according to their factor endowment status, increasing their relatively abundant and inexpensive factor inputs to replace relatively scarce and expensive factors of production. The impact of household factor endowment on farmers' factor input decisions is mainly reflected in three aspects: First, farmers decide the scale of their agricultural operations according to their household factor endowment status. For example, in the absence of labour, some households may choose to transfer their land or even abandon it directly [19], and the age of agricultural labour has a significant negative impact on farmers' farmland transfer decisions and transfer scale [20], thus This affects the input of land production factors. Secondly, according to the

household factor endowment, farmers will choose relatively abundant and cheap factors of production for substitution [21], for example, to invest more in agricultural machinery to replace labour. Third, based on changes in household factor endowments, farmers may use more "capital" means of production, and when capital is relatively abundant, they may increase inputs of fertilizers, pesticides, films and other agricultural production materials, which can also replace relatively scarce land and labour to a certain extent. For example, the additional higher income earned by farming households from part-time work may encourage them to purchase more means of production in order to increase the efficiency of agricultural output.

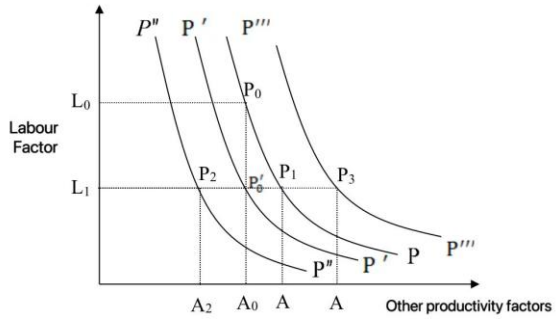


Figure 2. Potential impact of changes in labour factor endowments on farm households' factor input decisions

Figure 2 explores the potential impact of changes in factor endowments on farm households' factor input decisions, using labour factor endowments as an example. Where PP, P'P', P "P" and P'"P'" are all equal production lines, the household's initial factor endowment combination is assumed to be P0 (L0 and A0). When the household labour factor input decreases (from L0 to L1), the farmer has three possible options at this point: first, to increase other factor inputs. The first is that the other factor inputs exactly compensate for the loss of labour, and the factor input mix changes from P0 to P1 (L1 and A1) with no change in output; the second is that the increase in output due to the other factor inputs exceeds the loss of output due to the reduction in labour, causing the total output to increase instead, i.e. the factor input mix changes from P0 to P3 (L1 and A3), and the equal production line moves from PP to P'"P'". For example, by replacing the labour factor with an increase in the factor input of agricultural machinery, the farmer may be able to maintain agricultural production by hiring farm machinery and may also increase the area of land under cultivation as agricultural machinery saves time and labour. Secondly, other factor inputs remain unchanged and accept the reality of lower agricultural yields, i.e. the factor input mix becomes P'0 (L1 and A0) and the line of equal production moves from PP to P'P'. For example, in the case of an ageing household labour force, although inputs of factors of production such as land and physical means of production remain unchanged, agricultural production may become less productive as a result of 'sloppy' management due to a reduction in input labour time and reduced labour intensity. Thirdly, if households consider reducing the size of their farming operations based on the availability of labour factors, then in addition to the reduction in labour factors, there will also be a corresponding reduction in other factors of production, so that the factor input mix changes from P0 (L0 and A0) to P2 (L1 and A2), and the equal production line moves from PP to P "P". For example, as income from off-farm employment is much higher than income from farming operations, households will gradually reduce their expectations of farming operations, with minimal loss of agricultural output, and may even withdraw from farming production as income from part-time employment increases.

2.3. Influence of other factors on farming structure decisions and factor input decisions

Household factor endowments are not the only factor determining the production decisions of farm households. It has been shown that factor prices and agricultural commodity prices are also major factors influencing cropping structure and factor inputs to agricultural production [15]. The influence of factor and agricultural commodity prices is mainly reflected in the fact that, other things being equal, farmers will grow crops with fairly high agricultural commodity prices and will also choose relatively cheap factor inputs based on factor prices, thus reducing agricultural production costs and increasing agricultural incomes. For this reason, studying the factors influencing farmers' production decisions also requires a combination of factor prices and agricultural commodity prices.

