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Impact of the Grain for Green Project on the Well-Being of Farmer Households: A Case Study of the Mountainous Areas of Northern Hebei Province, China

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Abstract: There are close dynamic relationships among the livelihood, well-being, and ecological environment of farmer households. It is of great significance to scientifically clarify the impact of the Grain for Green policy on the livelihoods and well-being of farmer households in mountainous areas. Based on data from a survey of 392 farmer households in Zhangbei County, the system of indicators for livelihood assets and well-being of farmer households were constructed using the sustainable livelihood framework (SLF). The livelihood assets and well-being levels of different types of farmer households were measured, and a multiple linear regression model was used to analyze the impact of the Grain for Green policy implementation on the well-being levels of farmer households. The results showed that (1) the Grain for Green project caused changes in the livelihood of farmer households. The average livelihood diversity of farmer households was 3.008, and the returned farmland households (3.022) were higher than the nonreturned farmland households (2.975) in Zhangbei County. The level of natural assets among the total average livelihood assets of farmer households was the highest at 0.374, while the level of physical assets was the lowest at 0.018. The level of livelihood assets of returned farmland households (0.948) was lower than that of nonreturned farmland households (1.117). (2) The Grain for Green policy had an improving effect on the level of well-being of farmer households, but the effect was not significant. The level of well-being of all farmer households in Zhangbei County was 0.517, with the level of wealth contributing the most to the well-being of farmer households at 40.20% and the quality of the ecological environment contributing the least at 11.99%. The level of well-being of returned farmland households (0.518) was slightly higher than that of nonreturned farmland households (0.514). (3) The influencing degree of each factor on the level of well-being varied significantly. There are three main paths through which the Grain for Green policy affects the well-being of farmer households: by reallocating human assets, optimizing natural assets, and enhancing financial assets. The factor of household size had the highest degree, at 0.366, while educational attainment of household members, household labor capacity, annual household expenditure, livelihood diversity, number of large production tools, and total value of livestock were also important drivers of household well-being, and area of arable land was negatively associated with household well-being. There were also differences in the factors influencing the level of well-being of different types of farmer households.

Keywords: Grain for Green project; livelihood assets; livelihood diversity; well-being of farmer households; mountainous areas of northern Hebei Province

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1. Introduction

There are close dynamic relationships among the livelihood, well-being, and ecological environment of farmer households [1]. To relieve regional ecological pressure, improve the ecological environment, and enhance the well-being of farmer households, the Chinese government implemented the Grain for Green policy in 1999, and successively carried

out ecological projects such as the construction of the Three Northern Protective Forests System (phases IV and V), the construction of the Beijing–Tianjin Wind and Sand Source Control, the construction of the Yangtze River Protective Forest System (phases II and III), and the treatment of rock desertification in Southwest China [2]. The Grain for Green project is a management mode of ecological restoration by stopping cultivation of sloping land and planting trees and grass to restore vegetation. Participants in the Grain for Green policy need to systematically stop cultivating sloping land that is prone to soil erosion. Participating farmer households need to plant trees and grasses on these lands to restore vegetation according to local conditions, and they can be subsidized by the government. In the past 20 years, China had implemented reforestation and grass restoration of up to 3.43×10^5 km^2 and contributed more than 4% to the global greening area in the same period, which had significantly improved the ecological environment and ecosystem services quality. The changes in ecosystems affect the survival, livelihood development and the well-being of farmer households, either directly or indirectly. Ecosystems protection, livelihood development, and the improvement of well-being of farmer households are the core components of achieving the United Nations (UN) 2030 Sustainable Development Goals [3]. In the vast fragile mountainous areas of China, the contradictions between ecological environmental protection, livelihood development of farmer households, and well-being of farmer households are prominent. How to protect the ecological environment to improve the livelihood and well-being of farmer households in ecologically fragile areas is an urgent issue. Therefore, it is important to scientifically clarify the impacts of Grain for Green policy on the livelihoods and well-being of farmer households in mountainous areas.

Studies outside of China paid less attention to ecological projects, especially in terms of their relationships with livelihoods and well-being of farmer households. However, methods for measuring and assessing ecosystem services, livelihoods, and well-being of farmer households are all relatively well established. Ecosystem services can be used to measure the effectiveness of ecological policies, and the value and physical quantity of ecosystem services can be estimated through value-equivalent scales and the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) model [4,5]. The livelihoods of farmer households are measured by drawing on the sustainable livelihood framework, and the human development index; life satisfaction, and well-being index frameworks are used to assess well-being of farmer households [6–8]. Existing research had also been performed on the relationships between ecosystem services and well-being of farmer households, which had been measured with the coupled coordination model, elasticity coefficient, and bivariate spatial autocorrelation, with different results. Ciftcioglu et al. [9] believed that the impact of ecosystem services on the satisfaction of material needs was significant, and ecosystem services appeared to be a significant positive influence on the well-being of farmer households. Jones et al. [10] pointed out that ecosystem services had a negative influence on human health and physical well-being. Although there are few foreign related studies, they provide support for this study in terms of theory and methodology.

Many scholars have studied the relationships among ecological conservation, livelihoods of farmer households, and well-being of farmer households in China, focusing on the relationship between livelihoods of farmer households and ecosystem services [11–13], the relationship between ecosystem services and well-being of farmer households [3,14–17], and the relationship between livelihoods and well-being of farmer households [18]. Recently, ecological protection and high-quality development have become the focus of efforts in China. With the implementation of ecological civilization and rural revitalization strategies, research on the relationship among ecosystem services, livelihoods of farmer households, and well-being of farmer households has become a hot academic issue. Based on the ecosystem services availability assessment, Liu et al. [19] believe that ecosystem services have a significant positive impact on the well-being of farmer households. Based on the theory of ecosystem services value, scholars have identified spatial and temporal variations in per capita ecological well-being and economic efficiency in Chinese cities at the prefecture level and above and have elucidated patterns of different types of ecological well-being [20]. A

study of the Yellow River headwaters showed that ecological compensation had an important impact on the well-being of farmer households, which could compensate for the loss of well-being to stimulate conservation and improve the well-being of farmer households [21]. Therefore, reasons, implications, and pathways of ecological compensation mechanisms were proposed from the perspective of resource opportunity–cost [22]. Moreover, coupling relationships between ecosystem service functions and well-being of farmer households were found in the areas with relatively poor economic development [23,24]. Concurrently, research on the impact of the Grain for Green policy on the well-being of farmer households is emerging. You et al. [25] examined the impact of the Grain for Green policy on the well-being of farmer households and the direction of optimizing ecological compensation. Liu et al. [26] explored the impact of the Grain for Green policy in the Loess Plateau region on changes in ecosystem services and well-being of farmer households. Through a comparative analysis of farm household panel data, Yao et al. [27] found that there were differences in the impact of the Grain for Green policy on the well-being of farmer households in the Yellow River Basin and Yangtze River Basin of China. Overall, the existing studies focused on the contribution of ecosystem services to human well-being, and the dependence of human well-being on ecosystem services, as well as the coupling relationship between ecosystem service and human well-being. However, the impact of Grain for Green project on the well-being of farmer households is still lacking.

The mountainous areas of northern Hebei Province are a typical ecologically fragile area and agro-pastoral ecotone in China, with a single type of livelihood and a low level of well-being for farmer households. Many ecological projects exist in this region, such as the Three Northern Protective Forests System, the Taihang Mountains Greening project, and the Beijing–Tianjin Wind and Sand Source Control. Grain for Green is an important means of implementing these ecological projects. The Grain for Green project has a significant impact on land holdings of farmer households and regional vegetation, which in turn affects their livelihoods and well-being. The objectives of this study include the following main aspects: (1) to measure the livelihood assets and well-being levels of farmer households in the mountainous areas of northern Hebei; (2) to explore the influencing factors on the well-being of farm households; and (3) to reveal the impact paths of the Grain for Green project on the well-being of farmer households.

