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Regional Differences of Farmers' Willingness to Grow Grain and Its Influencing Factors in Shandong Province under the Background of New-Type Urbanization

Xufang Zhang, Minghua Zhao, Xiaojie Wang and Rongqing Han *

School of Geography and Environment, Shandong Normal University, Jinan 250358, China
* Correspondence: hanrongqing@sdnu.edu.cn

Abstract: Taking Shandong Province as the research area, we explored the willingness of farmers to grow grain and the influencing factors. By constructing the evaluation system of their willingness with 6 levels and 15 indicators based on field investigation, and quantitatively analyzing the influence degree and impact assessment of factors through a logistic regression model, the regional differences in farmers' willingness were summarized, and the influencing factors were recognized. This study indicates that there were obvious regional differences in farmers' willingness, which were the highest in the western region, the second in the eastern region, and the lowest in the central region. Specifically, the willingness varies significantly among cities, among which Laiwu has the highest willingness (0.76), while Tai'an has the lowest (0.41). The level of urbanization in different regions and the main influencing factors are different, and the same factor has different degrees of influence on cities, leading to regional differences. In terms of urbanization level, the main influencing factors in areas with high urbanization levels are the proportion of grain income and grain expenditure. However, in areas with a low urbanization level, it is the farmers' planting attitude. From the perspective of influence mode, different factors have positive and negative differences in the willingness. Additionally, farmers' willingness is becoming more and more rational, and more consideration is given to economic benefits. Among the influencing factors, the land planting mode, the proportion of grain income, and the proportion of grain expenditure are the most important factors, and 82% (11) of the cities are affected by the above three factors. Finally, the corresponding incentive measures are proposed by the regional differences in the influencing factors in various cities.

Keywords: spatial differences; logistic regression models; impact assessment; new-type urbanization; Shandong Province; farmers' willingness

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1. Introduction

The new type of urbanization is a coordinated effort to promote regional economic, spatial, social, ecological, and urban-rural integration. Urbanization is characterized by overall planning between urban and rural areas, integration between urban and rural areas, industrial interaction, conservation-intensive, ecologically livable, and harmonious development [1,2]. Since the beginning of the 21st century, the rapid urban development due to the Chinese new-type urbanization strategy has led to the conversion of a large amount of agricultural land into land for construction, and the rural labor forces have been decreasing due to their transfer into nonagricultural industries [3–5]. Despite a series of subsidies and relief policies formulated and implemented by the state to strengthen and benefit agriculture, there are still situations where the cost of growing food has escalated, and the comparative efficiency of growing food has declined [6–8]. Farmers' willingness to grow food has been affected accordingly, and the phenomenon of sloppy food cultivation, less food cultivation, and abandonment of food cultivation has also intensified [6,9]. Food is the basis for economic development, social stability, and national independence [10]. In particular, China is a country with a large population, and a certain amount of food

supply is essential. Although China has accomplished great strides in the field of grain production in recent years [11,12], there is still a long way to go to ensure an adequate supply of grain from the small amount of arable land per capita and weak agricultural infrastructure [13,14]. Especially, farmers are the mainstay of food production, and their decision to grow food is directly related to national food security and social stability [5].

Scholars around the world have conducted relevant studies on farmers' willingness to grow food [15–25]. Firstly, some scholars have argued that the dual economic structure of urban and rural areas and the differentiation of farmer types have an impact on the willingness to grow grain. China's dualistic economic structure is related to the income gap between urban and rural residents [26]. The dual economic structure has led to a widening income gap between urban and rural residents, and a large number of farmers have flocked to cities to seek employment opportunities to increase their income, thus, weakening farmers' willingness to grow grain and engage in agricultural development [27]; at the same time, differences in the degree of specialization in agricultural operations and the input intensity of production factors have brought about structural differentiation in the types of farming households [28,29]. Thus, there are differences in the grain planting willingness of different types of farmers [30]. Secondly, some scholars have also studied and summarized the relationship between the grain growing mechanism and farmers' willingness to grow grain [31]. Building a long-term mechanism for enhancing food production should include incentives, efficiency, early warning, services, disaster resistance, and supervision [32]; meanwhile, mobilizing farmers' enthusiasm for food production also requires the construction and improvement of a benefits compensation mechanism [4]. For example, government subsidy policies can promote the adoption of agricultural technology as well as increase food production and farmers' income [33,34]. Thirdly, some scholars have conducted some empirical studies on farmers' willingness to grow grains and its influencing factors [35]. The reasons that affect farmers' enthusiasm for growing grains include many aspects: low utilization rate of agricultural equipment, lack of connection between agricultural machinery training and practice, nonstandard development of farmers' professional cooperatives, high grain production costs, and low comparative benefits of growing grains [36,37]. These are the fundamental reasons for low enthusiasm for growing grains. In addition, different factors have different impacts on farmers' willingness to grow grains [38]. Factors that have a positive effect on willingness to grow food include education level, years of experience in growing food, the proportion of returns from growing food, food prices, the strength of technical support for agriculture, etc. [39] Factors that have harmful willingness to grow food include farmers' health level, labor shortage, prices of production materials, and the proportion of women working in agriculture [40,41], while the effects of farmers' age, the proportion of food subsidies, and the ease of selling food are not significant [42,43]. It is also believed that farmers' willingness to grow grains differs among different age groups, for example, young adults born after 1980 are less willing to grow grains than farmers born before 1980 [44], while the mechanism of the impact of working outside the home on grain production is relatively complex, which will promote grain sown areas overall but may weaken grain cultivation in suburban and hilly mountainous areas [45,46]. Fourthly, there are also some studies on how to increase farmers' incentives to grow grains and improve the incentive mechanism for growing grains. Many scholars believe that grain subsidies should be further increased and the method of subsidies improved [47]. At the same time, the effect of the current subsidy system on enhancing the willingness to grow grains is affirmed [48]. However, some scholars believe that the subsidy policy has not achieved the expected effect in mobilizing the willingness to grow grains [49,50]. The subsidy policy has not had the effect of increasing the areas sown for grains and increasing production [51]. In addition, some scholars also believe that strategies, such as industrialized operation, the "three-pronged approach" of price, scale and technology, regulating the price of agricultural materials, realizing intensive planting, attracting talents, and strengthening technical training can improve farmers' enthusiasm for growing grains [52]. In addition, some scholars believe that the impact of new-type

urbanization on farmers' willingness to grow food is two-way [53,54]: On the one hand, it brings a large number of employment opportunities, causing a large number of young and strong rural laborers to flow out and arable land to be abandoned, resulting in a waste of land resources and a reduction in willingness to grow grains [39,55]. On the other hand, urbanization has optimized the distribution of resources, leading to increasing levels of mechanization in agriculture [56], which has reduced the burden of work on farmers and, to some extent, increased their willingness to grow food.

In short, previous scholars have summarized the reasons for farmers' low willingness to grow grains, assessed the effect of grain subsidy policies and other factors in increasing the motivation to grow grains, and proposed policy measures to increase farmers' motivation to grow grains from multiple perspectives [43,57,58], but less research has been conducted on the influencing factors that lead to regional differences in farmers' grain-growing decision-making behavior, without clarifying which regions' farmers are least willing to grow grains in and the differences in the influencing factors across regions.