In short, changes in household factor endowments will continue to exist and deepen for a long time to come, and the question of "who should farm" and "how to farm" will eventually become a realistic issue that we must face. At present, while changes in household factor endowments have had a negative impact on agricultural production, the factor substitution choices made by farmers based on the relative prices of factors have to a certain extent promoted the advancement of agricultural production technology, especially the widespread dissemination of modern production factors such as agricultural machinery and fertilisers. However, theoretical and empirical analyses at this stage are unable to draw precise conclusions on the impact of household factor endowments on farmers' production decisions.

3. Model Construction and Data Description

3.1. Model construction

According to the previous theoretical analysis, farmers' production decisions are mainly reflected in two aspects: cropping structure decisions and production factor input decisions. Therefore, this study first analyses the influence of household factor endowment on farmers' decision on cropping structure, and on this basis further investigates the influence of household factor endowment on farmers' input of labour factors (mainly considering the situation of agricultural hired labour), agricultural machinery input, fertiliser, pesticide and film and other production materials input in the process of cropping.

3.1.1. Farmers' cropping structure decision model

Drawing on the study by Hu Xuezhi [5] and others, an empirical analysis was conducted on the impact of household factor endowments on farming structure, and the specific form of the farming structure decision model was as follows:

$$\ln y_{it}^{*} = \beta_0 + \beta_1 \ln P_{(j)it-1} + \beta_2 \ln P_{(f)it-1} + \beta_3 \ln P_{(p)it-1} + \beta_4 \ln P_{(m)it-1} + \beta_5 \ln P_{(t)it-1} + \beta_6 \ln A_{it} + \beta_7 \ln B_{it} + \beta_8 \ln S_{it} + \beta_9 \ln L_{it} + \beta_{10} \ln Edu_{it} + \beta_{11} \ln NL_{it} + \beta_{12} \ln PX_{it} + \beta_{13} \ln BT_{it} + \beta_{14} \ln ZPSR_{it} + \beta_{15} \ln JYSR_{it} + \beta_{16} \ln GDZC_{it} + \varepsilon_{it} \quad (1)$$

$$y_{it} = \begin{cases} y_{it}^{*}, & \text{if } y_{it} > 0 \text{ or } y_{it} \le 1 \\ 0, & if\ y_{it} \le 0 \end{cases} \quad (2)$$

Where y_{it} denotes the ratio of the area sown to food crops to cash crops in year t for farmer i and y_{it}^{*} is the latent variable; $P_{(j)it-1}$, $P_{(f)it-1}$, $P_{(p)it-1}$ and $P_{(t)it-1}$ denote the prices of food, fertilizer, pesticides and film in year t-1, respectively, and $P_{(m)it-1}$ denotes the price of diesel in year t-1, representing the price of agricultural machinery; A_{it}, B_{it}, S_{it}, L_{it}, Edu_{it}, NL_{it}, PX_{it}, BT_{it}, $ZPSR_{it}$, $JYSR_{it}$ and $GDZC_{it}$ denote the total household arable land area, the number of arable plots, the area of transferred arable land, the number of agricultural labourers, the average number of years of education of agricultural labourers, the average age of agricultural labourers, the average number of times agricultural labourers have been trained, the total amount of agricultural subsidies, the household disposable income, the household income from agricultural operations and the household productive fixed assets in year t of farm household i respectively.

3.1.2. A model of farm household production factor input decisions

The specific form of the various factor of production input decision models is as follows:

$$\begin{aligned}\ln y_{(x)it} &= \beta_{(x)0} + \beta_{(x)1}\ln P_{(j)it-1} + \beta_{(x)2}\ln P_{(f)it} + \beta_{(x)3}\ln P_{(p)it} + \beta_{(x)4}\ln P_{(m)it} + \beta_{(x)5}\ln P_{(t)it} \\ &+ \beta_{(x)6}\ln A_{it} + \beta_{(x)7}\ln B_{it} + \beta_{(x)8}\ln S_{it} + \beta_{(x)9}\ln L_{it} + \beta_{(x)10}\ln Edu_{it} + +\beta_{(x)11}\ln NL_{it} \\ &+ \beta_{(x)12}\ln PX_{it} + \beta_{(x)13}\ln BT_{it} + \beta_{(x)14}\ln ZPSR_{it} + \beta_{(x)15}\ln JYSR_{it} + \beta_{(x)16}\ln GDZC_{it} + \varepsilon_{it}\end{aligned} \quad (3)$$