2. Materials and Methods

2.1. Study Area

Zhangbei County is located in the northwestern part of Zhangjiakou City, at the transition zone between the Inner Mongolia Plateau and the North China Plain. The geographical location is 40°57′–41°34′ N and 114°10′–115°27′ E. It covers 4185 km^2, including 18 towns (7 towns and 11 townships). The elevation ranges between 1300 m and 2128 m, and the terrain is complex and diverse, including plateaus, hills, mountains, and basins (Figure 1). Agriculture and animal husbandry are intertwined within the county, and the ecological environment is sensitive and fragile. Due to the continental monsoon climate of the middle latitude temperate zone, the average annual temperature of the area is only 3.2 °C and the average annual precipitation is only 392.7 mm, which is suitable for staggered seasonal vegetable cultivation. By the end of 2021, the total population of Zhangbei County was 0.356 million. Zhangbei County is a component of an important green ecological barrier in northern China, responsible for building a strong ecological barrier in the Beijing–Tianjin–Hebei region. The Grain for Green project was piloted since 2000 and fully launched in 2002. The county completed the Grain for Green project for 625.07 km^2, of which 320.87 km^2 were returned to forest and 304.20 km^2 were afforested on barren hills. The policy involves 18 townships and more than 60,000 farmer households in the county. In the past 20 years, the vegetation coverage rate in Zhangbei County increased significantly, and the ecological environment continually improved, which affected the livelihoods and well-being of farmer households. Given the large-scale and significant Grain for Green policy achievements in Zhangbei County, a survey was conducted on

the impacts of the policy on the livelihoods and well-being of farmer households in some townships of Zhangbei County.

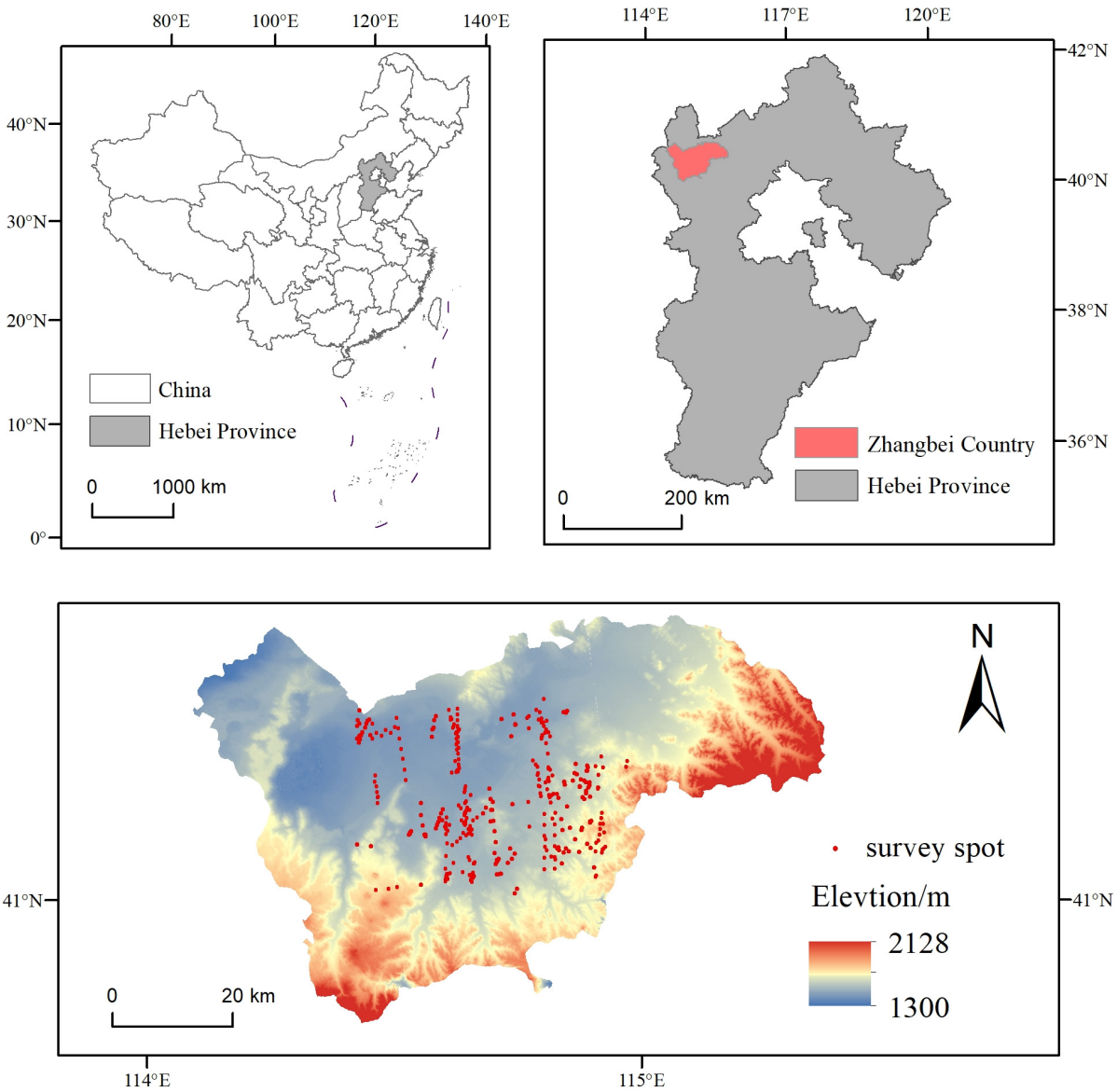

Figure 1. Location of the study area.

2.2. Data Sources

Based on participatory rural appraisal (PRA), the data used in this study were obtained through a questionnaire and semi-structured interviews with farmer households. Based on the physical geography, accessibility, and implementation of the Grain for Green policy in Zhangbei County, 392 farmer households in 26 villages in 8 townships were selected for research interviews (Figure 1). The survey used random sampling in the policy coverage area to ensure the randomness of the selected farmer households. Based on the farmers' own evaluation, analysis, implementation, supervision, and assessment of the Grain for Green policy status, an in-depth understanding of the policy and the living and production environment of the farmers in Zhangbei County was conducted. A total of 398 questionnaires were distributed in this survey, and 6 invalid questionnaires were eliminated resulting in a total of 392 valid questionnaires involving 1173 people. The questionnaire efficiency was 98.5%. The average survey time was between 25 and 30 min per farmer household. A random sampling method was used to select the survey sample, and the

392 sample households selected were to some extent able to reflect the basic characteristics of the farmer households in the study area. The survey results from these number of questionnaires also have a strong explanatory power.

Since the implementation of the Grain for Green policy, Zhangbei County successively returned farmland to forest and grass on sloping farmland above 25°, on sloping farmland with important water sources between 15° and 25°, and on sandy farmland. Farmer households without the above-mentioned types of arable land were not able to participate in the Grain for Green policy. There are also some farmer households whose households are dominated by women, who had no other source of livelihood and chose not to participate in the policy. Therefore, in this study, the surveyed households are divided into returned farmland households and nonreturned farmland households based on whether they participated in the policy. Among the surveyed farmer households, there are 273 returned farmland households, accounting for 69.6% of the total valid sample households and 119 nonreturned farmland households, accounting for 30.4% of the total valid sample households.

The survey covered the basic information of farmer households, the basic information of land, the status of livelihood assets, and the farmer households' response to the Grain for Green policy. The basic information of farmer households included number of family members, age, education level, nature of employment, working hours, and salary income. The basic land information included land type, crop planting situation, the status of farmer households' land returned to forest and grass, and land input status. The status of livelihood assets included human assets, natural assets, physical assets, social assets, and financial assets. The farmer households' response to the Grain for Green policy included knowledge and judgment of the policy, willingness to participate in the policy, behavioral choice concerning the policy, and expectations of the policy.

