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Impact of Livelihood Capital on the Adoption Behaviour of Integrated Agricultural Services among Farmers

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Abstract: Based on the sustainable livelihoods framework (DFID) and the theory of farmer behaviour, this study uses data points from 505 field-based household surveys conducted by the group in Liaoning Province in 2021–2022 to investigate the impact of livelihood capital on farmers' adoption of integrated agricultural services (IASs). Using the entropy method and the intermediary effect model, this paper tests the mediating effect of value perceptions on the path of influence. The findings of this study show that the adoption rate of IASs is low and that farmers lack sufficient knowledge of these services. Moreover, natural, human, and social capital significantly and positively effect farmers' IAS application behaviour. Farmers' perceptions of economic value and ecological value also have a mediating effect on their IAS adoption. Accordingly, this paper proposes the following recommendations: attention should be given to the cultivation and publicity of IASs, policy support for IASs should be strengthened, the level of farmers' livelihood capital should be improved, farmers should be guided to break through the constraints of their current livelihood capital, and farmers' value perceptions should be improved enough to encourage them to take the initiative to participate in these services.

Keywords: livelihood capital; integrated agricultural service; value perception; intermediary effect



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1. Introduction

“Big country, small farmers” has always been China's basic national condition. With the acceleration of industrialisation and urbanisation processes in China, an increasing number of agricultural labourers are flowing into non-agricultural industries offering higher incomes [1,2]. In 2021, China's rural population was 495.83 million people, with the labour force comprising 27.879 million people or 56.2% of the total (data source: China's Rural Statistical Yearbook, 2022). The agricultural labour force has also aged and become feminised [3,4]. Regarding agricultural development experiences worldwide, agricultural social services not only compensate for the shortage of family labour but also foster the intensive management of specific production segments, improve field farming efficiency, and enable farmers to increase their income [5–8]. Since the 18th National Congress of the Communist Party of China (CPC), increased efforts have been devoted to strengthening agricultural socialisation services. Not only is the adaptation of agriculture to the new economic norm inevitable, but it is also a key measure for promoting the reform of the agricultural management system and for realising the modernisation of China's agriculture with Chinese characteristics [9,10].

To introduce small farm production into the track of modern agricultural development, in 2019, the Ministry of Agriculture and Rural Development (MARD) proposed accelerating the upgrading of agricultural mechanisation services, promoting innovation in the service industry. New agricultural mechanisation service subjects were thus deemed the basis for the construction of the entire mechanisation process and integrated agricultural service centres. Led by the Ministry of Agriculture and Rural Affairs, 100 integrated agricultural

service centres across the country were selected to lead more farmers to adopt integrated agricultural services and guide the integration of small farmers into agricultural modernisation. As a new type of agricultural social service, relying on integrated agricultural service centres, integrated agricultural services (IASs) assist farmers in completing the whole industry chain in all-around agricultural services, such as agricultural machinery, agricultural materials, breeding, plant protection, breeding, processing, and sales, without transferring their right to operate on land. Compared to the common scattered agricultural machinery service main body, the IAS centre has more abundant and comprehensive operating equipment and service links radiating from the whole production industry chain. Hence, IASs effectively improve the efficiency of agricultural machinery services and expand the field thereof, realising rich, hierarchical scale operations while providing mechanised high-efficiency and high-quality services for farmers' lives, agroecology, including rural energy and environmental protection, and so on [11–13]. In 2020, the world's rural population reached 341,705,000 people; as a populous country, China's agricultural population accounted for 14.9% of the world's rural population, ranking second in the world (Source: UN FAO database, 2021). How to help farmers achieve higher returns with limited resources based on limited arable land and how to promote the effective linkage between small farmers and modern agriculture are inevitable questions in regards to achieving the sustainable development of land utilisation as well as agricultural development. Farmers, as the critical core of agricultural production and management, are both the demanders and the final users of IASs. Hence, it is of great practical and theoretical value to analyse the influence mechanism and path of farmers' IAS adoption.