Where $y_{(x)it}$ denotes the average amount of mu of household input factors in year t for farm household i, where X denotes the main input factors such as fertiliser, pesticides, agricultural machinery and agricultural labour; $P_{(j)it-1}$ denotes the price of food in year t-1, $P_{(f)it}$, $P_{(p)it}$ and $P_{(t)it}$ denote the prices of fertiliser, pesticides and film in that year respectively, and $P_{(m)it}$ denotes the price of diesel in that year, which is used as a substitute for the price of agricultural machinery used; the other variables have the same meaning as in the above, and will not be repeated here.

3.2. Data sources and descriptions

This study uses data from the National Rural Fixed Observation Point Survey of the Rural Economic Research Centre of the Ministry of Agriculture from 2004 to 2013. In consideration of data availability, continuity and consistency of statistical calibre, household factor endowments were divided into land factor endowment, labour factor endowment and capital factor endowment in this study, and the subdivision variables of each factor were set and measured as shown in Table 1. According to the analysis framework and the arrangement of the research content, the data of farm households with zero or blank planting area were excluded, and a total of 147,713 samples were obtained, including all provinces in China, and the relevant values were standardised to eliminate the effect of inflation. The sample data are panel data of farm households in each province from 2004 to 2013, and the empirical analysis is conducted based on a panel data fixed effects model using Stata 12.0 software. In particular, it should be noted that the price factor is also an important influencing variable on farmers' production decisions, but this study only uses the price factor variable as a control variable and does not specifically analyse the influence of the price factor on farmers' production decisions. Due to space constraints, only the mean values of the main variables are presented (see Table 1).

Table 1. Definition and interpretation of each variable

Type	Segmentation variables	Variable type	Alternative variables or metrics	Unit	Average
Farmers' cropping structure decisions	Area under food crops as a proportion of total acreage	Dependent variable	Area under food crops/Total area under cultivation	%	0.7874
Farmers' input decisions on factors of production	Average fertilizer use per acre	Dependent variable	Cost of fertiliser / Area sown	Yuan/Acre	94.9958
	Average pesticide use per acre	Dependent variable	Pesticide costs/Area sown	Yuan/Acre	47.7319
	Average acreage of film use	Dependent variable	Film costs/Area sown	Yuan/Acre	54.0102
	Average acreage of hired labour use	Dependent variable	Cost of hired labour / Area sown	Yuan/Acre	125.1875
	Average acreage of farm machinery used	Dependent variable	Agricultural machinery costs/Area sown	Yuan/Acre	67.8591
Land factor endowment	Arable land area	Independent variable	Total area of family contracted land	Acre	9.6607
	Area of arable land transferred	Independent variable	Subcontracted-in - Subcontracted-out arable land area	Acre	0.0185
	Degree of arable land fragmentation	Independent variable	Number of family-run arable plots at the end of the year	Block	5.5769
Labour factor endowment	Number of agricultural labourers	Independent variable	Number of family agricultural labourers	Person	1.6769
	Age of the workforce	Independent variable	Average age of the workforce	Age	43.7838
	Level of education of the workforce	Independent variable	Average years of schooling in the workforce	Year	6.8655
	Workforce training	Independent variable	Whether the workforce is trained	Numerical values	0.3128
Capital factor endowment	Amount of government subsidy	Independent variable	Revenue received from government	Yuan	705.4914
	Household disposable income	Independent variable	Total annual household income	Yuan	46868.77
	Income from agricultural operations	Independent variable	Household business income	Yuan	12672.27
	Productive fixed assets	Independent variable	Original value of productive fixed assets at the end of the year	Yuan	15240.53

Price elements	Fertilizer prices	Control variables	Amount of fertilizer purchased/Amount of fertilizer	Yuan/Kg	2.1840
	Pesticide prices	Control variables	Amount of pesticides purchased/Number of pesticides	Yuan/Kg	20.8151
	Agricultural machinery prices	Control variables	Amount of diesel purchased / Quantity of diesel	Yuan/Kg	5.3366
	Film prices	Control variables	Amount of film purchased / Quantity of film	Yuan/Kg	8.7769
	Grain prices	Control variables	Amount/Quantity of produce sold	Yuan/Kg	2.1523

Source: Compiled from data on rural households from 2004 to 2013 from fixed observation sites across the country. Due to space limitations, the values of extreme values, variance and standard deviation of each variable are not listed.