Shandong Province has natural geographical conditions suitable for the development of agriculture, and its east-west difference is more obvious than the north-south difference, which is suitable for the growth and development of a variety of crops [57,58]. Therefore, it is one of the major grain-producing provinces in China, and its grain production is very important to ensure national food security [59]. However, as urbanization levels rise, the proportion of farmers' household income other than from grain cultivation increases [60], and more and more farmers give up grain cultivation as the proportion of the population growing grain decreases [61]. At the same time, unlike other major grain-producing provinces, Shandong belongs to the economically developed eastern coastal provinces and has good advantages in terms of development of external links, with a variety of contradictions, such as the contradiction between people and land [62], the contradiction between the economic development of other industries and agricultural development, and the economic benefits of grain cultivation and the income from working outside the home. Therefore, taking Shandong Province as the research object and carrying out research on farmers' incentive mechanisms for grain cultivation in the context of new-type urbanization is more typical than in other regions [63]. It will also help to further explore the advantages of regional grain-production resources in the major grain-producing provinces and will also be more conducive to coordinating the relationship between regional economic development and grain production and enhancing regional food security.

Based on this, this study takes the main grain-producing regions of Shandong Province in China as an example and analyzes the factors affecting the willingness to grow grains from the perspectives of farmers' basic personal characteristics, household characteristics, household economic income composition, and government support. Next, a regression model of willingness to grow grains is constructed, and the regional differences in willingness to grow grains and the differences in the strength of willingness to grow grains are evaluated, respectively. Then, the factors affecting willingness to grow grains are identified. Finally, a reference basis for future policy formulation based on an econometric model is provided.

2. Materials and Methods

2.1. Data Sources, Methodology, and Sample Characteristics

2.1.1. Model Theoretical Framework and Research Hypotheses

In this paper, three rounds of research were conducted. In the first round, the typical grain-growing villages were investigated to determine the factors that had a great impact on farmers' willingness to grow grain, and the contents of the questionnaires were summarized. In the second round, the survey was carried out in regions within the province, and the content of the questionnaire was constantly improved to make it more understandable. The third round is mainly for the areas with more unqualified respondents to carry out the supplementary survey. The research was carried out by means of field surveys,

questionnaire distribution, field visits to farmers, looking up statistical yearbooks, and other means.

In the process of data collection, the method of combining classification, concentration, and randomization was used to rank the grain-production and grain-planting areas of each county (district) in the same city, and the counties with higher grain-production and grain-planting areas were preferred, and the economic development of each county was comprehensively considered. On this basis, 3 to 5 villages were randomly selected in each county according to the principle of stratified sampling, and farmers were randomly selected in each village. Semi-structured interviews were used to conduct face-to-face interviews with the heads of farmers or their family members. The survey time for each farmer was approximately 20 min. The sample distribution is shown in Figure 1. Six modules and 31 influencing factors created the survey form (Appendix A), which covers the fundamental traits of farmers, aspects of food production and management, regional physical and geographical conditions, fundamentals of food growth, market factors, policies, and dangers. With 434 valid responses and an efficiency rating of 86.80 percent, a total of 650 questionnaires were sent and 500 questionnaires were returned.

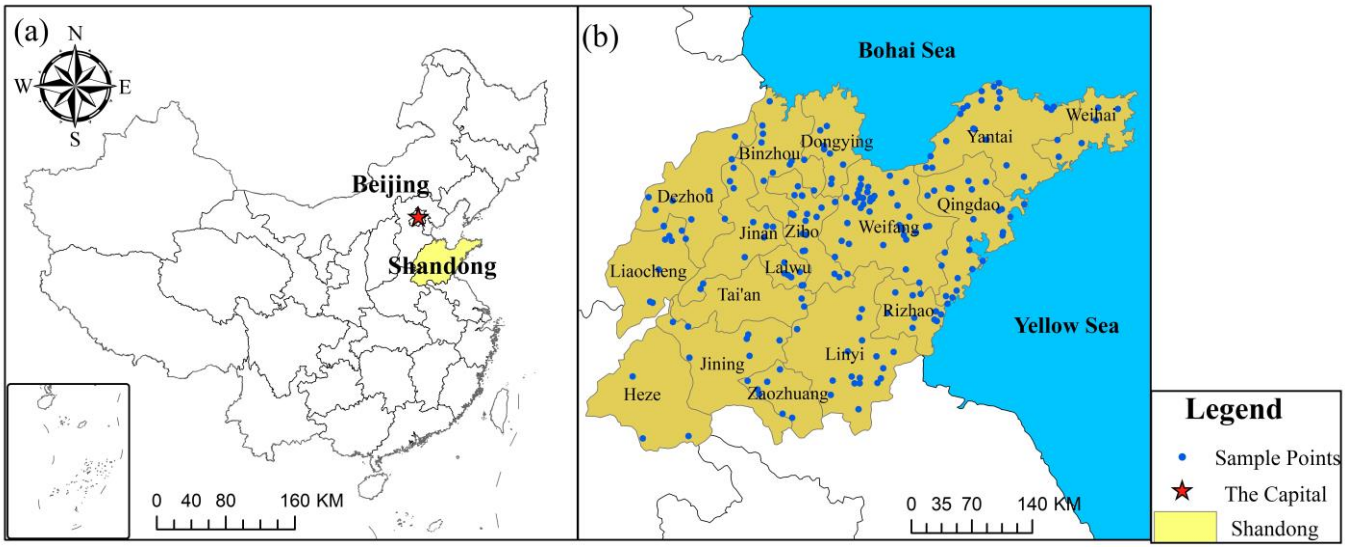

Figure 1. (**a**) Location of Shandong Province in China. (**b**) Distribution of survey sample sites in Shandong Province.

Several follow-up polls were conducted because the data collected from the initial survey would still have certain limitations. For instance, in certain questions, the total number of households did not equal the sum of the populations of those who were farmers, workers, and people who could not work or earn a living. This is due to the following factors: first, there may be a population of seasonal workers who also identify as farmers; second, there are elderly people who can assist families with basic labor; third, there are university students who are enrolled in classes; many people do not regard them as either farming or working, or as nonworking or nonearning. The population statistics in the survey tables may become inconsistent as a result of all the aforementioned factors. The perception of food production and income expenditure data also had anomalies, which were later confirmed by a targeted follow-up study.

The statistical yearbook was used to determine the urban population and total population of 17 cities in Shandong. The urban population and total population data for each region from 2016 to 2020 were averaged to determine the urbanization level of each urban area, with data from 2014 to 2018 being used due to Laiwu City's incorporation into Jinan City in 2019. In order to estimate the rate of urbanization in the region and to further investigate the relationship between urbanization and farmers' propensity to plant, 5 years of urbanization rates were averaged.

Finally, using the statistical program SPSS, the survey data were checked, entered into a database, and analyzed.