In terms of the demand and development of agricultural mechanisation services, many domestic and foreign scholars have indicated that the development of mechanisation in agriculture improves resource utilisation [14], enhances the efficiency of farming [15], increases the nutrition of crops [7], enhances farmers' income levels [16], and is an important means of reducing poverty in agricultural countries [7]. Moreover, the future development of mechanisation in agriculture will transition towards a more energy-efficient electrification process [17]. Scholars at home and abroad have also obtained results on the factors affecting farmers' application of agricultural socialisation services. Many studies have shown that farmers' agricultural decision making is significantly affected by their levels of various types of capital [18]. In terms of natural capital, their family's cultivation area [19,20], number of years of land cultivation [21,22], and other land resource endowments positively affect farmers' application of agricultural socialisation services, while their degree of land fragmentation [23,24] and cost of land use [21] negatively affects farmers' application of socialisation services [25]. Concerning physical capital, physical conditions such as farmers' housing as well as farm machinery influence their use of agricultural mechanisation services [26]. Regarding human capital, health status [23] and education level [22,27] have a significant positive effect on the adoption of social services by farmers, while the number of labourers in their household inhibits their use of farm mechanisation services [22]. For economic capital, factors such as the credit environment of the farm household have a facilitating effect on the use of farm mechanisation services [27], and financial capital promotes the agricultural production of farmers [14]. With regards to social capital, their frequency of contact with agricultural technicians has a positive effect on farmers' adoption of farm mechanisation services [19]. In addition, female farmers are more inclined to use agricultural socialisation services [25], while factors such as coordination of village collectives [28], farmers' age [19,22,25] and the ecological zone [27] impact their adoption of agricultural mechanisation. All of the studies cited above have thus examined the impact of various types of capital endowments on the adoption of agricultural socialisation services from different perspectives. Nevertheless, livelihood capital is the benchmark for farmers' survival and adjustments to their production decisions. Therefore, the literature has clearly demonstrated that livelihood capital influences the adoption of socialisation services with regards to participation in agricultural activities [29,30], the

use of agricultural resources [14,31], household livelihood choices [32,33], scaling up of production [34], and other behaviours.

Based on the above review of the literature, most studies have focused on the impact of one aspect of socialised services or one aspect of capital endowment. As a new type of socialised service, IAS extends both vertically—to “one-stop” agricultural machinery operation services such as ploughing, planting, management and harvesting, drying in the production area, and postproduction processing—and horizontally—to “one-stop” agricultural services such as collective purchase of agricultural materials, technological consultation, demonstration and training, and product sales and docking. The expansion of agricultural services therefore needs to be studied from the perspective of the whole industrial chain. Hence, based on the sustainable livelihood framework (DFID) and the theory of farmer behaviour, using 505 points of field research data in Liaoning Province, this paper explores the impact of livelihood capital on farmers’ decision making regarding their adoption of IASs. Based on the measurement of livelihood capital and the results of this study, we propose specific policy recommendations that can promote the organic connection between small farmers and modern agriculture according to their local conditions, thereby accelerating the upgrading of agricultural mechanisation.

2. Theoretical Framework and Research Hypotheses

2.1. Construction of the Theoretical System of Farm Household Livelihood Capital

According to the Russian economist A.V. Chayanov, farmers who work on “non-capitalist family farms” do not seek to maximise profits in their business objectives. To maintain their livelihoods, they produce even when economic profits are negative, whereby high-quality subsistence capital can help them better withstand external risks as well as mitigate their vulnerability [32,33]. Huang Zongzhi, on the other hand, distinguishes China from Western countries’ pattern of developing the scale of agricultural production and argues that China’s smallholder economy has demonstrated strong vitality in the context of “many people, little land” and that it will long continue to do so. In addition, he believes that the income of Chinese small farmers is the sum of their agricultural income and non-farm wage income, i.e., their non-farm income is the crutch of small farmers’ overall agricultural income [35–37]. Combining the above two theories on farm household behaviour, both subsistence capital and the non-farm income of a farm household thus affect its production decisions.

Livelihood is one’s mean of earning a living, a concept first proposed explicitly by Scoones [38], who stated that livelihoods are based on capabilities, capital (including material and social resources), and activities [39,40]. Thus, livelihood capital includes the capabilities owned by individuals, the assets needed for their household’s life (including material and social resources), and their activities [41]. It is the material basis and guarantee for the survival of farming households and their adjustments of production and business behaviours. Hence, the maximisation of household welfare and its individual capitals are closely linked to each other. The sustainable livelihoods framework, proposed by the UK Department for International Development [42], puts farm households at the centre of development; it has been widely recognised and used because it emphasises the role of farm households in rural poverty and sustainable development, detailing the impacts of policies, laws, and organisations on the livelihoods of farm households. Farmers’ behavioural choices are rational choices, based on their own resource endowments, made to adapt to environmental changes. That is, farmers’ behaviours are based on rational judgements of their needs for sustainable livelihoods. Drawing on existing research, this paper thus divides the livelihood capital measurement system into five dimensions, natural, material, human, financial, and social capital, employing the extreme entropy method to assign weights to these five categories of livelihood capital [43–46].