4. Empirical analysis of the impact of factor endowment characteristics on the production decisions of farm households

4.1. Impact of household factor endowments on farming structure decisions

The econometric results in Table 2 show that most of the subdivision variables of land, labour and capital factor endowments have statistically significant effects on farmers' cropping structure decisions, and all price variables pass the significance level test. The statistical significance of the estimated coefficients of the variables also indicates that the model estimates are good and have strong realistic explanatory power. The estimated results of the model reflect that household factor endowments have a significant influence on farmers' cropping structure decisions, and that farmers will consider their household factor endowments when deciding on the cropping structure of their farm.

Table 2. Fixed effects regression results for factors influencing farmers' cropping structure decisions

Variable	Coef.	Std.Err.	T Value	P>|t|	[95%Conf.Interval]
Arable land area	-0.0005**	0.0002	-3.14	0.0020	(-0.0008, -0.0002)
Area of arable land transferred	0.0026***	0.0007	3.73	0.0000	(0.0013,0.0040)
Number of plots of cultivated land	0.0030***	0.0005	6.30	0.0000	(0.0020,0.0039)
Household disposable income (log)	-0.0088**	0.0034	-2.62	0.0009	(-0.0154, -0.0022)
Income from agricultural operations (log)	-0.0285***	0.0025	-11.46	0.0000	(-0.0333, -0.0236)
Productive fixed assets (log)	0.0023	0.0017	1.38	0.1680	(-0.0010,0.0056)
Government subsidies (logarithmic)	0.0101***	0.0013	7.89	0.0000	(0.0076,0.0126)
Pesticide prices (log)	0.0103***	0.0021	4.83	0.0000	(0.0062,0.0145)
Film prices (log)	0.0115**	0.0035	3.24	0.0010	(0.0045,0.0184)
Diesel prices (log)	-0.0108***	0.0022	-4.93	0.0000	(-0.0090,0.0064)
Fertiliser prices (log)	-0.0087*	0.0036	-2.44	0.0150	(0.2237,0.3222)
Food prices (log)	0.0513***	0.0039	4.34	0.0000	(-0.0293,0.0019)
Number of agricultural labourers	-0.0087***	0.0018	-4.72	0.0000	(0.0006,0.0161)
Age of the workforce	0.0012***	0.0003	3.61	0.0000	(-0.0024,0.0119)
Level of education of the workforce	0.0001	0.0005	0.24	0.8110	(-0.0024,0.0119)
Workforce training	0.0031	0.0020	1.57	0.1160	(-0.0008,0.0070)
Constant term	-0.1360***	0.0326	-4.17	0.0000	(-0.1998, -0.0721)

Note: ***, ** and * indicate significant at the 1%, 5% and 10% statistical levels respectively. Same below.

Firstly, the breakdown of land factor endowments all passed the significance level test, with the area of cultivated land transferred and the number of cultivated plots having a significant positive effect on farmers' choice to grow food, and the area of cultivated land having a significant negative effect. Generally speaking, farmers will choose to grow a variety of crops for risk diversification reasons, and because food crops are easy to manage and mechanised, they are more likely to use the land they have transferred for growing food crops. The estimated coefficients were -0.0005 and 0.0026 respectively, indicating that the larger the area of household farming, the smaller the proportion of food crops that farmers grow, and the more land that is transferred, the greater the proportion of food crops that farmers grow, which is consistent with the theoretical expectation that farmers will diversify their risk. . It is worth noting that there is a significant positive effect of the number of plots on farmers' choice to grow food crops, with an estimated coefficient of 0.0030, indicating that the greater the number of plots, the stronger farmers' willingness to grow food crops. The possible reasons for this are that the small size of arable land and the fragmentation of the land are common in China, and the primary choice of farmers is to "satisfy their food needs". As a result, farmers choose to grow more food crops that are easy to manage and essential to their livelihoods, taking into account a number of factors.