2.1.2. Research Methodology

(1) In order to describe the different sorts of farmers' willingness to cultivate food and the weight of each factor, the study constructed a mathematical model. Farmers' willingness to produce food is used as the explanatory variable y in this model. The contributing elements are divided into several dimensions, such as the basic characteristics of farmers' individuals and families, the scale of production and operation, the proportion of the household economy and grain income and expenditure, etc. With y following a binary distribution, a logistic binary regression model was utilized, with "1" for willingness to grow food and "0" for unwillingness to grow food. Let the probability of $y = 1$ be P, then:

$$P(y) = f\left(\beta_0 + \sum_{j=1}^{m} \beta_j x_{ij}\right) = \frac{1}{1 + \exp\left[-\left(\beta_0 + \sum_{j=1}^{m} \beta_j x_{ij}\right)\right]} + \varepsilon_i \quad (1)$$

$$P(y) = \frac{\exp(Z)}{1 + \exp(Z)} = \frac{1}{1 + \exp(-Z)} \quad (2)$$

$$Z = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_i x_i \quad (3)$$

where $P(y)$ is the probability of willingness to grow food; x_{ij} is the jth influence factor of the ith factor; β_j is the regression coefficient of the jth influence factor, which represents the influence intensity of variable xi on $p(y)$, namely, the weight of each influencing factor; m is the number of influence factors; β_0 is the regression intercept, which represents the natural logarithm of the ratio (the ratio of the probability of $y = 1$ to $y = 0$) when all the independent variables have 0 values; ε_i is the random disturbance term; i is the factor number.

The significance test of the regression model consists of a goodness-of-fit test of the overall model and individual parameter tests. The overall model test is expressed as the natural logarithm of the estimated likelihood ratio function of the parameters. The Wald test is used for the individual parameter tests. For multivariate logistic regression models, the larger the Wald value, the better the significance test.

The modeling results of the tested models are assessed in terms of the strength of the model linkage, which indicates the goodness of fit of the regression analysis, and the correct prediction rate, which reflects the performance of the model. The connection strength includes Cox Snell and Nagelkerke. The higher the value of the connection strength, the more closely the independent variable is linked to the dependent variable. The model prediction value is between 0 and 1. The prediction value is divided into two categories according to a certain threshold value: One for values greater than the threshold value and zero for values less than the threshold value. One-half is the threshold value in this paper, and the prediction results are divided into two categories according to this value: 0 or 1. (2) To determine the driving factors of grain-planting intentions at different urbanization levels, the cumulative contribution of each influencing factor is calculated. Weights of 4, 3, 2, and 1 are assigned to the first–fourth impact factors, respectively, and the degree of impact of each indicator is calculated for the different subdistricts, with the higher the value, the higher the impact factor.

$$w_i = \sum_{q=1}^{n} H_q^i \quad (4)$$

where w_i is the degree of influence of the ith indicator; q is the qth city in the subregion and H_q^i is the weight of factor i in city q.

2.1.3. Basic Characteristics of Farming Households in the Shandong Province Grain-Growing Sample

The agricultural population in the Shandong Province is small, but the proportion of farmers engaged in agriculture is high. This survey included 1723 participants, with an average household size of two farmers, and the percentage of participants who worked in agriculture was 54.56%. With 62.24 percent, Yantai has the highest percentage of residents working in agriculture, while Jinan has the lowest percentage at 43.75%. In terms of farming households, 432 households, or 99.54% of all farming households, are engaged in agriculture.

The middle-aged and elderly people aged 40–50 are the main force in farming, and the new generation of a reserve labor force of farmers in the future is seriously insufficient. Between the ages of 40 and 50, nearly half (45.43 percent) of farmers work in agriculture. Then comes the 50–60 age range, which makes up almost 70% of the entire farming population, and the over-60 age range, which makes up another 17.45% of the farming population. Only 2.13 percent of rural residents under the age of 20 work in food production. Eight towns do not even have any farmers under the age of 20, and the vast majority of them have left agriculture, even the countryside.

The literacy level of the farming population is generally low, with junior high school and primary school levels predominating. The education level of middle school (51.60%) and primary school (36.28%) of the agricultural population in Shandong Province accounted for nearly 90% of the total; there are relatively few people with a high school education level, and very few with a college-level or above (0.74%), with only a tiny proportion of the total farming population in five cities, namely Jinan, Heze, Dezhou, Jining, and Dongying, the highest proportion of which is less than 10%.

Many rural residents have jobs outside the house. Several households combine "farming + working" at the same time. A total of 461 people, or 26.76 percent of the total population examined for this research, were employed outside of their homes, with an average of 1.62 people working per family. A total of 275 of them were year-round employees, making up 59.65% of the population, while 186 of them were seasonal employees, making up 40.35% of the working population. The proportion of the working population in Weihai is the highest, accounting for more than half of the total surveyed population (53.66%), far higher than the provincial average. The proportion of the working population in Tai'an is the lowest, at 17.36%.

2.2. Theoretical Analysis, Model Setting and Variable

2.2.1. Model Theoretical Framework and Research Hypotheses

Farmers' grain planting is a productive investment decision-making behavior. They usually make decisions on whether to plant grains or how much area to plant grains according to their health, family economic conditions and local nature, and economic and social conditions in order to maximize benefits and income. In assessing the extent of farmers' willingness to grow food and considering the factors that influence it, several assumptions were constructed based on their practical lives.

Hypothesis 1. *Farmers' characteristics have an impact on their willingness to grow food. One is the effect of age on willingness to grow food* [64]. *The older a farmer is, the more likely he or she is to follow traditions and be more willing to grow food* [24], *from choosing crops to adopting farming techniques, and to be bound by traditional farming practices and experience. The second is the influence of personal education level on willingness to grow food. In general, the higher the level of education, the easier it is to accept new techniques for growing food* [65], *but the more opportunities there are to work outside the home, the more likely it is to leave food production.*

Hypothesis 2. *The land condition affects the willingness to grow food. The level of the land has a positive effect on the willingness to grow food* [28]. *In general, the flatter and larger the land, the easier it is to realize the scale effect of food cultivation, and the more willing farmers are to grow*

food [66]. *The better the irrigation conditions of the land, the easier it is to ensure stable and high grain yields and the more motivated farmers are to grow grains.*

Hypothesis 3. *The prices of food, agricultural materials, water, and electricity have an impact on farmers' willingness to grow food* [67]. *In general, the higher the price of food, the higher the income of farmers will be, and the more willing farmers are to grow food. On the contrary, the higher the price of pesticides, seeds, fertilizers, and other production materials, the higher the expenditure on growing food, the lower the income from food, and the lower the willingness to grow food* [68].

Hypothesis 4. *The share of food income has an impact on the willingness to grow food* [69,70]. *The share of income from food growing in total household income has a positive effect on the willingness to grow food. The higher the share of income from food cultivation in total income, the more dependent farmers' livelihoods are on food income, and the stronger their willingness to grow food* [42,71].