The DFID sustainable livelihood analysis framework is illustrated in Figure 1:

Social capital reflects farmers' social relations and interpersonal networks: the number of village cadres, whether to participate in cooperatives, interpersonal trust, and interpersonal networks have been selected in this paper [20,21,47]. Usually, social capital can broaden the channels for farmers to obtain information and help, particularly information related to IASs. Therefore, this paper proposes research hypothesis H5:

H5: *Social capital has a facilitating effect on the adoption of IASs.*

2.2.2. The Mediating Role of Value Perceptions in the Influence of IAS Adoption Behaviour

Behavioural economics theory suggests that the essence of human behavioural change is due to cognitive change. IASs are a new type of socialised service that is essentially a productive investment, and the influence of livelihood capital on farmers' application of the IAS will inevitably be realised through cognitive change [49]. Then, only when farmers believe that the benefits of IASs are higher than the inputs will they be willing to adopt them. Combined with existing research, this paper categorises farmers' value perceptions into economic and ecological aspects. Economic value perception means that farmers believe that the adoption of IASs can help reduce production costs or increase agricultural income, thereby increasing family income; ecological value perception means that the adoption of IASs can be a more reasonable input of pesticides and chemical fertilisers or the use of straw resources, thereby achieving the rational use of arable land and reducing surface and environmental pollution [49,50]. Theoretically, the improvement of livelihood capital will increase farmers' level of perception; the more farmers recognise the economic and ecological value of IASs, the more farmers with abundant livelihood capital are inclined to adopt these services. Therefore, this paper hypothesises the following:

H6: *There is a mediating effect of perceived economic value on the impact mechanisms of livelihood capital on farmers' IAS adoption.*

H7: *There is a mediating effect of perceived ecological value on the impact mechanisms of livelihood capital on farmers' IAS adoption.*

3. Data Sources and Model Construction

3.1. Data Sources

The research data are derived from four field household surveys conducted by the research group in Liaoning Province in 2021–2022. Liaoning Province, the main grain-producing area in China, is also an important blackland pilot region. It has a rural population of 11,865,400 in Liaoning Province (data source: Seventh National Population Census of China) and had a grain cultivation area of 35,436 thousand hectares in 2021, accounting for 81.9% of the total cultivated area amid an annual production of 25,387,000 tonnes of grain crops (data source: China's Rural Statistical Yearbook, 2022). Thus, Liaoning Province, as a study area, is both representative and universal. This survey selected core grain crop growing areas in Liaoning Province and the radiation areas of the typical demonstration platforms for IAS and adopted a stratified random sampling method to survey 26 villages in 9 counties (districts) in the central, western, and northern parts of Liaoning Province. We carried out whole cluster sampling on the basis of villages, with 20 households randomly selected from each village and one representative from each household sent with the cooperation of the village ministry. The subject group conducted one-on-one interviews with farmers within each village through the questionnaire to gather information on their villages and households. These were followed by telephone tracking interviews to supplement the questionnaire content.

The number of questionnaires issued in this research totalled 520, all of which were recovered. The questionnaire recovery rate was therefore 100%, although after invalid questionnaires were excluded, only 505 valid questionnaires were obtained. The questionnaire validity rate was therefore 97.1%, as illustrated in Table 1. The statistical results of the

sample show that the adoption rate of IAS is 32.28%, which is on the low side. Overall, the sample shows that the general health condition is relatively good but that the ageing of the countryside is serious, while the average education level is somewhat low. Regarding the income structure, the interviewees' labour rate is on the low side, and the typical family's income from agriculture accounts for a relatively high proportion thereof. This indicates that agricultural income is the main source of income for these farming families.

Table 1. Source and distribution of sample farmers.

County (District) Name	Households	Percentage (%)
Changtu	109	21.6
Faku	67	13.3
Heishan	50	9.9
Kaiyuan	20	4.0
Kangping	58	11.5
Liaozhong	47	9.3
Qinghe	44	8.7
Xifeng	45	8.9
Xinmin	65	12.8
total	505	100.0

3.2. Variable Selection and Measurement

This paper measures IAS adoption behaviour by whether farmers adopt IAS or not. IASs mainly include a series of services provided by IAS subjects throughout the entire production process of the agricultural industry, including the preproduction purchase of agricultural materials, land preparation, sowing, mid-production transplanting, fertilisation, pest control, and postproduction harvesting and straw treatment. A dichotomous variable was used to assign a value for whether farmers adopted IAS, and farmers who adopted any one or more of the services were considered to have adopted IAS and were assigned a value of 1; farmers who did not adopt any of the services were assigned a value of 0.