Secondly, the number of agricultural labourers in the labour factor endowment has a significant negative influence on the farming structure decision, the age of labourers has a significant positive influence, and the education and training of labourers has a statistically insignificant influence on the farming structure decision. This suggests that the greater the number of agricultural labourers, the more reluctant farmers are to grow more food crops, the older the labourers are, the more willing they are to grow food crops, and the education and training of the labourers have little effect on the farmers' decision on cropping structure. Possible reasons for this include: Firstly, the more agricultural labour a household has, the more labour time and intensity of labour it can devote, and farmers are more willing to grow cash crops or speciality crops that are more efficient and can make full use of labour resources. Secondly, the older the labour force is, the more willing farmers are to grow food crops based on their labour capacity. Thirdly, the influence of collective decision making

reduces the importance of human capital on household farming decisions, resulting in a weaker influence of labour force education and training on farmers' farming structure decisions, which is in line with the findings of Hu Xuezhi [5] et al.

Thirdly, the capital elements of household disposable income and farm business income have a significant negative effect on farmers' decision to grow crops, with estimated coefficients of -0.0088 and -0.0285 respectively, government subsidies have a significant positive effect, and the variable of household ownership of productive fixed assets has a positive but statistically insignificant effect. This indicates that the higher the household farm income and disposable income, the lower the willingness of farmers to grow food crops, while the government related subsidies significantly increase the share of farmers growing food crops. The possible reason for this result is that farmers prefer to grow more economically efficient crops based on profit maximisation, but government subsidies can, to a certain extent, stimulate farmers to grow more food. This is also more consistent with the real-life results of farmers' planting decisions.

4.2. Influence of household factor endowments on farm households' factor input decisions

4.2.1. Impact on agricultural hired labour inputs

Looking at the econometric results in Table 3, the area of cultivated land, number of plots, income from farming operations and productive fixed assets have a significant negative effect on household agricultural hired labour inputs, while household disposable income, government subsidies and age of labour have a significant positive effect, and all price variables pass the significance level test statistically. In terms of impact, household disposable income and government subsidies have the largest impact on household agricultural labour, with estimated coefficients of 0.2736 and 0.1087 respectively, indicating that households with abundant capital factor endowments invest more in agricultural labour. In terms of the effect, both the area of cultivated land and the number of cultivated plots have a negative impact on household agricultural labour input, with estimated coefficients of -0.0045 and -0.0165 respectively, indicating that the characteristics of China's ultra-small and highly fragmented land factor endowment make farmers mostly reluctant to invest in agricultural labour. In terms of the impact of labour factor endowment on agricultural hired labour, only older households are willing to increase their agricultural hired labour input, indicating that older households will appropriately reduce the area of land under cultivation due to their declining labour capacity, but will also compensate for the possible loss due to labour shortage by increasing their agricultural hired labour input. It can therefore be surmised that the state of China's land factor endowment is not conducive to the development of large-scale agricultural operations by farming households, and it is unlikely that agricultural hired labour inputs will be increased. However, as rural household incomes rise and government subsidies increase, farm households' capital factor endowments improve, helping to increase agricultural hired labour inputs. Possible reasons for the smaller impact of labour factor endowment on farm households' agricultural hired labour inputs are: firstly, in the event of a shortage of household labour, farmers are able to choose alternatives to agricultural hired labour, such as farm machinery operations and pesticide spraying. Secondly, with the low returns from agricultural production and operations and the rising cost of labour, most small and scattered farmers are reluctant to hire labour as the income from farming may not be sufficient to cover their hiring costs. Thirdly, in an era of massive rural labour exodus, the majority of those still working at home in agriculture are elderly people and women, for whom agricultural labour means depriving themselves of 'employment' opportunities.