Hypothesis 5. *Relevant national policies and marketing methods have an impact on farmers' willingness to grow food* [72]. *The greater the scope and strength of grain subsidies, the greater the benefits farmers receive from grain production and the more inclined they are to grow grains* [34]. *In addition, the smoothness of grain marketing channels has a positive impact on the willingness to grow grains. The more marketing channels provided by governments and enterprises at all levels, the easier it is to sell grains, and the more farmers are willing to grow grains* [52].

Hypothesis 6. *The purpose of growing food and the level of labor participation required to grow food have an impact on farmers' willingness to grow food* [73]. *Those who grow food to ensure their food rations will continue to do so. The more labor input is required in the process of growing food, and the longer it takes up farmers' time, the less willing they are to grow food* [74].

2.2.2. Design of Variables for Model Construction

The selection of influencing factors should be combined with the actual and regional variability of the study area. Shandong Province is one of the main grain-producing regions in China, with a large area under grain cultivation, high yields, a large population, and relatively few arable land resources per capita. At the same time, cultivation conditions vary across the region, and cultivation preferences differ. By screening the questionnaires and summarizing previous studies, six categories of multiple variables were introduced into the model (Table 1).

Table 1. Description of variables influencing farmers' willingness to grow food.

Variable Type	Variable Name	Sub-Variable Name	Variable Code	Significance
Explained variables		Willingness to grow food	Y	Willing = 1, Unwilling = 0
Explanatory variables	1. Basic characteristics of decision-makers	Age	X1	20~40 years old = 1, 40~50 years old = 2, 50~60 years old = 3, over 60 years old = 4
		Education level	X2	Primary and below = 1, Middle school = 2, High school = 3, College and above = 4
		Household working population	X3	Expressed as actual values

Table 1. *Cont.*

Variable Type	Variable Name	Sub-Variable Name	Variable Code	Significance
	2. Scale of production of food and agriculture	Grains growing area	X4	Based on the number of hectares planted for food in 2015 obtained from the survey
		Type of land use	X5	Irrigated land = 1, dry land = 0
		Terrain flatness	X6	Flat = 1, sloping = 0
		Degree of mechanization	X7	Mechanized area/grain-growing area $\geq$ 0.5, assigned a value of 1; otherwise, assigned 0
	3. Food production and income	Average grain yield per acre	X8	Expressed as actual values
		Income from food growing as a proportion of total income	X9	Expressed as actual values
	4. Food expenditure	Food expenditure as a proportion of total expenditure	X10	Expressed as actual values
	5. Food receipts, expenditures, and marketing methods	Food balance position	X11	Expressed as a ratio of food income/food expenditure
		Grain marketing methods	X12	Collective acquisition = 1, Self-selling = 0
	6. Attitudinal characteristics of food and farming	Purpose of food growing	X13	Own rations = 1, other = 0
		Land cultivation methods	X14	Unwilling to rent (self-grown) = 1, willing to rent = 0
		Tendency to grow food crops in the future	X15	Wheat, maize, and rice = 1, others = 0

The basic information on the surveyed farmers and their food production is shown in Table 2 below.

Table 2. Summary statistics of sample farmers' characteristics and evaluation of food production.

Farmers' Characteristics	Type	Number (pcs)	Percentage (%)
Age of head of household	40 years and under	64	14.75
	40–50 years old	206	47.47
	50–60 years old	99	22.81
	Over 60 years old	65	14.98
Education level of head of household	Primary school and below	120	27.65
	Junior High School	245	56.45
	High School	66	15.21
	Tertiary and above	3	0.69
Grains marketing methods	Self-selling	380	87.56
	Collective acquisition	54	12.44
Purpose of food growing	Secure your rations	312	71.89
	Other	122	28.11
Land cultivation methods	Yes (for rent)	185	42.63
	No (self-seeded)	249	57.37
High-income growing methods	Growing food	104	23.96
	Planting other crops	330	76.04
Propensity to grow future crops	Growing food crops	304	70.05
	Growing other crops	130	29.95

3. Results

3.1. Econometric Evaluation of Farmers' Willingness to Grow Food in Shandong Province and Analysis of the Influence Mechanism

3.1.1. Model Accuracy Check

In order to assess the rejection variables according to the likelihood of the Wald statistic, the backward stepwise rejection selection approach was used in a binary logistic regression analysis on the valid survey samples using SPSS. Maximum likelihood estimation and the Hosmer–Lemeshow test were used to verify the simulation effect of the model. The larger the maximum likelihood estimate is, the better the prediction effect of the model is. At the significance level of 0.01, the minimum value of the maximum likelihood index for 18 logistic models is 451.5067, and the simulation prediction accuracy is 76.7281%. The smaller the value of significance is, the higher the accuracy of the model. In this model, the maximum significance value is 0.1611, which has a high accuracy. At the significance level of 0.01, the smallest COX-Snell R^2 is 0.2737, and the smallest Nagelkerke R^2 is 0.3682, indicating that there is no significant difference between the predicted value and the real value. All the models underwent the HL test. The overall fitting effect of the model is good, and the regression results have credibility.

3.1.2. Analysis of the Mechanisms Influencing Willingness to Grow Food

Logistic regression analysis was carried out for the whole of Shandong Province, and the coefficients of each factor obtained according to Formula (3) were used as the weights of influence on the willingness to grow food [75,76]. The larger the coefficient, the greater the weight. According to the weight of each factor, the influence of each factor on farmers' willingness to grow grain was determined.

The simulation results show that the following factors, in descending order, have an impact on farmers' willingness to grow grains: the way farmers cultivate their land; the percentage of income they obtain from growing grains; the percentage of expenditure on growing grains; the purpose of growing grains; the propensity to grow grains; the age of farmers; the number of household laborers; the degree of agricultural mechanization; the terrain's flatness; and the education level of the household head. However, the average grain yield per acre, the ratio of grain income to expenditure, the mode of grain sales, the area of grain planting, and other factors do not have a significant impact on farmers' willingness to grow grains.

From the nature of the impact of various factors on the willingness to grow grains, most of the factors are positive, while the education level of the head of household has a negative impact on the willingness to grow grains.

There is a significant positive correlation between land planting methods and farmers' willingness to grow grains. That is, if the land is planted by themselves, the willingness to grow grains is very high, which shows that farmers attach importance to the right to land management [69]. The propensity to cultivate food is considerably and favorably connected to the proportion of income from food production in overall income. The desire to grow food increases with the proportion of revenue from food production to total income; conversely, the smaller the proportion, the less dependent household consumption expenditure is on food income, and the weaker the desire to grow food. This highlights the significance of economic revenue for household development, which has a significant impact on farmers' decisions over whether or not to plant food [77].

Farmers' willingness to cultivate food is positively connected to the proportion of household spending on food cultivation. Farmers that spend more money on food production typically have more land available for food production, larger economies of scale, more substantial advantages when growing food, and greater farmer motivation.

The intention behind raising food and the inclination to do so are positively associated. As more individuals choose organic and pollution-free foods, food safety has become a major topic of discussion [78]. In addition, many farmers have chosen to raise their food

to secure food security, which also reflects the overall anxiety and worry among farmers regarding food safety and market procedures.