In terms of intermediary variables, farmers' perceptions of economic value and ecological value were measured by their agreement that the "adoption of IAS can increase household income" and the "adoption of IAS can reduce pollution". Perceived economic value and perceived ecological value were measured by farmers' agreement with statements that the "adoption of IAS can improve household income" and the "adoption of IAS can reduce pollution", and a five-point Likert scale was used to assign values to the level of farmers' agreement, i.e., "Strongly Disagree = 1; More Disagree = 2; Fairly Agree = 3; More Agree = 4; and Strongly Agree = 5".

Meanwhile, farmers' gender, age, topography, and ethnicity impact their adoption of social services [19,22,25]. To more accurately measure the impact of livelihood capital on IAS adoption by farmers, this paper selects gender, age, and whether the farmers are ethnic minorities as control variables.

The definitional assignments and descriptive statistics for each of the above variables are illustrated in Table 2.

Table 2. Variable assignment and descriptive statistics.

Variable Category	Variable Name	Variable Definition	Mean	Std.
Implicit variable	IAS Adoption behaviour (Y)	Adopted = 1; Not adopted = 0	0.323	0.468
Core independent variables				
Natural capital(X1)	Degree of fine crushing (X1-1)	Number of plots of arable land (plots)	5.743	4.712
	Scale of cultivation (X1-2)	Actual planted area (Mu)	32.715	45.493
	Levelling of arable land (X1-3)	Very poor = 1; Poor = 2; Fair = 3; Better = 4; Very good = 5	3.579	0.763

Table 2. Cont.

Variable Category	Variable Name	Variable Definition	Mean	Std.
Material capital(X2)	Number of agricultural machines (X2-1)	Number of agricultural machinery owned (vehicles)	0.758	0.952
	Car ownership (X2-2)	Yes = 1; No = 0	0.313	0.468
	Number of years of housing use (X2-3)	20+ years = 1; 15–20 years = 2; 15–10 = 3; 10–5 = 4; less than 5 years = 5	1.543	1.007
	Number of durable goods (X2-4)	Number of durable goods owned by households (pieces)	4.055	1.412
Human capital(X3)	Number of labourers (X3-1)	Actual number of labourers in the household (persons)	3.004	1.12
	Educational attainment (X3-2)	Below primary = 1; Primary = 2; Junior high = 3; Senior high (medium Professional) = 4; College and above = 5	1.78	0.7697
	Health status (X3-3)	Very poor = 1; Poor = 2; Fair = 3; Better = 4; Very good = 5	4.283	0.882
	Employment (X3-4)	Yes = 1; No = 0	0.269	0.444
Economic capital(X4)	Household income (X4-1)	20,000 and below = 1; 20,001–40,000 = 2; 40,001–60,000 = 3; 60,001–80,000 = 4; 80,001 and above = 5	4.186	1.248
	Share of income from agriculture (X4-2)	0–20% = 1; 21–40% = 2; 41–60% = 3; 61–80% = 4; 81% and above = 5	3.099	1.493
	Agricultural insurance inputs (X4-3)	Input price per unit area (yuan/mu)	4.8795	3.597
Social capital(X5)	Number of village cadres (X5-1)	Number of family village cadres (persons)	0.115	0.325
	Participation in cooperation or not (X5-2)	Yes = 1; No = 0	0.214	0.4104
	Society interpersonal trust (X5-3)	Very distrustful = 1; More distrustful = 2; Fair = 3; More Trust = 4; Very much trust = 5	3.893	0.727
	Interpersonal networks (X5-4)	Number of correspondents (persons)	89.4396	107.963
Intermediary variable				
	Perceived economic value (M1)	Strongly Disagree = 1; More Disagree = 2; Fairly = 3; More Agree = 4; Strongly agree = 5	3.608	0.889
	Perceived ecological value (M2)	Strongly Disagree = 1; More Disagree = 2; Fairly = 3; More Agree = 4; Strongly agree = 5	3.711	0.8259
Control variable				
	Gender (C1)	Male = 1; Female = 0	0.727	0.446
	Age (C2)	Actual age of farmers (years)	57.485	10.725
	Minorities (C3)	Yes = 1; No = 0	0.277	0.448

3.3. Modelling

3.3.1. Construction of the Sustainable Indicator System

In this study, the extreme entropy value method is used to objectively determine the weights of each indicator of farmers' livelihood capital and the level of livelihood capital in each dimension and to derive the value of farmers' livelihood capital level through the weighted average method [51,52]. The specific operational procedures are as follows:

First, the base matrix $Y = (y_{ij})$, y_{ij} is constructed by representing the observations of the j th indicator for the i th farmer, and $i = 1, 2, \dots, j = 1, 2, \dots$