2.3. Methods

2.3.1. Theoretical Analysis Framework

The implementation of the Grain for Green project inevitably leads to changes in the livelihoods and land-use behavior of farmer households, thus affecting their well-being. This study established a theoretical analysis framework along the lines of "Grain for Green → livelihood characteristics of farmer households → well-being of farmer households → analysis of factors influencing well-being of farmer households → policy recommendations" (Figure 2). Since livelihood assets do not fully reflect the livelihood characteristics of farm households, this study introduced livelihood diversity. This study quantitatively assessed the livelihood diversity of farmer households through survey results; based on SLF, a system of indicators for livelihood assets of farmer households was constructed from five aspects: human assets, natural assets, physical assets, social assets, and financial assets, to quantitatively assess the status of livelihood assets of farmer households after the implementation of the Grain for Green policy. Based on the conceptual framework of human well-being, a system of indicators for the well-being of farmer households was constructed to quantitatively assess the level of farmer households' well-being after fallowing from four aspects: labor force conditions, wealth level, ecological environment quality, and social conditions. A multiple linear regression stepwise analysis model was established to quantitatively assess the factors influencing the well-being of farmer households, and to explore how the Grain for Green project affects well-being of farmer households by acting on livelihood diversity and livelihood assets. Based on the relevant conclusions, relevant policy recommendations are put forward to provide a scientific basis for the government to formulate relevant policies.

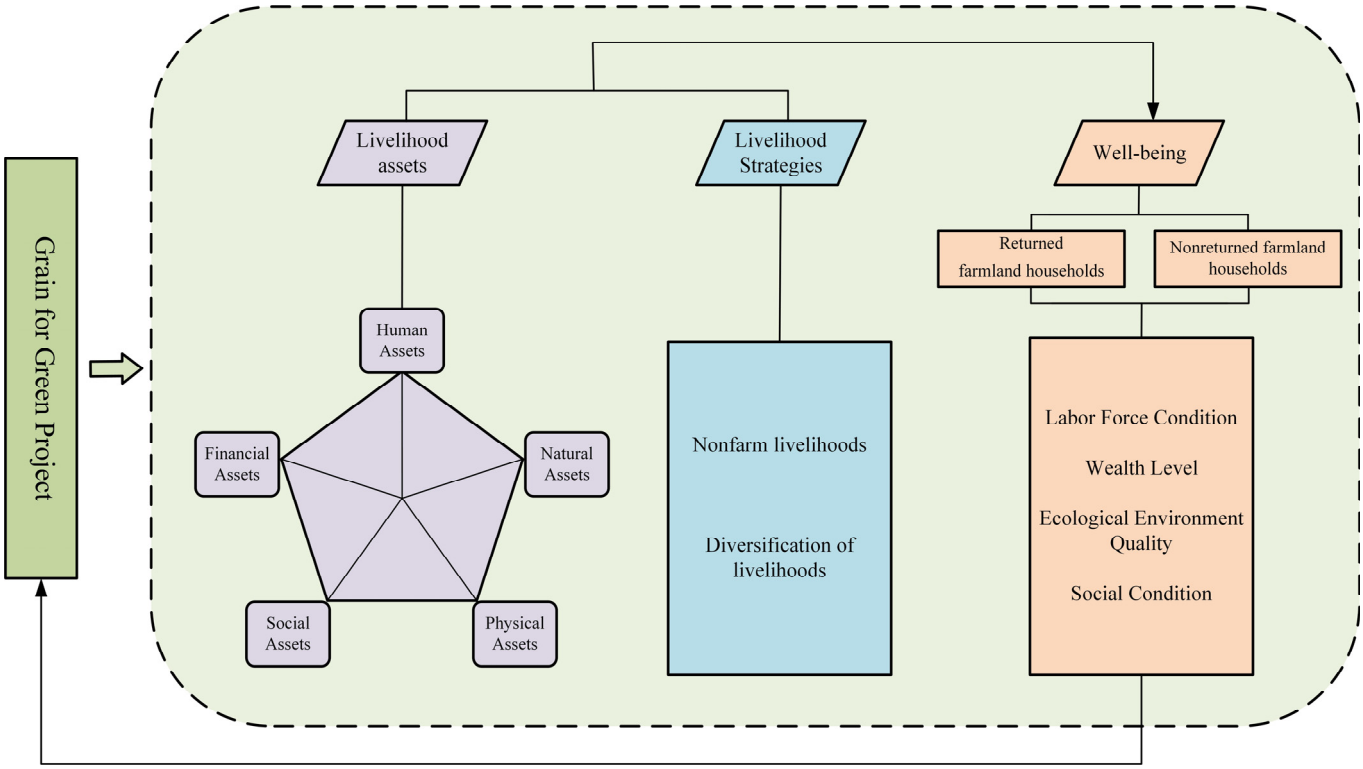

Figure 2. Analysis framework.

2.3.2. Measurement of Livelihood Diversity

According to the survey results, livelihood diversity is increased by one unit whenever a farmer household engages in a certain livelihood activity, until the total number of types of livelihood activities engaged in by the household is reached. The calculation formula is as follows:

$$N = \sum \beta_i \quad (1)$$

where N is farmer household livelihood diversity and β_i is farmer household livelihood type.

2.3.3. Measurement of Livelihood Assets and Well-Being

1. Indicator Selection

Referring to the sustainable livelihood framework of the United Kingdom Department for International Development [28,29], the evaluation system for livelihood assets of farmer households in Zhangbei County was constructed from five dimensions, including human, natural, physical, social, and financial assets (Table 1), with corresponding adjustments to the actual situation in the study area. The implementation of the Grain for Green policy may lead to changes in the local ecological environment, so the livelihood assets of farmer households need to include the ecological environment of the area they live in. The indicator of the area fallowed to farming was used to measure this livelihood asset. The farmers of China tend to go out to work during the agricultural leisure season, so the indicator of the number of channels for outworking was included in social assets. Zhangbei County is located in an agro-pastoral ecotone, and livestock farming is an important means of livelihood for farmer households in this area and an important way to reserve wealth, so the total value of livestock was included in financial assets. The well-being of farmer households involves production, living, health, and safety conditions of rural farmer households, concentrating on the improvement of living standards, production conditions, infrastructure, and social security. This method was based on the conceptual framework of human well-being and its multidimensional and hierarchical structure, following the principles of scientificity, validity, and hierarchy.

The system of indicators for well-being of farmer households was constructed from the four dimensions of household characteristics, wealth level, ecological environment quality, and social conditions (Table 2).

Table 1. Indicators of livelihood assets of farmer households.

Asset Type	Indicator	Symbol	Indicator Meaning and Value	Nature	Weight
Human assets (HA)	Household size	H1	Total household size	Positive	0.010
	Educational attainment of household members	H2	No formal education (little literacy) = 0; elementary school = 1; junior high school = 2; high school, junior college = 3; college, senior college = 4; university undergraduate and above = 5	Positive	0.042
	Household labor capacity	H3	Assigned according to age, where 6 and below = 0; 7–18 = 1; 18–25 = 2; 26–45 = 5; 46–60 = 4; 60 and above (including military/students aged 19–60) = 3	Positive	0.016
Natural assets (NA)	Area of arable land	N1	Household arable land area	Positive	0.045
	Area of watered land	N2	Area of household watered land	Positive	0.328
	Area fallowed to farming	N3	Area of land fallowed to farming by household	Negative	0.001
Physical assets (PA)	Residential index	P1	Residential index = $\alpha M + \beta C + \gamma N$, where M, C, and N denote the number of houses, house structure, and residential age, respectively; α, β, and γ are the weights of the three, respectively, using the entropy value method to calculate α = 0.3949, β = 0.4023, and γ = 0.2028. House structure: civil structure = 1, brick structure = 2, brick and mixed structure = 4, others: such as brick = 3, relief = 0. If the house consists of different structures, the weighted summation is calculated in proportion to the number of rooms	Positive	0.005
	Number of large production tools	P2	Number of asset types owned by farmer households	Positive	0.013
Social assets (SA)	Number of public officials among relatives	S1	Number of public officials among relatives	Positive	0.290
	Number of channels for outworking	S2	Number of types of channels for outworking	Positive	0.024
	Number of social contacts	S3	Assigned according to the number of cell phone contacts, no cell phone = 0, 0–20 people = 1, 21–50 people = 2, 51–100 people = 3, 101 and above = 4	Positive	0.023
Financial assets (FA)	Total value of livestock	F1	Total value of livestock = number of livestock × unit price of livestock (differentiate between young and adult livestock, unit price obtained from research data)	Positive	0.138
	Annual household income	F2	The sum of farm income, wage income, financial income (direct grain subsidy, old-age insurance, low-income insurance, social security), subsidies for retired farming and other income (medicine collection, etc.) in one year	Positive	0.063
	Annual household expenditure	F3	Sum of children's school fees, food consumption, gift expenditure, health expenditure, consumption of durable goods, and consumption of daily necessities, etc., in one year	Negative	0.001

Table 2. Indicators of well-being levels of farmer households.