Table 3. Fixed effects results for factors influencing the decision to use agricultural hired labour

Variable	Coef.	Std.Err.	T Value	P>|t|	[95%Conf.Interval]
Arable land area	-0.0045***	0.0010	-4.64	0.0000	（-0.0064, -0.0026）
Area of arable land transferred	-0.0011	0.0046	-0.24	0.8100	（-0.0102, 0.0080）
Number of plots of cultivated land	-0.0165***	0.0031	-5.37	0.0000	（-0.0225, -0.0105）
Household disposable income (log)	0.2736***	0.0225	12.18	0.0000	（0.2295, 0.3176）
Income from agricultural operations (log)	-0.0629***	0.0169	-3.72	0.0000	（-0.0960, -0.0298）
Productive fixed assets (log)	-0.0267*	0.0112	-2.40	0.0170	（-0.0486, -0.0049）
Government subsidies (logarithmic)	0.1087***	0.0082	13.28	0.0000	（0.0927, 0.1248）
Pesticide prices (log)	0.2361***	0.0114	20.79	0.0000	（0.2139, 0.2584）
Film prices (log)	0.4481***	0.0192	23.40	0.0000	（0.4106, 0.4857）
Diesel prices (log)	0.2071***	0.0136	15.23	0.0000	（0.1805, 0.2338）
Fertiliser prices (log)	0.0037*	0.0250	0.15	0.0010	（-0.0452, 0.0527）
Food prices (log)	0.2729***	0.0251	10.86	0.0000	（0.2237, 0.3222）
Number of agricultural labourers	-0.0053	0.0122	-0.44	0.6620	（-0.0293, 0.0186）
Age of the workforce	0.0118***	0.0022	5.28	0.0000	（0.0074, 0.0161）
Level of education of the workforce	0.0048	0.0036	1.31	0.1920	（-0.0024, 0.0119）
Workforce training	0.0083	0.0138	0.60	0.5490	（-0.0188, 0.0353）
Constant term	-1.8370***	0.2139	-8.59	0.0000	（-2.2563, -1.4178）

4.2.2. Impact on agricultural machinery inputs

The econometric results in Table 4 show that the area of cultivated land diverted, household disposable income, age of labour force and education level of labour force have a significant positive effect on the factor input of agricultural machinery of farm households, with estimated coefficients of 0.0079, 0.3274, 0.0164 and 0.0215 in that order, and all price variables pass the significance level test statistically, indicating that the overall estimation effect of the model is good and strong explanatory power for the real situation. The

regression results suggest that farmers with more arable land in circulation, higher household income, older labour force and higher education levels have greater input in agricultural machinery factors, meaning that farmers with these household factor endowment characteristics will be willing to increase the use of agricultural machinery. Possible reasons for this include: firstly, the more arable land is transferred, the greater the household's labour resources can hardly meet the needs of the production operation, and more agricultural machinery inputs can effectively reduce production costs compared to agricultural hired labour. Secondly, the purchase cost of agricultural machinery is generally higher, and even hiring agricultural machinery requires a considerable amount of service fees, so disposable income becomes an important factor in whether farmers are willing to invest more in agricultural machinery. Thirdly, the older the family members are, the deeper their attachment to the land. They are psychologically unable to transfer the land or leave it abandoned, and they are unable to complete the whole agricultural production and operation by themselves, so they will generally choose to work with agricultural machinery which saves time and labour and the cost is relatively low. Fourthly, farmers with a high level of education have a higher willingness to accept new technologies. For farmers with a higher level of knowledge, their quality and ability to operate small and medium-sized agricultural machinery is also higher, and in the case of labour shortage, such farmers will increase the input of agricultural machinery factors.

Table 4. Fixed effects results for factors influencing input decisions for agricultural machinery factors

Variable	Coef.	Std.Err.	T Value	P>|t|	[95%Conf.Interval]
Arable land area	0.0005	0.0009	0.59	0.5560	（-0.0117, 0.0022）
Area of arable land transferred	0.0079***	0.0023	3.44	0.0010	（0.0034, 0.0124）
Number of plots of cultivated land	-0.0024	0.0029	-0.81	0.4190	（-0.0081, 0.0034）
Household disposable income (log)	0.3274***	0.00271	12.10	0.0000	（0.2743, 0.3804）
Income from agricultural operations (log)	0.0192	0.0209	0.92	0.3580	（-0.0217, 0.0601）
Productive fixed assets (log)	-0.0242	0.0132	-1.83	0.0680	(-0.0501,0.0018)
Government subsidies (logarithmic)	-0.0044	0.0086	-0.51	0.6110	(-0.0211,0.0124)
Pesticide prices (log)	0.0632***	0.0142	4.46	0.0000	(0.0354,0.0910)
Film prices (log)	0.2039***	0.0245	8.34	0.0000	(0.1560,0.2518)
Diesel prices (log)	-0.0354*	0.0157	-2.26	0.0240	(-0.0661, -0.0046)
Fertiliser prices (log)	0.2057***	0.0283	7.26	0.0000	(0.1502,0.2613)
Food prices (log)	0.1746***	0.0314	5.56	0.0000	(0.1131,0.2361)
Number of agricultural labourers	-0.0219	0.0138	-1.59	0.1110	(-0.0489,0.0051)
Age of the workforce	0.0164***	0.0027	6.09	0.0000	(0.0111,0.0217)
Level of education of the workforce	0.0215**	0.0069	3.09	0.0020	（0.0079,0.0351)
Workforce training	0.0044	0.0140	0.32	0.7510	（-0.0230,0.0319）
Constant term	-1.0295***	0.2518	-4.09	0.0000	（-1.5231, -0.5358）