Farmers' willingness to grow food is influenced by their predisposition to do so [79]. Traditional food crops, including wheat, maize, and rice, are more likely to be grown by farmers. Their food rations can be guaranteed by this decision, and if there is an excess of food, they can sell it and make money from the food.

The inclination of the family head to cultivate food is positively correlated with his or her age [80]. The opportunity cost of engaging in other economic endeavors decreases with age, and household heads are less likely to seek jobs outside the home. On the other hand, as they become older, they get more experience in farming, which increases their readiness to cultivate grains. Of course, it should also be considered that as farmers age to a certain extent, their labor ability will weaken, and at this point, their willingness to cultivate food is influenced by their physical condition and declines. There should, therefore, be a reasonable upper limit to the age of households.

The willingness to grow food is also positively correlated with the number of people employed. When farmers decide to grow food, they can be less concerned with the pressure of economic returns from the amount of land output and consider more food production that involves less and less labor time while still meeting the family's food needs [9], so their willingness to grow food is stronger than that of households with no or few workers. This is because the presence of people working outside the home can increase household income. This also reflects that in the current economic development situation, the income from growing grains is increasingly not an important part of family economic income, and farmers' willingness to grow grains is no longer based on increasing family income as the main consideration of motivation.

The willingness to cultivate food is positively connected with the level of agricultural mechanization [81]. Science and technological advancements have led to a gradual rise in agricultural mechanization, which has gradually liberated agricultural laborers from agricultural production and given them more employment possibilities. As a result, farmers are more motivated to continue growing food at higher levels of mechanization, which can ensure the family's food ration and also slightly raise income levels.

The household head's education degree hurts their willingness to cultivate food [82]. The greater one's education, the greater one's access to career opportunities outside of agriculture, and the greater one's contribution to the household income. Those with higher education levels in the household typically leave the house to work to uphold the principle of maximizing household revenue. This also reflects that China's agricultural output is largely low-tech and that planting grain does not require a high level of education for producers.

The willingness to cultivate food is impacted by the type of land use to a certain extent [28]. Watered land typically produces high yields and ensures agricultural production, but it is more likely to be used as vegetable land for high-yield agricultural cultivation. Economic advancement and material affluence have caused a shift in the goal of food production, which now focuses more on providing the family with food rations rather than generating the family's revenue. As a result, drylands are utilized for food cultivation instead.

Farmers' inclination to grow grains is not sufficiently influenced by variables, including the average grain yield per acre, the grain income to expenditure ratio, the grain marketing strategies, and the area used for grain planting. Particularly, the number of grains produced per acre and the area that is planted with grains have essentially little influence on farmers' intentions to cultivate grains. This shows that farmers are producing grains more for household rations than to increase household grain output in the current setting, where China has attained a subsistence level. Accordingly, farmers are not impacted much by the grain's income-to-expenditure ratio and the mode of grain sales. These results are similar to previous studies, but there are some differences due to regional differences [64,83].

3.2. Regional Differences in Farmers' Willingness to Grow Food in Shandong Province

3.2.1. Regional Differences in Farmers' Willingness to Grow Food

A logistics regression analysis was carried out on 17 prefecture-level cities in Shandong separately, and the willingness to grow grains of each city was obtained. The anticipated findings were expressed using ArcGIS software at equal intervals to illustrate the regional variations in farmers' propensity to cultivate food in Shandong Province (Figure 2). In 17 cities in Shandong Province, it is clear that there are significant spatial disparities in farmers' willingness to grow food. Farmers' willingness to grow food is highest in the western region, followed by the eastern region, and is at its lowest in the central region. From the results of the 17 cities, farmers' willingness to grow grains in Laiwu is the highest at 0.76. Followed by Rizhao and Dezhou, farmers' willingness to grow grains is 0.73 and 0.72, respectively. Farmers in Tai'an and Dongying have the lowest willingness to grow grains, 0.48 and 0.41, respectively. The impact of local economic growth and openness on regional agricultural production and farmers' willingness to raise food is reflected in this spatial disparity.

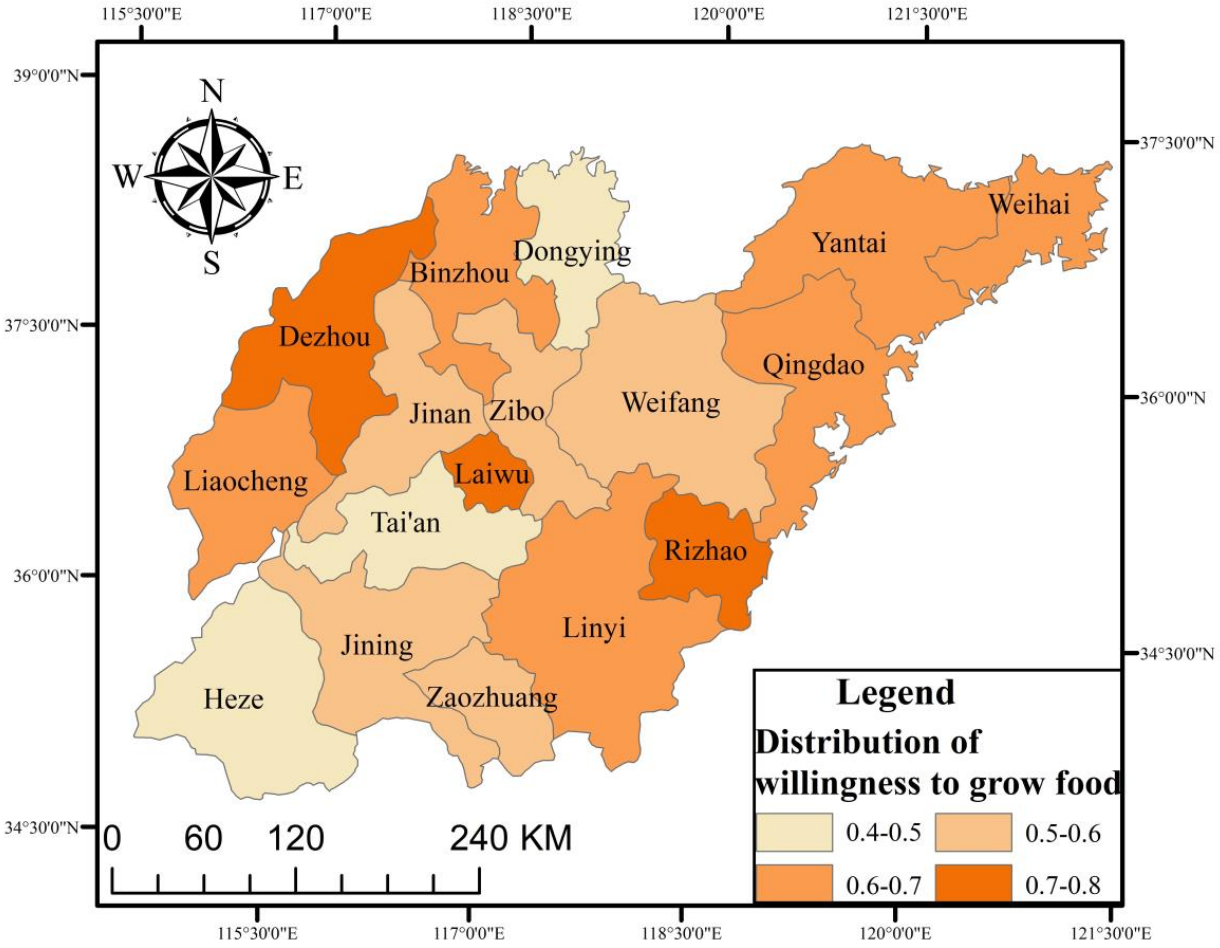

Figure 2. Willingness to grow grains in different cities in Shandong Province.