Then, the above matrix is used to generate a new matrix $Z = (z_{ij})$, the elements of which correspond to the elements of the above matrix as follows:

$$z_{ij} = \frac{y_{ij}}{\sum_{i=1}^m y_{ij}} \quad (1)$$

Next, the information entropy value of the j th indicator E_j , with the information effect evaluation D_j . The specific formula is derived as follows:

$$E_j = -K \sum_{i=1}^m \sum_{j=1}^n (Z_{ij})^{D_j} Z_{ij} \ln Z_{ij} \ln D_j = 1 - E_j \quad (2)$$

Finally, the weights of the indicators ω_j and the composite evaluation value v_j are calculated with the following formulas:

$$\omega_j = \frac{D_j}{\sum_{j=1}^n D_j}, v_j = \sum_{j=1}^n \omega_j y_{ij} \quad (3)$$

3.3.2. Econometric Analysis of the Adoption Behaviour of Farm Households

According to the theoretical analysis, IAS adoption behaviour belongs to the dichotomous variable, so the binary logit model was chosen for conducting the empirical analysis in this paper [26], and the two-valued model is as follows:

$$\text{Logit}(Y = 1 | X_j, C_j) = \varphi(\alpha_1 + \beta_1 X_j + \gamma_j C_j + \varepsilon_1) \quad (4)$$

where Y denotes whether the farmer adopts the IAS, taking the value of 1 (adopting) or 0 (not adopting); X_j is the level of livelihood capital of the farmer's j th item ($j = 1, 2, 3, 4, 5$); C_j denotes the control variable ($j = 1, 2, 3$); α_1 represents the constant term; β_1 and γ_j denote the coefficients to be estimated; and ε_1 is the random error term.

3.3.3. Analysis of Intermediary Effects

This study employs the test of the mediating effect proposed by Wen Zhonglin and Ye Baojuan [53] to test the mediating role of value perception in the impact mechanisms of livelihood capital on farmers' IAS adoption behaviour and to further explore the mechanism of the influence pathway of livelihood capital, value perception, and farmers' IAS adoption behaviour. The model is set up as follows:

$$M_j = \varphi(\alpha_2 + \beta_2 X_j + \varepsilon_2) \quad (5)$$

$$\text{Logit}(Y = 1 | X_j, M_j, C_j) = \varphi(\alpha_3 + \beta_3 X_j + \lambda_j) \quad (6)$$

where M_j represents the value perception level of farmers ($j = 1, 2$); α_2 and α_3 are constant terms; β_2 , β_3 , λ_j , and γ_j denote the coefficients to be estimated; and ε_2 and ε_3 are random error terms.

According to the steps of the intermediary effect test in Wen Zhonglin [53], first, the significance of the coefficient β_1 in Equation (4) is verified as the premise of the intermediary effect test; if β_1 is significant, then it can be further verified. Second, the significance of β_2 and λ_j in Equations (5) and (6) is examined, and if they are all significant, then there is an intermediary effect. If the results of the test in turn are not significant, then the use of the nonparametric percentile is needed. If the results of the sequential tests are not significant, the nonparametric percentile of the bootstrap method needs to be used to perform the interval test on the coefficient product. That is, if the test result does not include 0, there is an intermediary effect, and if the interval result includes 0, there is no intermediary effect.

At the same time, to ensure the validity of the research results, Stata 15.0 was used in this study to diagnose multicollinearity, and the obtained variance factor (VIF) values are between 1.06 and 1.14, with an average value of 1.08. All the VIF values are less than 10, which indicates that there is no serious multicollinearity in this model.

4. Empirical Evidence and Analysis of Results

In this paper, Stata 15.0 was used to conduct econometric regression analysis. First, we tested the independent effects of each dimension of livelihood capital on the application behaviour of IASs by farm households (Model 1–Model 5) to measure the total effect of

each dimension of livelihood capital on the IAS application behaviour of farm households. Second, we used a binary logit model (Model 6) to test the impact of livelihood capital on the IAS application behaviour of farm households. Finally, we used a probit model (Model 7) to further test the robustness of the regression results, and the results showed that the core variables were significant. There is no substantial difference between the binary logit model (Model 6) and the binary logit model in terms of robustness and direction of influence, so the binary logit model can be judged to be more robust and can be used as the basis for analysing the regression results.