Well-Being Dimension	Indicator	Symbol	Indicator Assignment	Nature	Weight
Labor force condition (FL)	Household size	F1	Number of farmer household members	Positive	0.052
	Household labor capacity	F2	Assignment according to age, where 6 years and below = 0; 7–18 years = 1; 18–25 years = 2; 26–45 years = 5; 46–60 years = 4; 60 years and above (including military/students aged between 19 and 60) = 3	Positive	0.059
	Educational attainment of labor force	F3	No formal education (little literacy) = 0; elementary school = 1; junior high school = 2; high school, junior college = 3; college or senior college = 4; university undergraduate and above = 5	Positive	0.092
	Number of people engaged in non-cultivation agriculture	F4	Assigned according to the nature of employment, where farming = 0; farming + other employment = 1; other employment = 2	Positive	0.112
Wealth level (WL)	Annual household income	T1	Sum of agricultural income, wage income, financial income (direct food subsidy, old-age insurance, low-income insurance, social security), fallowing subsidy, and other income (medicine picking, etc.) in one year	Positive	0.152
	Annual household expenditure	T2	Sum of school fees of children, food consumption, gift expenditure, health expenditure, consumption of durable goods, consumption of daily necessities, etc., in one year	Negative	0.102
	Arable land per capita	T3	Arable land/total population	Positive	0.109
	Housing area per capita	T4	Average housing area per capita	Positive	0.028
Ecological environment quality (EQ)	Water safety	Z1	Assigned according to farmers' perception of changes in water pollution after fallowing, strong = 0; constant = 1; diminished = 2	Positive	0.039
	Air safety	Z2	Assigned according to farmers' perception of whether air quality has improved after fallowing, worse = 0; no change = 1; better = 2	Positive	0.020
	Soil and water conservation	Z3	Values Assigned according to whether farmers' soil erosion has improved after fallowing, severe = 0; no change = 1; improved = 2	Positive	0.021
	Soil safety	Z4	Assigned according to whether the farmer is serious about soil contamination after fallowing, serious = 0; not serious = 1	Positive	0.011
Social conditions (SC)	Traffic accessibility	S1	Distance of farmer households to the nearest road	Negative	0.141
	Resource accessibility	S2	Distance of farmer households to the nearest hospital or school	Negative	0.054
	Policy satisfaction	S3	Assignment of values according to whether farmers are willing to participate in the Grain for Green policy, indifferent = 0; very unwilling = 1; not very willing = 2; average = 3; very willing = 4	Positive	0.011

2. Indicator Weight Determination

The nature of the indicators is divided according to their attributes of the selected indicators and the assigned values. Positive indicators are those that represent upward or forward progress, and the higher the value of these indicators the better the evaluation, while the opposite is true for negative indicators. To facilitate the calculation and make the indicators' trend the same, the negative indicators are converted to positive. Since the indicators have different dimensions, the study adopts the standardization of the mean value to process the indicators independent of the dimension. The entropy value method was used to determine the index weights [30]. The calculation formula is as follows:

$$Y_{ij} = \frac{y_{ij}}{\sum_{i=1}^{m} y_{ij}} \tag{2}$$

$$e_j = -\frac{1}{ln\ m} \sum_{i=1}^{m} Y_{ij} ln\ Y_{ij} \tag{3}$$

$$d_j = 1 - e_j \tag{4}$$

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \tag{5}$$

where y_{ij} is the value of the jth indicator of the ith statistical unit after dimensionless processing, e_j is the entropy value of the jth indicator, m is the number of samples, d_j denotes the coefficient of variability of the jth indicator, and w_j is the weight of the jth indicator.

3. Measurement of Indicators

The livelihood assets and well-being level of farmer households was calculated using the linear weighted summation. The calculation formula is as follows:

$$F = \sum W_j Y_{ij} \tag{6}$$

where F is the total value of livelihood assets or the well-being level of farmer households, W_j is the weight of the livelihood asset index of the jth item or the well-being index of the jth item, and Y_{ij} is the standardized value of the jth item in the ith statistical unit.

2.3.4. Multiple Linear Regression

The well-being of farmer households is often the result of multiple factors, rather than a single factor [31]. The well-being level of farmer households is influenced by numerous factors, such as livelihood diversity and livelihood assets of farmer households. This study attempted to find the optimal combination of each indicator of livelihood of farmer households to explain the level of well-being of farmer households. Therefore, we chose multiple linear regression to solve this problem. In this study, we constructed a multiple linear regression model with 14 indicators of livelihood assets of farmer households and livelihood diversity as independent variables and the level of well-being of farmer households as dependent variable, as a way to quantitatively identify specific factors affecting the well-being level of farmer households. The regression model is as follows:

$$Y = B_0 + B_1 X_1 + B_2 X_2 + \cdots + B_i X_i + \varepsilon \tag{7}$$

where Y represents the welfare level of farmer households, X_i (i = 1, 2, 3, ...) represents the relevant indicators, B_0 represents the regression constant, B_i represents the regression coefficient, and ε represents a random error term.

3. Results

3.1. Analysis of the Livelihood Characteristics of Farmer Households

Based on the interpretation of the sustainable livelihood framework, the livelihood status of farmer households depends on the comprehensive role of various livelihood assets, and their livelihood goals are also achieved on this basis [32,33]. However, livelihood assets cannot indicate the choice of farmer households of livelihood activities, so the characteristics of livelihoods of farmer households include two aspects: livelihood assets and livelihood diversity.

3.1.1. Livelihood Diversity Characteristics of Farmer Households

Farmer households are rational economic agents that can choose different livelihood activities according to their available livelihood assets. Farmer households can maintain their status by diversifying their livelihood activities through different asset allocations to cope with risks and shocks [34]. After conducting a survey of 392 farmer households, three distinct types of farming livelihoods were identified: food crops, cash crops, and vegetable crops. In addition, nonfarming livelihoods were also present, including animal husbandry, forestry, part-time work, self-employment, permanent work, and freelance work.

The statistics show that the average livelihood diversity of the returned farmland households is higher than that of the nonreturned farmland households (Figure 3), which is because returned farmland households have shifted to other livelihood activities after retiring from farming. However, the difference in average livelihood diversity between the two types of farmer households is not significant, probably because most nonreturned households are engaged in more than one type of cultivation.

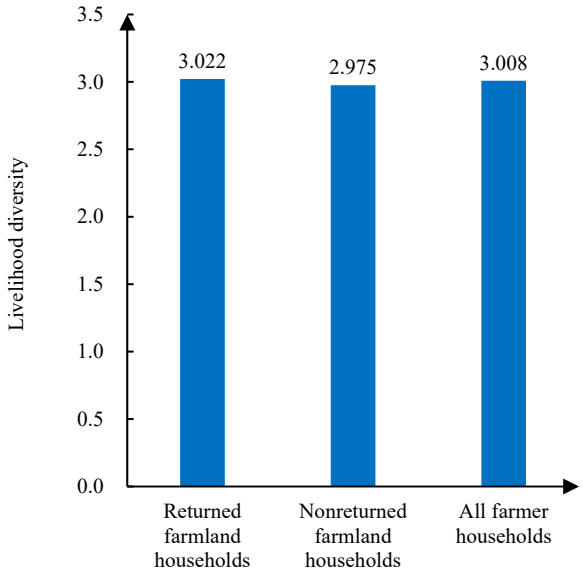

Figure 3. Average livelihood diversity of different types of farmer households.

3.1.2. Livelihood Asset Characteristics of Farmer Households

Zhangbei County is located in the Bashang plateau area, and the landscape can be divided into the dam-head mountainous area, the hilly area, and the undulating plateau area [35]. The special topography and climatic conditions have led to ecological fragility and frequent natural disasters in the area. As a result, in general, Zhangbei farmer households have low levels of livelihood assets and live in poverty.