4.2.3. Impact on inputs to agricultural production

The econometric results in Table 5 show that the price variables of the means of production have a significant effect on the use of fertilizer, pesticides and film. In terms of the estimated coefficients and statistical significance of the household factor endowment subdivision variables, all the subdivision variables of the land factor passed the significance level test for their effects on fertiliser, pesticide and film inputs, the labour factor endowment had a significant effect on fertiliser inputs and a relatively small effect on pesticide and film inputs, and the capital factor endowment also had a significant effect on farmers' inputs of means of production. The model is consistent with the theoretical expectation that the input decisions of farmers are not only influenced by the prices of various means of production, but are also constrained by household factor endowments.

Specifically, the impact of household factor endowment on agricultural inputs is characterised by the following main features: first, land factor endowment has a greater impact on agricultural inputs, with the area of cultivated land and the number of cultivated plots having a significant negative impact on agricultural inputs, while the area of cultivated land in transit has a significant positive impact. The coefficients of fertilizer input, for example, are -0.0030, -0.0235 and 0.0130 for the area of cultivated land, the number of cultivated plots and the area of transferred cultivated land respectively, indicating that the greater the number of transferred plots, the greater the input of fertilizer and other means of production by farmers, while the more dispersed the cultivated land is, the less motivated farmers are to invest in means of production. Secondly, the effect of labour factor endowment on farmers' fertiliser inputs is more pronounced, while the effect on pesticide and film inputs is smaller, with almost all variables being statistically insignificant. The reason for this may be that pesticides and films are two production materials that are used in small quantities each year by ultra-small-scale farmers, so a little more or less input will not have a significant impact on agricultural production; however, fertiliser is an effective supplement to land inputs, and when farmers have scarce land and surplus labour, farmers will compensate for the lack of land resources by increasing fertiliser inputs. Thirdly, capital factors have a significant effect on fertiliser, pesticide and film inputs, and the estimated coefficients of the subdivided variables and their signs reflect the obvious feature that capital factor endowments have mainly positive effects on fertiliser inputs and mainly negative effects on pesticide and film inputs. The estimated coefficients of government subsidies on fertiliser, pesticide and film inputs are 0.1157, -0.0273 and -0.0187, respectively, for the following possible reasons: Firstly, the vast majority of farmers in China have small arable land and produce mainly to meet household needs, so they use less pesticide for food safety reasons. Secondly, the use of pesticides and films is a rigid demand for agricultural production and operation, and accounts for a relatively low proportion of the overall cost of agricultural production, and farmers' input to this is less stimulated by the capital factor. Thirdly, in general, when land is tight, increasing fertiliser inputs can significantly increase

crop yields and the cost of fertiliser inputs per unit area is relatively high, so farmers' fertiliser input decisions are easily influenced by the "capital adequacy" of the household.