4.1. Impact of Livelihood Capital on Farmers' IAS Adoption Behaviour

4.1.1. The Effect of Natural Capital on the IAS Adoption Behaviour by Farm Households

Model 6 in Table 3 shows that natural capital positively affects the adoption behaviour of farmers in adopting IAS and it passes the significance test at the 1% level, which is consistent with the expected direction. The larger the farmers' cultivated area is, the easier it is to form the IAS scale. Compared with the use of their own farm machinery or manpower for planting, the adoption of IASs is more economical and has the advantage of negotiating with the main body of the IASs; the better the quality of farmers' cultivated land, the more they have the conditions for the adoption of IASs, the easier it is to achieve the initiative in the process of IAS, and the more likely it is to obtain a preferential price. Therefore, natural capital has a significant positive effect on farmers' adoption behaviour, and hypothesis H1 of this paper is verified.

Table 3. Regression results of livelihood capital on IAS adoption behaviour by farmers.

Variable Name	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)
Natural capital (X1)	0.305 *** (4.94)					0.3875 *** (0.0727)	0.2264 *** (0.0409)
Material capital (X2)		0.0388 (1.64)				−0.0021 (−0.0276)	−0.0035 (−0.0162)
Human capital (X3)			0.0553 *** (4.07)			0.0464 ** (0.0161)	0.0281 ** (0.0095)
Economic capital (X4)				0.0584 ** (2.82)		0.0458 (0.024)	0.0249 (0.0138)
Social capital (X5)					0.163 *** (7.23)	0.1717 *** (0.0252)	0.1013 *** (0.0145)
Control variable							
Gender (C1)	−0.0399 (−0.18)	0.0489 (0.22)	0.0174 (0.08)	0.107 (0.49)	0.0811 (0.35)	−0.1143 (−0.2443)	−0.0655 (−0.144)
Age (C2)	−0.0077 (−0.82)	−0.0104 (−1.10)	−0.00107 (−0.11)	−0.0172 (−1.88)	−0.0033 (−0.34)	0.0160 (0.0118)	0.0097 (0.0069)
Minorities (C3)	−0.586 * (−2.49)	−0.549 * (−2.42)	−0.602 ** (−2.60)	−0.569 * (−2.50)	−0.635 ** (−2.61)	−0.7733 ** (−0.2597)	−0.4414 ** (−0.1465)
_cons.	−16.41 *** (−4.85)	−2.141 (−1.39)	−3.678 *** (−3.31)	−3.263 * (−2.42)	−9.167 *** (−6.49)	−36.529 *** (−4.8617)	−21.416 *** (−2.6913)
R2	0.0632	0.0182	0.0402	0.0269	0.1058	0.1842	0.1837
Likelihood	−297.526	−311.845	−304.844	−309.058	−284.027	−259.1126	−259.278

Note: ***, **, and * indicate that the parameter estimates are significant at the 0.01, 0.05, and 0.1 levels, respectively, and the numbers in parentheses are t-values.

4.1.2. The Effect of Material Capital on the IAS Adoption Behaviour of Farm Households

Material capital has a negative effect on the IAS adoption behaviour of farm households and fails the significance test; the effect is not significant, contrary to the expected direction. Based on an analysis of the reasons, the possible explanations are, on the one hand, that in recent years there has been a serious outflow of labour from rural areas, most of the farmers who go out to work live in towns and cities, and the homesteads in the rural areas are generally houses that are 20 years old or older (70.29%); beyond that, the

level of the material capital of the farm households is higher, and the farm households have sufficient farm machines at home, so that they can carry out the work themselves during the production process or even provide basic farm machine services. Therefore, material capital does not have a significant effect on farmers' IAS adoption behaviour, and hypothesis **H2** of this paper is not verified.

4.1.3. The Effect of Human Capital on Farmers' IAS Adoption Behaviour

Human capital positively affects farmers' IAS adoption behaviour and passes the significance test at the 5% level, which is consistent with the expected direction. The higher the farmers' education level, the more they accept new things and the more willing they are to adopt new types of social services; the higher the farmers' health level, the more likely they are to go out to engage in non-agricultural work, and the cost of agricultural work in the busy season will be higher, so they are more willing to adopt IASs; at the same time, many rural labourers are going out to work, and the number of labourers engaging in agricultural is limited, so the farmers are in greater need of IASs to compensate for the lack of family labour. Therefore, human capital has a significant positive effect on farmers' adoption behaviour, and hypothesis **H3** of this paper is verified.

4.1.4. The Effect of Economic Capital on Farmers' IAS Adoption Behaviour

Model 6 in Table 3 shows that economic capital has a positive effect on farmers' adoption behaviour, which is consistent with the expected direction, but it fails the significance test. On the one hand, the higher the household income, the more capital can be used to dispose of IASs, and the more willingness to adopt these services there is; however, based on the current situation of a rural labour force exodus and serious ageing, the households with a low household income still need IASs to compensate for the labour shortage. On the other hand, households with a lower share of agricultural income have a high proportion of labourers going out to work, and there is a shortage of labourers engaged in planting during busy farming seasons, while households with a relatively high share of agricultural income have most of their operations invested in agricultural services, and farmers are more eager to enhance the level of household agricultural production through integrated agricultural services. Therefore, the effect of economic capital on the adoption behaviour of farmers is not significant, and hypothesis **H4** of this paper is not verified.