The order of average livelihood asset levels of farmer households in Zhangbei County is natural assets > social assets > financial assets > human assets > physical assets. A comparison of returned farmland and nonreturned farmland households reveals that the average total asset levels of returned farmland households are lower than those of nonreturned farmland households. Among them, only the financial assets of the returned

farmland households are higher than those of the nonreturned farmland households, while the rest of the assets are lower than those of the nonreturned farmland households. The level of natural assets in Zhangbei County is 0.374 (Figure 4), contributing the most to the total assets, at 37.43% (Figure 5). In terms of the contribution of each indicator to natural assets, the area of watered land contributes the most, at 87.69% (Table 3). In comparing returned farmland and nonreturned farmland households, the level of natural assets of nonreturned farmland households is greater than that of returned farmland households. The human assets per capita of all farmer households in Zhangbei County are 0.068, contributing 6.77% to the total assets (Table 3). The education attainment of household members contributes the most to the level of human assets, at 61.69%, while the size of the household contributes the least, at 14.76%. The level of human assets of nonreturned farmland households is greater than that of returned farmland households. The level of physical assets in Zhangbei County is 0.018, contributing 1.83% to the total assets and accounting for the lowest proportion. The number of large production tools and the residential index contribute 72.96% and 27.04%, respectively. The physical assets of returned farmland households are slightly lower than those of nonreturned farmland households, with the contribution of each indicator following the trend of total farmer households. The level of social assets is 0.337, which is the second highest contribution to total assets, at 33.75%. The number of public officials among relatives contributes the most to the social assets, at 86.09%. The social assets of returned farmland households (0.328) are lower than those of nonreturned farmland households (0.359). The average level of the financial assets of farmer households in Zhangbei County is 0.202, contributing 20.21% to the total assets. The value of livestock makes the largest contribution to the financial assets, exceeding 2/3 of the total financial assets.

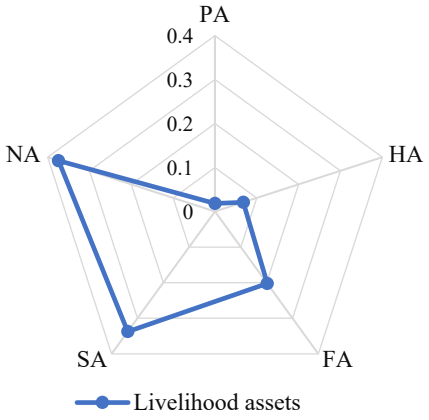

Figure 4. Livelihood assets of farmer households.

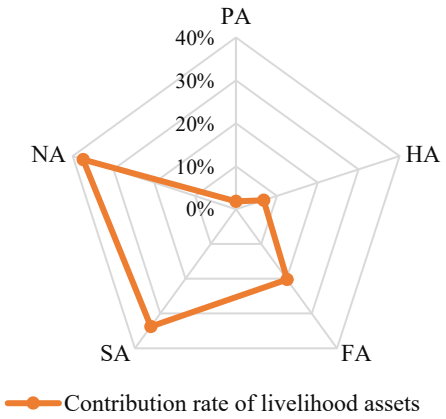

Figure 5. Contribution of livelihood assets.

Table 3. Level and contribution of average livelihood assets of farmer households.

Livelihood Assets		Returned Farmland Households		Nonreturned Farmland Households		All Farmer Households	
		Asset Level	Contribution Rate %	Asset level	Contribution Rate %	Asset Level	Contribution Rate %
Human assets	Household size	0.010	14.97	0.010	14.30	0.010	14.76
	Educational attainment of household members	0.041	61.43	0.044	62.26	0.042	61.69
	Household labor capacity	0.016	23.60	0.017	23.43	0.016	23.55
Natural assets	Area of arable land	0.044	13.38	0.046	9.61	0.045	11.92
	Area of watered land	0.285	86.21	0.428	90.06	0.328	87.69
	Area fallowed to farming	0.001	0.41	0.002	0.34	0.001	0.38
Physical assets	Residential index	0.005	26.54	0.005	28.11	0.005	27.04
	Number of large production tools	0.013	73.46	0.014	71.90	0.013	72.96
Social assets	Number of public officials among relatives	0.280	85.30	0.315	87.74	0.290	86.09
	Number of channels for outworking	0.025	7.48	0.022	5.99	0.024	7.00
	Number of social contacts	0.024	7.22	0.023	6.27	0.023	6.91
Financial assets	Total value of livestock	0.143	69.31	0.127	65.69	0.138	68.26
	Annual household income	0.062	30.30	0.066	33.90	0.063	31.34
	Annual household expenditure	0.001	0.39	0.001	0.41	0.001	0.39

3.2. Analysis of the Level of Well-Being of Farmer Households

The level of well-being of all farmer households in Zhangbei County is 0.517; that of returned farmland households is 0.518 and that of nonreturned farmland households is 0.514. The contribution of each indicator to the well-being of farmer households shows that the wealth level contributes the most, at 40.20%, while the ecological environment quality contributes the least, at 11.99% (Figure 6). A comparison of returned farmland households with nonreturned farmland households reveals that the labor force condition of nonreturned farmland households is greater than those of returned farmland households, because older people in general are less able to work and are more inclined to return farmland.

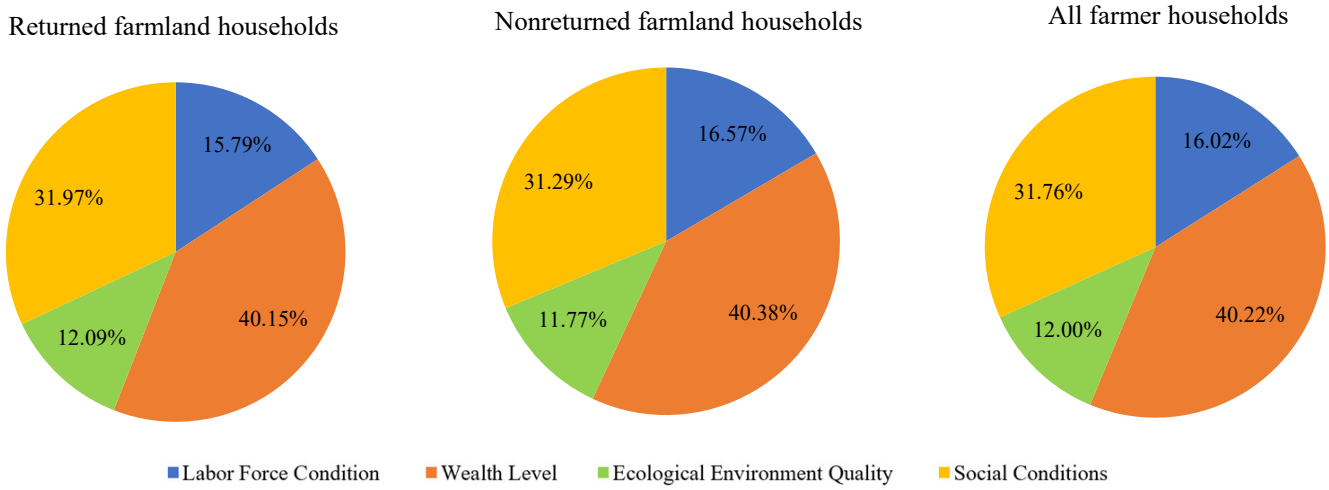

Figure 6. Contribution rates to well-being of farmer households.

As can be understood from Table 4, the number of people engaged in non-cultivation agriculture plays a vital role in labor force conditions, contributing the most, while the household size contributes the least. Comparing returned farmland households with nonreturned farmland households, the labor force conditions in nonreturned farmland households contribute more to the level of well-being than in returned farmland households. In terms of the contribution of each indicator to the wealth level, the arable land per capita contributes the most, with a contribution of 48.65%, followed by annual household expenditure. The wealth level of nonreturned farmland households is greater than that of returned farmland households. Comparing the contribution of each factor to the ecological environment quality, in descending order these are water safety > air safety > soil and water conservation > soil safety. The overall contribution of the ecological environment quality in returned farmland households is slightly higher than that in nonreturned farmland households. Social conditions make the second highest contribution to the level of well-being of farmer households. Traffic accessibility makes the largest contribution to social conditions at 70.73%, significantly higher than the other two indicators. The level of social conditions is higher for returned farmland households than for nonreturned farmland households.