With high soil fertility, high levels of grain production, and ease of mechanization, the western cities of Dezhou, Liaocheng, and Binzhou offer favorable fundamental circumstances for agricultural development. These qualities are especially prevalent on the plains. However, despite the region's low degree of economic growth and farmers' relative reliance on grain production, they are highly motivated to cultivate the crop.

Qingdao, Yantai, Weihai, and other cities in the east are located in the eastern coastal open areas. Nonagricultural industries are relatively developed, and there are many

opportunities to attract agricultural labor. The family's economic income depends more on migrant workers or the development of orchards, fisheries, and other industries. However, these areas have a good agricultural base and a tradition of growing food, so farmers' willingness to grow food is relatively high.

The central cities of Tai'an, Dongying, Jinan, and Heze, with their rapid urbanization and high level of economic development, have mountainous and hilly terrain, while Dongying, in the north, has saline soils with low land fertility. Heze, in the southwest, has been engaged in the flower gardening industry, mainly peonies, in recent years, thus, making farmers' willingness to grow food very low in these cities.

3.2.2. Differences in Willingness to Grow Food under the Influence of New-Type Urbanization

Population urbanization is an important sign of new-type urbanization and an important reflection of the scale of urbanization. The proportion of the urban population to the total population is commonly used to indicate the level of urbanization in a certain region [1]. The process of urbanization has a great impact on the area of arable land, government subsidy policies, and residents' income, thus, putting farmers' willingness to grow grains in a dynamic change. The urbanization level of each region in Shandong is expressed by averaging the urban population data from 2016 to 2020 for that area.

The 17 municipalities were divided into four categories (Figure 3), namely: high urbanization level and high willingness to grow food, high urbanization level and low willingness to grow food, low urbanization level and high willingness to grow food, and low urbanization level and low willingness to grow food. Using the average value of urbanization level and willingness to grow food as the critical values, the value more significant than the average level is the high value, and the value less than the average level is the low value.

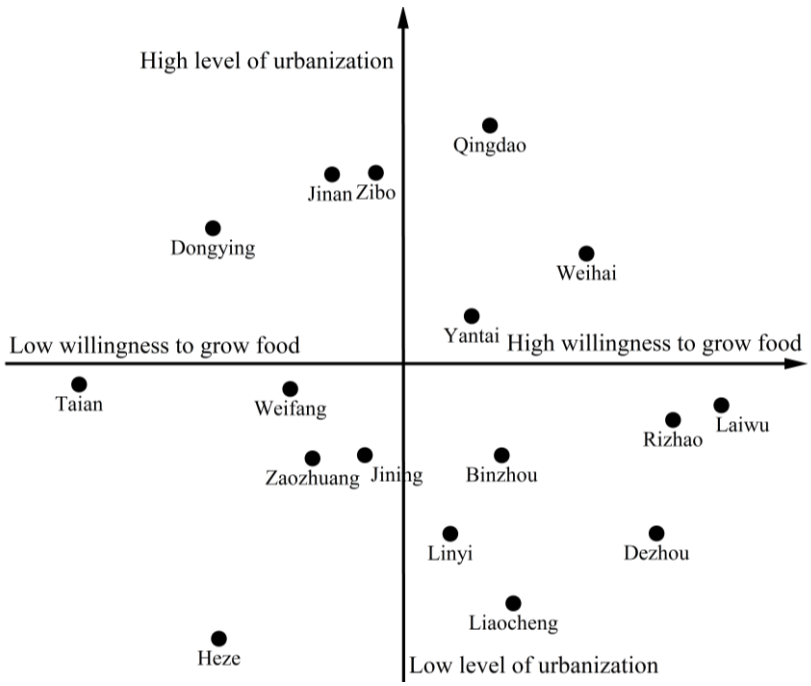

Figure 3. Differences in willingness to grow food in regions with different levels of urbanization.

In areas with high urbanization levels and high willingness to grow food, farmers' incomes are relatively high and government agricultural subsidies are strong, household incomes are guaranteed [84], a large number of young and strong laborers choose to stay in the local area, and there are many people engaged in agricultural technology, which makes growing food less intensive. This all makes the willingness to grow food high, even

at high urbanization levels. In areas with low levels of urbanization and low willingness to grow food, the overall economy is underdeveloped, resulting in a large out-migration of labor [85], with the remaining population being mostly elderly or children who do not have the ability to engage in heavy agricultural work, in addition to the low level of government subsidies for agriculture in these areas, making farmers less motivated to engage in agricultural work. Areas with high urbanization levels and low willingness to grow food are mostly areas with more developed secondary industries, which are richer in mineral resources and have a stronger industrial base, providing more job options for farmers [86]. In addition to government support, the income will also be more than that obtained from growing food. Therefore, farmers are more inclined to choose to work in factories rather than grow grains. Areas with low urbanization levels and high willingness to grow food are mostly traditional inland agricultural areas, where farmers see growing food as a responsibility. There are no pillar industries in these areas, and farmers are conservative and reluctant to go out to work, preferring to stay in their hometowns to cultivate.

3.3. Identification of Factors Influencing Regional Differences in Farmers' Willingness to Grow Food in Shandong Province

3.3.1. Main Factors Affecting Farmers' Willingness to Grow Food in Different Regions

The 17 sub-province regions in Shandong have different levels of economic development, and the number of local agricultural workers is also different, so the influencing factors of farmers' willingness to grow grain are also very different [6]. A logistic model was used to calculate the influencing factors of farmers' willingness to plant grain in the 17 cities separately. In addition, the coefficients of each factor in Formula (3) are taken as the weight of the influence on grain planting intentions, that is, the larger the coefficient, the higher the weight, according to the weight of each factor to determine the main influencing factors. The results showed that the main factors influencing farmers' willingness to grow food varied (Table 3).

Table 3. Statistical summary of main influencing factors of farmers' willingness to grow grains in 17 cities of Shandong Province.