Table 5. Regression results of fixed effects of factors influencing farmers' input decisions on means of production

Variable	Fertilizer use (logarithmic)			Pesticide use (logarithmic)			Film usage (logarithmic)	
	Coef.	P>|t|		Coef.	P>|t|		Coef.	P>|t|
Arable land area	-0.0030**	0.0020		-0.0040***	0.0010		-0.0063***	0.0000
Area of arable land transferred	0.0130**	0.0050		0.0197***	0.0000		0.0078*	0.0120
Number of plots of cultivated land	-0.0235***	0.0000		-0.0060**	0.0080		-0.0059***	0.0080
Household disposable income (log)	0.3350***	0.0000		-0.0237	0.1310		0.0188	0.1750
Income from agricultural operations (log)	-0.0966***	0.0000		-0.0195*	0.0900		0.0240**	0.0200
Productive fixed assets (log)	0.0142	0.1510		-0.0163*	0.0460		-0.0125*	0.0640
Government subsidies (logarithmic)	0.1157***	0.0000		-0.0273***	0.0000		-0.0187***	0.0000
Pesticide prices (log)	0.3847***	0.0000		0.1910***	0.0000		-0.0549***	0.0000
Film prices (log)	0.8268***	0.0000		-0.0668***	0.0000		-0.0591***	0.0000
Diesel prices (log)	0.7087***	0.0000		-0.1469***	0.0000		-0.1173***	0.0000
Fertiliser prices (log)	-0.0195	0.3310		0.1429***	0.0000		0.0561****	0.0000
Food prices (log)	0.1015***	0.0000		0.0116	0.5170		0.0204**	0.2290
Number of agricultural labourers	0.0208*	0.0510		-0.0114	0.1950		-0.0135*	0.0670
Age of the workforce	0.0211***	0.0000		0.0031*	0.0590		-0.0004	0.7570
Level of education of the workforce	0.0030	0.1690		-0.0001	0.9740		-0.0003	0.8240
Workforce training	-0.0617***	0.0000		0.0043	0.6980		-0.0091	0.2410
Constant term	-5.0787***	0.0000		3.6894***	0.0000		3.1505***	0.0000

5. Research Conclusions and Implications

The above findings indicate that changes in household factor endowments have a significant impact on farming structure decisions. Specifically, factor endowments such as area of cultivated land transferred, number of cultivated plots, age of labour force, government subsidies and productive fixed assets owned by households had significant positive effects on farming decisions, while cultivated land area, number of agricultural labourers, household disposable income and farm business income had significant negative effects. Possible explanations for this result include: first, the arable land area of the rural fixed-observation site sample farmers is generally small, i.e. they are mainly small-scale farmers operating on a small scale, while the ultra-small-scale small farmers are generally more willing to grow food crops based on a combination of factors such as their livelihood needs, available labour capacity and subsidies for growing food. Secondly, for households with more agricultural labour, more arable land and relatively abundant capital elements, they are more inclined to pursue profit maximisation, and it would undoubtedly be a better choice to reduce food crop cultivation to save more land for other crops (such as cash crops) that are more economically efficient. In other words, households will make more 'favourable' decisions about the structure of their cropping based on their endowment of the main factors of production, such as land, labour and capital.

Meanwhile, a further analysis of the impact of changes in household factor endowments on farmers' factor input decisions reveals that the main subdivision variables of land and capital factors have a significant positive impact on agricultural labour, agricultural machinery inputs and agricultural production materials inputs, while the main variables of labour factors have more negative impacts. In other words, under the same conditions, farmers with relative advantages in labour factors prioritize how to make full use of household labour resources, while farmers with relative advantages in land and capital factors increase their inputs in agricultural labour, agricultural machinery and material means of production. It can be assumed that with the continued outflow of rural labour, especially as the trend towards an ageing, part-time and feminised workforce continues to deepen, farmers will invest more in agricultural labour and agricultural machinery to replace the shortage of household labour in the future.

In addition, the results of the study also reflect the undisputed fact that farmers' decisions on farming structure and production factor inputs are influenced by household factor endowments, and that capital and labour factors are in fact not scarce for ultra-small-scale farmers in China. As long as the comparative efficiency of agricultural production and operation reaches a certain level, the "profit-seeking" nature of capital will inevitably stimulate farmers to invest in agricultural production, and concerns about "who will grow the land" and "how to grow the land" will naturally subside. The concern about "who will farm" and "how to farm" will naturally subside. At that time, agricultural production and operation, as an important area that affects people's livelihood, will require special attention in order to ensure farmers' interests and achieve sustainable agricultural development. Therefore, focusing on issues such as changes in agricultural production factor inputs and their costs, the optimisation of factor endowment structures and the enhancement of comparative agricultural efficiency will be closer to the actual needs of China's agricultural development.

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