Table 4. Levels and contributions of each indicator of well-being per farmer household.

	Indicator	**Returned Farmland Households**		**Nonreturned Farmland Households**		**All Farmer Households**	
		Well-Being Level	**Contribution Rate %**	**Well-Being Level**	**Contribution Rate %**	**Well-Being Level**	**Contribution Rate %**
Labor force condition	Household size	0.014	17.51	0.016	18.36	0.015	17.78
	Household labor capacity	0.017	20.78	0.018	21.49	0.017	21.00
	Educational attainment of labor force	0.023	27.61	0.024	28.11	0.023	27.76
	Number of people engaged in non-cultivation agriculture	0.028	34.10	0.027	32.04	0.028	33.46
Wealth level	Annual household income	0.008	3.62	0.007	3.55	0.008	3.60
	Annual household expenditure	0.091	43.48	0.089	43.36	0.090	43.44
	Arable land per capita	0.102	48.78	0.100	48.36	0.101	48.65
	Housing area per capita	0.009	4.12	0.010	4.73	0.009	4.30
Ecological environment quality	Water safety	0.022	34.66	0.020	33.68	0.021	34.37
	Air safety	0.018	28.28	0.017	27.87	0.018	28.16
	Soil and water conservation	0.013	20.01	0.013	20.73	0.013	20.22
	Soil safety	0.011	17.04	0.011	17.72	0.011	17.24
Social conditions	Traffic accessibility	0.117	70.39	0.114	71.53	0.116	70.73
	Resource accessibility	0.039	23.71	0.036	22.40	0.038	23.33
	Policy satisfaction	0.010	5.89	0.010	6.07	0.010	5.95

3.3. Impact of Livelihoods Assets on the Well-Being of Farmer Households

The well-being level of farmer households is influenced by a variety of factors, of which the livelihood assets of farmer households are often the basis. Figure 7 shows that there is a significant positive relationship between livelihood assets of farmer households and the level of well-being. The negative value of livelihood assets of farmer households in the figure is caused by logarithmic data of livelihood assets of farmer households. The purpose of using logarithms is to make the normal relationship between the distribution of livelihood assets data of farmer households more apparent, as well as to reduce the absolute value of the data, and does not affect the scientific validity of the final conclusions. The linear regression analysis of livelihood assets and well-being levels passed the significance test at the 1% level, which further suggests that higher livelihood assets of farmer households are associated with higher levels of well-being of farmer households.

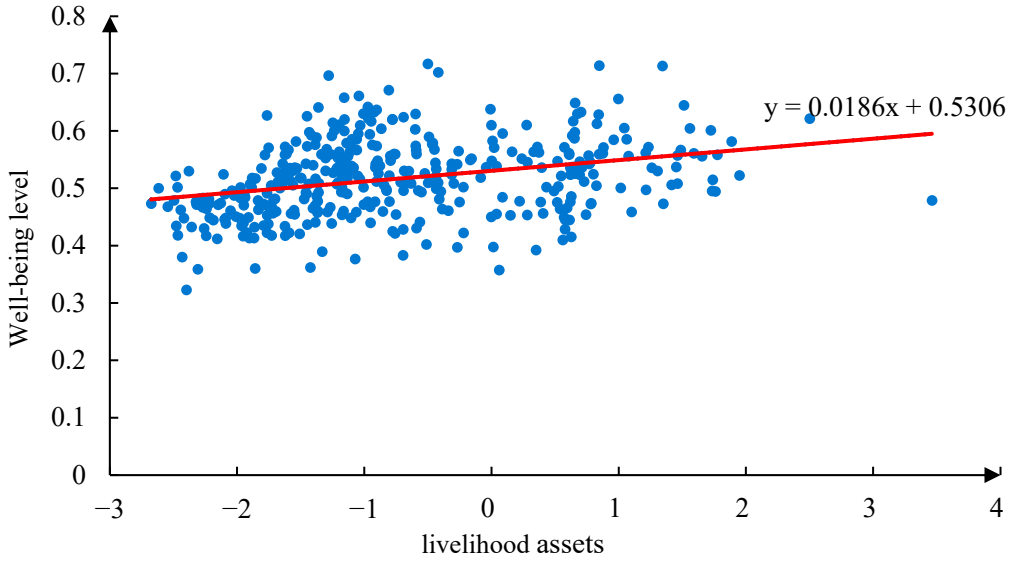

Figure 7. Scatter plot of correlation between livelihood assets and well-being levels of farmer households. Note: The purpose of using the logarithm of the dependent variable is to narrow its range of values and highlight the correlation between the variables.

Because there is a significant correlation between the level of farmer household well-being and livelihood assets, this study used the value of farmer household well-being in Zhangbei County as the dependent variable; the indicators of livelihood diversity and livelihood assets are the independent variables. Using SPSS 26, a multiple linear regression model was applied to analyze the impact of the livelihoods of farmer households on the well-being of farmer households under the effect of the Grain for Green policy, and to identify the factors influencing the well-being of farmer households (Table 5).

Table 5. Factors influencing well-being of farmer households.

Impact Factor	All Farmer Households		Returned Farmland Households		Nonreturned Farmland Households	
	Standard Coefficient	Sig.	Standard Coefficient	Sig.	Standard Coefficient	Sig.
Household size	0.366 ***	0.000	0.345 ***	0.000	0.392 ***	0.000
Educational attainment of household members	0.323 ***	0.000	0.305 ***	0.000	0.415 ***	0.000
Household labor capacity	0.166 ***	0.010	0.203 **	0.015	0.156	0.128
Area of arable land	−0.208 ***	0.000	−0.19 ***	0.000	−0.199 ***	0.000
Area of watered land	0.034	0.343	0.042	0.380	−0.012	0.813
Area fallowed to farming	−0.048	0.097	−0.035	0.317	—	—
Residential index	0.015	0.603	0.053	0.145	−0.044	0.379
Number of large production tools	0.086 ***	0.005	0.035	0.376	0.116 **	0.021
Number of public officials among relatives	0.026	0.395	0.017	0.659	−0.008	0.867
Number of channels for outworking	0.009	0.767	0.014	0.688	−0.030	0.540
Number of social contacts	−0.005	0.862	−0.056	0.146	0.067	0.180
Total value of livestock	0.064 **	0.034	0.076 **	0.034	0.081	0.106
Annual household income	0.055	0.091	0.081 **	0.034	0.056	0.344
Annual household expenditure	0.157 ***	0.000	0.222 ***	0.000	0.071	0.179
Livelihood diversity	0.107 ***	0.003	0.091 **	0.047	0.149 ***	0.009
Constant	—	0.000	—	0.000	—	0.000

Note: *** and ** indicate significance at the 1% and 5% levels, respectively.

3.3.1. Analysis of Factors Influencing the Well-Being of all Farmer Households

The results show an adjusted R^2 = 0.679, indicating that the model has a high degree of model fit. Eight variables had significant effects on the level of well-being of farmer households in terms of livelihood diversity and livelihood assets of farmer households. Household size, education attainment of household members, area of arable land, annual household expenditure, number of large production tools, livelihood diversity, household labor capacity, and total value of livestock are the key factors influencing the well-being of farmer households in Zhangbei County because they all passed the significance test at the 1% or 5% level.

4. Livelihood diversity affects the well-being of farmer households

Table 5 shows that the coefficient of 0.107 for the effect of livelihood diversity on the well-being of farmer households passed the significance test at the 1% level, indicating that the higher the diversity of livelihoods of farmer households, the higher the level of well-being of farmer households. The Grain for Green policy has led farmer households to shift from farming to other livelihood activities, enriching their livelihood diversity, expanding their choice of livelihood strategies, and enhancing their defense and coping capacities against external risks, thus increasing their well-being.