City	First Impact Factor	Second Impact Factor	Third Impact Factor	Fourth Impact Factor
Binzhou	Self-grown or not	Type of land	Terrain	Guaranteed rations
Dezhou	Terrain	Self-grown or not	Mechanization	Type of land
Dongying	Expenditure ratio	Mechanization	Planting tendencies	Income ratio
Heze	Income ratio	Self-grown or not	Sales methods	Age
Jinan	Expenditure ratio	Income ratio	Type of land	Mechanization
Jining	Expenditure ratio	Self-grown or not	Income ratio	Guaranteed rations
Laiwu	Self-grown or not	Income ratio	Education level	Age
Liaocheng	Income ratio	Expenditure ratio	Guaranteed rations	Education level
Linyi	Income ratio	Expenditure ratio	Self-grown or not	Terrain
Qingdao	Expenditure ratio	Income ratio	Self-grown or not	Terrain
Rizhao	Expenditure ratio	Type of land	Terrain	Age
Tai'an	Planting tendencies	Self-grown or not	Sales methods	Guaranteed rations
Weifang	Self-grown or not	Income ratio	Grains production	Planting tendencies
Weihai	Working population	Guaranteed rations	Grains growing area	Planting tendencies
Yantai	Income ratio	Expenditure ratio	Mechanization	Type of land
Zaozhuang	Self-grown or not	Education level	Grains growing area	The ratio of income to expenditure
Zibo	Income ratio	Guaranteed rations	Self-grown or not	Expenditure ratio

It can be seen that the choice of willingness to grow food is more influenced by the level of economic development and agricultural status of each locality. Expenditure ratio, income ratio, and whether to grow one's own land were the most influential factors in 14 out of 17 localities, or 82.35%. The top influencing factor was the expenditure ratio in 35.29% of the cities; the income ratio was 29.41% and whether to grow one's seeds in 17.65% of the cities.

In many towns, the age of household heads and the degree of their education were not the primary influencing variables when it came to influencing factors representing the fundamental qualities of decision-makers. Among the first four influencing factors, only Heze, Laiwu, and Rizhao have the influence factor of age, while the education level is only reflected in Laiwu, Liaocheng, and Zaozhuang. However, the factor of family workers is the most prominent in Weihai along the eastern coast, which is the main influencing factor, which also reflects the impact of more employment opportunities for migrant workers brought by the opening conditions of the eastern coast on food production.

In terms of the factors influencing the scale of manifest grain production, the area of grain cultivation is only the third factor influencing the choice of willingness to cultivate grains in Weihai and Zaozhuang, and the type of land use is the main factor influencing Binzhou, Dezhou, Jinan, Rizhao, and Yantai. Meanwhile, the flatness of the terrain is the main factor influencing Binzhou, Dezhou, Linyi, Qingdao, and Rizhao, and the degree of land mechanization is the main factor influencing Dezhou, Dongying, Jinan, and Yantai. It can be seen that the scale status of regional grain production has a greater impact on the western region and is the main aspect that affects its ability to carry out large-scale operations and increase economic income.

In terms of influencing factors reflecting the economic benefits of grain production, the average yield of grain per mu has almost no influence on the choice of willingness to grow grains, while three factors, namely the proportion of income from growing grains to total income, the proportion of expenditure on grains to total expenditure, and the ratio of income to expenditure on grains, are the most important influencing factors in almost all cities. It can be reflected that farmers' willingness to choose to grow grains is more from an economic point of view, with the drive for economic benefits being the most influential aspect. Grain marketing methods are only an influential factor in Heze and Tai'an, indicating that the grain distribution market in some areas needs to be further improved.

In terms of influencing factors characterized by farmers' attitudes towards farming, whether the land is home-grown or rented out is another major factor influencing each municipality. This influencing factor was found in 10 cities, including Binzhou, Dezhou, Heze, Jining, Linyi, Qingdao, Tai'an, Weifang, Zaozhuang, and Zibo, which also shows that the current management rights of the land are closely related to the willingness of farmers to cultivate grain. The purpose of planting is also a major factor influencing farmers' willingness to grow food in many cities, with nearly half of the top four influencing factors, including securing food rations, while the propensity to plant is only found in four cities, namely Weihai, Weifang, Tai'an, and Dongying.

The analysis presented above demonstrates that farmers' willingness to choose to grow food is becoming more rational, giving more thought to the economic benefits, and it also reflects the improved fundamental conditions of agricultural production and the national agricultural policies that are now becoming increasingly favorable to agricultural production [87]. Regional disparities are a result of a combination of factors, including the degree of economic development and the fundamental circumstances of agricultural production in each region.

3.3.2. Drivers of Willingness to Grow Food at Different Levels of Urbanization

The main driving factors of grain planting intentions in different regions are shown in the following table (Table 4).

Table 4. Differences in factors influencing farmers' willingness to grow food by region type.

	H-H	H-L	L-H	L-L
First contribution	Expenditure ratio	Income ratio	Self-grown or not	Self-grown or not
Second contribution	Income ratio	Expenditure ratio	Income ratio	Income ratio

H-H is high urbanization level and high willingness to grow food; H-L is high urbanization level and low willingness to grow food; L-H is low urbanization level and high willingness to grow food; L-L is low urbanization level and low willingness to grow food.

In Table 4, the willingness to grow grain is more closely related to the expenditure ratio and income ratio in areas with higher levels of urbanization [88]. This is mainly due to the fact that in these areas, where there is less labor turnover and more people engaged in agricultural skills, growing food is less intensive and the government's support for agriculture is stronger, farmers are less likely to need to consider other growing conditions and farmers focus on the income and expenditure of growing food [89]. In areas with low urbanization levels, farmers consider more whether to grow their food and the proportion of their income, mainly because in these areas there are more serious labor losses, and growing food is more intensive, so farmers will consider whether to grow their food on the land or rent it out, taking into account their situation [90].

4. Conclusions and Discussion

Through a quantitative analysis of the degree of influence on willingness to grow food and the magnitude of the role of influencing factors, this paper summarizes the regional differences in farmers' willingness to grow food in 17 cities in Shandong Province. It also lists the various factors affecting farmers' willingness to grow food and analyzes the mechanisms. The following is a summary of them.

Different factors have varying degrees of impact on farmers' willingness to raise food. The purpose of food cultivation, the propensity to grow food crops, the age of the household, the number of working family members, the degree of agricultural mechanization, the flatness of the land terrain, the education level of the household head, and the type of farming practices are all factors that can have an impact. These factors are listed in descending order of influence.

Different factors affect farmers' willingness to grow grains in different ways. The willingness to grow food is significantly and favorably correlated with land cultivation practices, the proportion of income from food production to total income, the proportion of expenditure on food production to total household expenditure, the purpose of food production, farmers' propensity to cultivate food crops, the age of the household, the number of working people, and the degree of agricultural mechanization. On the contrary, the household head's education degree hurts their willingness to cultivate food. In addition, the willingness to cultivate food is somewhat influenced by the type of land use. Average grain production, the ratio of grain income to expenditures, grain marketing strategies, and the area used for grain planting did not significantly affect farmers' willingness to grow grains.

There are obvious regional differences in farmers' willingness to grow grain in the 17 cities of Shandong Province, which is more obvious under the background of new urbanization. From the spatial perspective, farmers' willingness to grow grain in the western region is higher, followed by the eastern region, and the central region is the lowest, indicating the impact of spatial differences in the local economic development levels and opening degree on regional agricultural production and farmers' willingness to grow grain.