4.1.5. The Effect of Social Capital on Farmers' IAS Adoption Behaviour

Social capital has a positive effect on farmers' adoption of IAS and passes the significance test at the 1% level, which is consistent with the expected direction. The more interpersonal networks farmers have, the more channels they have for obtaining information, the richer the information they obtain, and the easier it is to accept new services; the richer farmers' social networks are, the more they help farmers understand the policies that benefit agriculture and the subsidy policies of IASs, which can promote farmers' adoption of these services. Additionally, the higher farmers' social trust is, the more willing they are to adopt new types of socialised services to improve their own agricultural production and management level. Therefore, social capital has a significant positive effect on the adoption of IAS by farmers, and hypothesis **H5** of this paper is verified.

4.2. *The Intermediary Effect of Value Perceptions on the Influence of Livelihood Capital on IAS Adoption Behaviour*

The regression results in Tables 4 and 5 show that when the perception of economic value is used as a mediator, the higher the level of social capital, the stronger farmers' recognition of the value of IASs and the more willing they are to adopt these services. There is a mediating role for the perception of economic value in the influence of social capital on the application of IAS by farmers. This shows that the richer farmers' social capital is, the richer and more comprehensive their access to subsidies and policies related to IASs,

which is conducive to understanding the economic value of the new socialised services and promotes farmers' adoption of these services.

Table 4. Regression results of the influence of livelihood capital on farmers' value perception.

Variables	Perceived Economic Value (M1)					Perceived Ecological Value (M2)				
	X1	0.160 *** (6.53)					0.125 *** (5.32)			
X2		0.0268 * (2.13)					0.00885 (0.74)			
X3			0.0317 *** (4.47)					0.0170 * (2.50)		
X4				0.0262 * (2.54)					0.00262 (0.27)	
X5					0.0827 *** (7.86)					0.0743 *** (7.39)
_cons.	−3.429 ** (−2.60)	2.907 *** (3.73)	2.253 *** (4.12)	3.291 *** (5.05)	−0.821 (−1.30)	−1.542 *** (−4.02)	−0.950 *** (−4.25)	−1.066 *** (−6.80)	−1.278 *** (−6.86)	−1.262 *** (−6.80)
R ²	0.0902	0.0214	0.0505	0.025	0.121	0.060	0.0078	0.0190	0.0069	0.1045
Prob > F	0.000	0.0285	0.000	0.0128	0.000	0.000	0.414	0.0478	0.483	0.000

Note: control variables have been controlled and the rest are as above. ***, **, and * indicate that the parameter estimates are significant at the 0.01, 0.05, and 0.1 levels, respectively.

Table 5. Regression results of the indirect effect of livelihood capital on IAS adoption behaviour.

Variables	Integrated Agricultural Services Adoption Behaviour (Y)									
	Perceived Economic Value (M1)					Perceived Ecological Value (M2)				
X1	0.0047 (0.74)					0.0176 * (2.51)				
X2		−0.0004 (−0.13)					0.00571 (1.68)			
X3			0.0018 (1.00)					0.00682 *** (3.53)		
X4				0.0033 (1.32)					0.0112 *** (4.08)	
X5					0.0091 ** (3.19)					0.0125 *** (4.00)
M1	0.334 *** (29.73)	0.336 *** (31.04)	0.334 *** (30.40)	0.335 *** (30.88)	0.324 *** (28.65)					
M2						0.323 *** (24.97)	0.330 *** (26.10)	0.326 *** (25.87)	0.330 *** (26.48)	0.314 *** (23.92)
_cons.	−0.890 * (−2.55)	−0.615 ** (−3.09)	−0.756 *** (−5.39)	−0.833 *** (−5.01)	−1.113 *** (−6.65)	−1.542 *** (−4.02)	−0.950 *** (−4.25)	−1.066 *** (−6.80)	−1.278 *** (−6.86)	−1.262 *** (−6.80)

Note: control variables have been controlled and the rest are as above. ***, **, and * indicate that the parameter estimates are significant at the 0.01, 0.05, and 0.1 levels, respectively.