5. Human assets drive the well-being of farmer households

Household size, education level of household members, and household labor capacity are important components of human assets, and their coefficients of influence on the well-being of farmer households are 0.366, 0.323, and 0.166, respectively, with their influences on the well-being of farmer households ranking first, second, and fourth, respectively. All three indicators passed the significance test at the 1% level, indicating that the higher the level of human assets, the higher the well-being level of farmer households. The Grain for Green policy has changed arable land holdings and increased other livelihood activities, such as forestry livelihoods. The Grain for Green policy released some human assets of farmer households from farming to other livelihoods, optimizing the allocation of human assets. Human assets are the basis for the participation of farmer household members in livelihood activities. Larger household sizes can contribute to an increased cumulative production time, leading to higher productivity. Higher levels of education mean that farmer households are better able to withstand external shocks. The external shocks faced by farmer households located in the agro-pastoral ecotone include natural disasters, declining crop and livestock prices, and epidemic diseases affecting livestock farming. Higher levels of education can help farmer households mitigate these shocks in two ways. Farmer households with a higher education level can use their knowledge to take effective measures against natural disasters that hit agriculture and against epidemics that harm livestock farming. In addition, higher education levels mean that farmer households can pursue more types of occupations, and they can choose to pursue other occupations to mitigate the negative effects of declining farm incomes on themselves. Higher levels of labor capacity mean that farmer households are more efficient in creating wealth. This suggests that human assets are a powerful driver of well-being of farmer households.

6. Natural assets affect the well-being of farmer households

The coefficient of the effect of arable land area on the well-being of farmer households is −0.208, which passed the significance test at the 1% level, indicating that arable land area is negatively correlated with the level of well-being of farmer households. The higher the arable land area of farmer households, the lower the level of well-being of farmer households. Zhangbei County has poor natural conditions and insufficient heat conditions. Moreover, a large amount of arable land is sloping and there are many stones on the surface of arable land. Farmer households engaged in grain production under such conditions have huge inputs and little returns, and even incur losses. Therefore, these reduce the level of well-being of farmer households. The arable land retired by farmer households is usually poor-quality farmland dominated by sloping fields. Therefore, the Grain for

Green policy improves the well-being of farmer households by reducing the quantity of poor-quality farmland.

7. Physical assets affect the well-being of farmer households

The coefficient of influence for the number of large production tools on the well-being of farmer households is 0.086, which passed the significance test at the 1% level, indicating that the higher the number of large production tools, the higher the level of well-being of farmer households. Most arable land retired by households is of inferior quality, such as sloping land, where the cultivation conditions are not conducive to the operation of large production tools. After the implementation of the Grain for Green policy, the quality of farmland held by farmer households increased, but the amount of holding decreased. The reduction in farmland holding led some farmer households to transfer their farmland to other farmers. A large amount of arable land was operated by local contractors. Retirement of poor-quality farmland and concentration of quality farmland make the use of large production tools much more efficient, which in turn increases the efficiency of the farmer households' use of farmland and provides the household with opportunities for other nonfarm part-time work, increasing household income. The physical assets of farmer households thus contribute to their level of well-being in terms of production efficiency and livelihood types.

8. Financial assets affect the well-being of farmer households

The coefficient of the effect of annual household expenditure on the well-being of farmer households is 0.157, which passed the significance test at the 1% level; the coefficient of the effect of the total value of livestock on the well-being of farmer households is 0.064, which passed the significance test at the 5% level, indicating that the higher the financial assets, the higher the well-being level of farmer households. The local farmer households pay for gifts to friends and relatives to maintain relationships. The large proportion of elderly people led to a large expenditure on health of farmer households. Gift expenditure and health expenditure affect the well-being of farmer households. Zhangbei County is located at an agro-pastoral ecotone, and rural livestock is more convenient and much more beneficial than farming for the same cost of investment. Before the implementation of the Grain for Green policy, farmer households put most of their time into agricultural cultivation and did not have much time to engage in livestock farming. The shift in labor to livestock farming after farmland has been retired has increased the level of well-being of farmer households by satisfying their dietary needs as well as reserving wealth.

3.3.2. Analysis of Factors Influencing the Well-Being of Different Types of Farmer Households

The analysis of the impact of livelihoods of farmer households on the well-being of different types of farmer households reveals that the factors influencing the well-being differed between returned farmland households and nonreturned farmland households (Table 5). The results show adjusted R^2 values of 0.670 and 0.726, respectively. The goodness of fit of the two models reached 67.0% and 72.6%, respectively, indicating the good fit of the models. Household size, education attainment of household members, livelihood diversity, and area of arable land are common influencing factors for both returned farmland and nonreturned farmland households. Additionally, the level of well-being of returned farmland households is also influenced by annual household expenditure, household labor capacity, annual household income, and total value of livestock; that of nonreturned farmland households is also influenced by the number of large production tools.

Table 5 demonstrates that educational attainment of household members and household size remain the two most significant influencing factors for both returned farmland and nonreturned farmland households, and both passed the significance test at the 1% level. This indicates that human assets remain fundamental to the well-being of farmer households. Similarly, the area of arable land remains a significant influence on the well-being of both types of farmer households and is negatively correlated with the well-being of farmer households. The coefficient of impact of livelihood diversity on the well-being of

returned farmland and nonreturned farmland households is 0.091 and 0.149, respectively, indicating that livelihood diversity has an impact on the well-being of different types of farmer households, but more so on nonreturned farmland households. Nonreturned farmland households have a lower livelihood diversity, and a richer livelihood diversity has a more significant effect on their well-being.

Annual household expenditure, household labor capacity, annual household income, and total value of livestock are significant influencing factors on the level of well-being of returned farmland households, with impact coefficients of 0.222, 0.203, 0.081, and 0.076, respectively. Annual household expenditure and household labor capacity are influencing factors for returned farmland households because these households have a higher proportion of elderly and young children, a higher dependency ratio, and higher expenditure on health care, which have greater impacts on their level of well-being. Annual household income is an influencing factor for returned farmland households because the average total assets of such households are lower than those of nonreturned farmland households, and to make up for the lack of total livelihood assets, household income needs to be increased. The total value of livestock becomes an impact factor for returned farmland households because they need to engage in other livelihood activities to earn an income after they have participated in the Grain for Green policy. As a typical agro-pastoral ecotone, Zhangbei County has a predominance of grassland, making it easier to raise livestock, and livestock farming has become the first choice for expanding household income.

The number of large production tools has a significant influence on the level of well-being of nonreturned farmland households, with an influence coefficient of 0.116, which passed the significance test at the 5% level. However, the number of large production tools is not an influential factor in the well-being of returned farmland households. This is because large production tools can be used by multiple farmer households and the demand for large production tools decreased after Grain for Green policy implementation.

4. Discussion

4.1. Geographical Differences and Similarities of Livelihoods of Farmer Households

The level of livelihood assets of farmer households in the mountainous areas of northern Hebei is low, because of the geographic limitations of such areas. However, the structural weight of livelihood assets in this study differs from other related studies. The high level of natural assets and lower level of human assets of farmer households in this study differs from the high level of human assets of farmer households in alpine ecologically fragile areas [36]. This may be related to geographical differences. The alpine ecological environment results in less available arable land, extremely low crop yields, and low livestock carrying capacity, which in turn leads to relatively low natural assets of farmer households and highlights the structural weight of human assets. This conjecture can be confirmed by the finding that rural reservoir migrants have the highest share of human assets and the second highest share of financial assets in their livelihood assets [37]. The loss of arable land by rural reservoir migrants due to reservoir construction led to an extremely low level of natural assets and increased the proportion of human assets; the large government compensation for migrant relocation raised the proportion of financial assets. Thus, livelihood assets of farmer households are related to the geographical environment and policy conditions of their regions, with significant geographical differences. Farmer households in alpine ecologically fragile areas addressed the problem of insufficient livelihood assets by tapping the potential of human assets and transforming the use of natural assets [36]. The present study's area is located in an agro-pastoral ecotone, which is also a kind of ecologically fragile area. Therefore, the government can learn from the above-mentioned practices and guide farmer households to explore the potential of their superior assets and change the way they use their inferior assets to improve their level of livelihood assets.