The main factors affecting farmers' willingness to grow grain in different cities are different. The influence degree of the same factor on each city is different, resulting in regional differences. The choice of willingness to grow food is more influenced by the level of economic development and agricultural status of each locality. The choice of farmers' willingness to grow grain is becoming more and more rational, and more economic benefits are considered. In places with a high level of urbanization, the ratio of grain income to

expenditure has a greater impact on farmers' willingness to grow grain, while in places with a low level of urbanization, whether to cultivate their own farmland has a greater impact on farmers' willingness to grow grain.

In regions with different urbanization levels, the driving factors affecting farmers' willingness to grow grain are different. According to the level of grain planting intentions and urbanization level, the 17 cities were divided into four categories. The areas with a high urbanization level and a high grain planting intention were the most economically developed cities, which developed earlier. The areas with a high urbanization level and a low willingness to grow grain are mostly the areas with relatively developed secondary industries, and each city has its own pillar industry. The areas with a low urbanization level and a high grain planting intention are mostly the traditional inland agricultural areas without pillar industries. The areas with a low urbanization level and a low willingness to grow grain are mostly industrial transformation areas. The urbanization rate in this region is fast, and the proportion of secondary and tertiary industries is constantly rising.

Several steps can be performed to increase farmers' motivation to cultivate food in response to the key influencing factors. For instance, several steps should be taken to increase the ratio of farmers' income to their expenditure on grain cultivation; government departments should raise the purchase price of grains and effectively regulate the price of agricultural materials, judiciously direct farmers to engage in diversified farming, increase agricultural technology promotion and technical training, enhance scientific and technological innovation as well as services for grain production, promote the use of alternative energy sources, and so on. In addition, each region has different stratum types, such as grain farmers, economic farmers, rural managers, local migrant workers, migrant workers, and individual industrial and commercial households. There are also differences in their willingness to grow grain, which could be the direction of further research.

The factors impacting future willingness to grow food have not yet been thoroughly investigated, but they could change as socioeconomic and technological levels rise and farmers are able to grow food faster. Which geographical areas have the most potential for exploration after evaluating farmers' willingness to cultivate food? Are farmers more likely to cultivate food in locations with great potential? How can the appropriate authorities efficiently and quickly combine the potential with farmers' motivation to grow food? These should be the key issues to be solved in the reform of the agricultural supply structure in the future. Therefore, future research on regional variations and potential exploitation priorities, as well as a proposal for integrating potential exploitation and farmers' willingness to cultivate food, are of considerable theoretical value and practical significance. In addition, natural disaster factors should also be considered, especially effective defense against natural disasters. Research on farmers' land abandonment, the participation of food-related cooperative organizations, and the improvement of technical services for food production should also be considered.

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Appendix A

Food Growing Intentions Questionnaire	
Address:	
Exact latitude and longitude:	
How many acres of land in the household (ha^2)	(ha^2)
Of which: area of cultivated grains (including wheat, maize, rice, sorghum, groundnuts, millet, soybeans, potatoes) (ha^2)	(ha^2)
Area of orchard (ha^2)	(ha^2)
Vegetable garden area (ha^2)	(ha^2)
Other area (ha^2)	(ha^2)
Type of food crops grown Wheat	Wheat□, Corn□,Rice□, Sorghum□, Groundnut□, Millet□, Soybeans□, Potatoes□
Type of land on which food is grown (ha^2)	Dry land (ha^2), Watered land (ha^2)
Topography of the land on which food is grown (ha^2)	Flat land (ha^2), Sloping land (ha^2)
Area that can be mechanized for farming (ha^2)	(ha^2)
Total annual yield of food crops (kg) (please pay special attention to this unit)	Wheat kg, Corn kg, Rice kg, Sorghum kg, Groundnut kg, Millet kg, Soybeans kg, Potatoes kg
Average annual yield of food crops per acre (kg/(ha^2))	Wheat kg/((ha^2)), Corn kg/(ha^2), Rice kg/(ha^2), Sorghum kg/(ha^2) Groundnut kg/(ha^2), Millet kg/(ha^2), Soybeans kg/(ha^2) Potatoes kg/(ha^2)
Type of cash crop grown	Cotton□, Peanut□, Oilseed rape□, None□
What other crops are grown?	
Was all the land planted with grains in the past five years	Yes□, No□
	If not all food, what crops were grown?
How many members in the household (persons)	(person)
How many members in the household (persons)	(person)
How many members in the household (persons)	Under 20 years□ person, 20–40□ person, 40–50□ person, 50–60□ person, 60 years old and above□ person
Education level of household head Primary school	Primary school and below□ person, junior secondary school□ person, senior secondary□ person, tertiary school and above□ person
Age of household	Under 20 years□ person, 20–40□ person, 40–50□ person, 50–60□ person, 60 years old and above□ person
Education level of the head of household	Primary School□, Junior High School□, Senior High School□, Tertiary School□
Number of people working outside the household	(person)
Number of people who cannot participate in labour or earn money	(person)
Whether willing to work outside the home	Yes□, No□
Total annual household income (yuan)	yuan

Total annual income from grains cultivation (yuan)	Wheat yuan, Corn yuan, Rice yuan, Sorghum yuan, Groundnut yuan, Millet yuan, Soybeans yuan, Potatoes yuan
Household annual cost of growing food Seeds Yuan,	Seeds yuan, Pesticides yuan, Fertilizer yuan, Watering yuan, Machinery yuan, Cost of hiring someone yuan
Labour costs for the family (total per year)	Total days, Total yuan
Food subsidies (yuan/ha)	Wheat yuan/(ha^2), Corn yuan/(ha^2), Rice yuan/(ha^2), Sorghum yuan/(ha^2), Groundnut yuan/(ha^2), Millet yuan/(ha^2), Soybeans yuan/(ha^2), Potatoes yuan/(ha^2)
Total annual household expenditure (yuan)	(yuan)
Purpose of growing food	Secure food rations for the family □, Sell to increase family income □, Farming □
How is the grains sold?	Self-selling □, Collective purchase □
Are you a member of a food cooperative?	Yes□, No□
Are you willing to sublet or contract out your land to others?	Sub-letting□, Self-growing □
The number of hours of work put into growing food each year over the past five years	Year-on-year increase□, year-on-year decrease□, about the same□
Which part of the food growing process involves the most labour time?	Preparation of land□, planting□, watering□, fertilising□, weeding□, harvesting□
Which type of farming is more profitable?	High income from growing food□, High income from growing other□
Which type of crop do you prefer to grow?	Wheat □, Corn □, Rice□, Sorghum□, Groundnut□, Millet□, Soybeans□, Potatoes□, Other crops□
Would you like to continue growing food in the future?	If yes, why?
	If no, why?

Notes: Where data are required for total annual production of food crops, average production per acre of food crops, annual income from food cultivation, food subsidy standards, etc., only the corresponding contents of the actual crops grown by the household are filled in the survey.

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