The comparison of the total livelihood assets of returned farmland and nonreturned farmland households revealed that the implementation of the Grain for Green policy

in the mountainous region of northern Hebei did not improve the livelihood assets of farmer households. This is completely opposite to the impact on the livelihood assets of farmer households in the Qinba Mountain area of Gansu after the Grain for Green policy implementation [38]. The Qinba region experienced the vigorous development of an ecological and economic forest and improved infrastructure, which improved the livelihood assets of farmer households. In addition, the climatic conditions in the Qinba Mountains are more advantageous for forestry development than those in northern Hebei. The improvements in livelihood assets of farmer households in the Qinba region after the Grain for Green policy implementation are the result of a combination of human and natural factors. This result provides guidance for improving livelihood assets of farmer households after the implementation Grain for Green policy in our study area. The Grain for Green policy requires additional policies supporting and guaranteeing improvements in the livelihood assets of farmer households. Due to the inexperience of local farmer households in forestry development, the government needs to introduce relevant guiding policies for industrial development to support local forestry development and protect the livelihood assets of farmer households.

The livelihood diversity of returned farmland households was higher than that of nonreturned farmland households, but the difference was not significant. This finding is consistent with those of other related studies [38,39]. This suggests that the Grain for Green policy has a positive impact on the livelihood strategies of farmer households in different regions, but there is still much room for this positive impact to improve. Reforestation and grass restoration affect human assets by acting on natural assets, causing a portion of labor to be released from agricultural production. Theoretically, this labor force should have gone in other directions, and the livelihood diversity of farmer households should subsequently have increased, but the facts were not exactly as expected. The quality of the labor force is limited by education level, skills, the insufficient number of channels to work outside, and insufficient social contacts. Therefore, the government should increase cooperation with enterprises, build information exchange and promotion platforms, broaden access of farmers to outside information, encourage laborers to work seasonally, and guide farmers to nonfarm employment to solve the employment problem.

4.2. Grain for Green Policy Impacts on the Well-Being of Farmer Households

Human well-being is a comprehensive, multidimensional, and strongly subjective concept and is closely related to human living conditions and perceptions [40]. The mountainous areas of northern Hebei have harsh natural conditions and low levels of economic development. Farmer households living under such economic conditions have different perceptions of the benefits arising from the implementation of the Grain for Green policy. Related studies show that the subjective well-being of farmer households in poor mountainous areas is most influenced by the wealth factor, and that well-being enhancement depends on economic development [41,42]. The high contribution of the wealth level to the well-being of farmer households in the study area indicates that such households perceive the economic benefits of the Grain for Green policy most strongly. The analysis of the factors affecting the well-being of farmer households in this study also supports this assertion, and the economic benefits of the Grain for Green policy act on the well-being of farmer households in three main ways. First, the Grain for Green policy improves the well-being of farmer households through the reallocation of human assets. The retirement of farmland releases some of the labor force to engage in other more rewarding and less laborious livelihood activities. Second, the Grain for Green policy improves the well-being of farmer households through the optimization of natural assets. Farmer households choose to retire low-quality, sloping land, increasing their income and reducing their labor burden; the remaining higher-quality, irrigated land is conducive to more efficient use of large production tools, further increasing yields, household income, and the well-being of the farmer households. Third, the Grain for Green policy improves the well-being of farmer households by enhancing their financial assets. Farmer households who have retired

farmland take advantage of livestock farming in the local agricultural–pastoral staggered zone, which can increase income and reserve wealth.

The primary objective of the Grain for Green policy is to enhance regional ecological quality. The policy has changed land-use types from cropland to woodland and grassland, driving changes in the ecosystem's service provisioning capacity [43]. The ecological benefits of the policy are reflected in the enhancement of ecosystem regulation and support services in the region [44], which are consistent with the results of our survey. A related study shows that ecosystem supply services have a greater impact on human well-being at lower levels of human economic development, but there is a lag in supply services [45]. This suggests that rural inhabitants in agro-pastoral ecotones have weaker perceptions of the regulating and supporting services, and stronger perceptions of supply services of the ecosystem. This is an important reason for the low contribution of ecosystem quality to the well-being of farmer households in the study area. Ecological improvement resulting from the Grain for Green policy is not the main path to improved well-being of farmer households. Therefore, the government should conduct various forms of publicity about the Grain for Green policy, to enhance recognition of farmers of the policy and their ecological perceptions.

The comparison with similar studies revealed that the Grain for Green policy did not significantly enhance the level of well-being of farm households [26,46], which corroborates the findings of our study. Liu et al. [46] believed that the ecological quality was improved faster than the socio-economic improvement in the relatively short period of time after the implementation of the Grain for Green policy. Therefore, the reason for this result may be that the Grain for Green policy has a certain lagging effect on promoting local economic development. You et al. [25] even pointed out that the implementation of the Grain for Green policy reduced the level of well-being of farm households, which is not consistent with the results of our study. This is due to the lack of government compensation to the farmers. The farmer households involved in our study all received policy subsidies from the government, including grain subsidies and monetary subsidies. Therefore, the government should do a good job in compensating the returned farmland households.

The mechanisms and pathways by which the implementation of ecological projects affects the well-being of farmer households vary across regions. The Grain for Green policy changes the ecosystem's service functions, which in turn can affect the well-being of farmer households. Therefore, the impact of ecological projects on the well-being of farmer households has been described in terms of changes in ecosystem service functions [26]. Due to weak perceptions of farmer households of the regulating and supporting functions of ecosystem services, the above research approach cannot well explain the mechanism of ecological projects effects on the well-being of farmer households from the perspectives of economic behavior and government security. Therefore, it is necessary to introduce livelihood characteristics into the study of such effects [47].

4.3. Limitations

This study used multiple linear regression to study the factors influencing the well-being of farmer households. This statistical model has been widely used in many fields and can effectively analyze combinations of factors, but it cannot analyze the interactions between the influencing factors. There is a certain spatial coupling relationship between farmer household livelihood characteristics and well-being levels, which cannot be measured using multiple linear regression.

Due to the unavailability of data related to farmer households before the Grain for Green policy implementation in Zhangbei County, this study can only illustrate the current situation of well-being of farmer households and cannot compare livelihoods and well-being levels of farmer households before and after policy implementation. Therefore, a comparison of livelihoods and well-being differences between returned farmland and nonreturned farmland households illustrates part of the impact of the policy on well-being of farmer households.

In the process of measuring livelihood assets of farmer households, some indicators are not included because they are difficult to quantify. For example, some ecological livelihood assets of farmer households cannot be effectively quantified and are not fully included in natural assets, which may affect the results of livelihood assets of farmer households.

5. Conclusions

This study systematically analyzed the impact of the Grain for Green policy on the well-being of farmer households in Zhangbei County, Hebei Province, China. The following three findings were obtained:

(1) The Grain for Green project caused changes in the livelihood of farmer households. The average livelihood diversity of farmer households was 3.008, and the returned farmland households (3.022) were higher than the nonreturned farmland households (2.975) in Zhangbei County. The average level of livelihood assets of farmer households in Zhangbei County was natural assets > social assets > financial assets > human assets > physical assets. The comparison between returned farmland households and nonreturned farmland households showed that the livelihood diversity of returned farmland households was higher than that of nonreturned farmland households, but the total livelihood assets were lower than those of nonreturned farmland households.

(2) The Grain for Green policy had an improving effect on the level of well-being of farmer households, but the effect was not significant. The well-being level of all farmer households in Zhangbei County was 0.517, with an overall low level of well-being. The well-being level of returned farmland households was slightly higher than that of nonreturned farmland households. The wealth level accounted for the largest share of the well-being structure of farmer households, and the contribution of ecological quality was the smallest.

(3) The degree of influence of the factors affecting the level of well-being of farmer households in Zhangbei County varied significantly. There were three main paths through which the Grain for Green policy affected the well-being of farmer households: by reallocating human assets, optimizing natural assets, and enhancing financial assets. The factor of household size had the highest degree, at 0.366, while educational attainment of household members, household labor capacity, annual household expenditure, livelihood diversity, number of large production tools, and total value of livestock were also important drivers of household well-being, and area of arable land was negatively associated with household well-being. There were also differences in the factors influencing the level of well-being of different types of farmer households.

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