When ecological value perception is used as a mediating variable, the higher the levels of natural, human, and social capital are, the higher the degree of farmers' perception of the ecological value of IASs, and the higher the level of farmers' adoption of these services, i.e., there is a mediating effect in the influence path of "livelihood capital → ecological value perception → IAS adoption behaviour". The better the level of farmers' natural capital, the higher the requirements for agricultural planting and management, and the more they will consider the sustainability of production while considering the economic returns in the process of production and management, which will prompt them to adopt IASs. Moreover, the better the level of farmers' human capital, the higher the level of their own cognitive level and the quality of their family's labour force, and the easier it is to obtain and absorb

the information related to the new things and have a better understanding of the role of IASs in the sustainable production and operation of the agricultural industry, which encourages them to adopt these services. Furthermore, the higher the level of social capital, the easier it is to achieve mutual benefits with other farmers in agricultural production, which encourages them to adopt IASs.

According to the steps of the intermediary effect test in Wen, Zhonglin, and Ye, Baojuan [53], an interval test on the coefficient product using the nonparametric percentile bootstrap method needs to be performed for the remaining influence paths. According to the intermediary effect test results in Table 6, when economic value perception is used as a mediator variable, the influences of “natural capital→economic value perception→integrated agricultural service adoption behaviour” and “human capital→economic value perception→integrated agricultural service adoption behaviour” are [0.0392, 0.0676] and [0.0053, 0.0149], respectively, indicating that neither of them contains zero. The better the natural capital conditions of farmers, the better their own cultivation conditions. For agricultural cultivation and management of higher income requirements, a higher input-output ratio will be pursued, encouraging the adoption of IASs. Farmers’ human capital level with a higher level of cognition is higher because the economic value of IASs with a more comprehensive understanding of the superiority of their own conditions is usually based on the labour opportunity, and, in the busy season, the IAS of the cost of the comparison will be considered, prompting the adoption of IAS. Notably, the direct effects of natural capital and human capital are not significant and thus can only promote the adoption of IAS behaviours by enhancing farmers’ perceived economic value. Therefore, research hypotheses H6 and H7 in this paper are partially verified.

Table 6. Results of the intermediary effect test.

Intermediary Path	Ratio	Std. Err.	Lower Confidence Interval	Upper Confidence Interval
X1→M1→Y	0.0533	0.0075	0.0392	0.0676
X3→M1→Y	0.0106	0.0025	0.0053	0.0149

5. Discussion

Based on a review and study of the literature, this study explores the following influence mechanism: livelihood capital→farmers’ value perception→IAS adoption behaviour. The results of this study therefore indicate that livelihood capital affects the adoption behaviour of farmers in different dimensions. That is, natural, human, and social capital significantly contribute to farmers’ adoption behaviour, while farmers’ value perception shows a different degree of contribution in the path of its influence.

The main research contribution of this paper mainly includes the following points. First, a new type of agricultural production socialisation, IASs, differ from ordinary socialised services in terms of their service subjects and service modes. With the wide application of agricultural socialised services, farmers will pay more attention to the service quality and convenience of agricultural socialised services. The socialised services they purchase will have higher requirements, whereby integrated agricultural services will become an inevitable trend in the development of agricultural socialisation services. However, IASs are still in the development stage, and the literature is limited to interpretations of policy. This paper, as the content of the study demonstrates, thus enriches research by bridging relevant gaps within it. In addition, Liaoning Province is an important production area for grain crops in China, whereby the selection of Liaoning farmers as the research object in this paper is critical, as it can help promote integrated agricultural services. Second, this study is different from most studies regarding the impact of individual capital endowment on the adoption of agricultural socialised services. Based on the DFID sustainable livelihood framework, this paper incorporates the livelihood capital of farmers in various dimensions into the adopted framework and applies the entropy method to measure and comprehensively explore the influence mechanism of livelihood capital on their adoption

of IASs. It thus systematically improves the research results in this field in terms of its research methodology. Finally, this paper applies the theory of behavioural economics to explore the mediating effect of farmers' value perception in their path to livelihood capital on their adoption of IASs, thereby clarifying the relevant results in the literature while refining the understanding of the impact of farmers' adoption of social services in the field of adoption behaviour.

Clearly, this study has some limitations. First, due to the influence of capacity and pandemics, the study area chosen in this paper was Liaoning Province. Although Liaoning Province, an important grain-growing region in China, is highly representative, future studies need to expand the sample size and scope to the three eastern provinces and even all of China to further improve the accuracy and universality of this research. Second, this study only explored farmers' adoption of IAS, the demand body. It did not include the behaviour of the service body or the functions of the government, the influencing factors. Since the adoption of IAS implies a dynamic relationship among farmers, service providers, and external actors, further research should consider the influence mechanism of policy regulation and policy subsidies on the promotion of IAS.

6. Research Findings and Policy Implications

Based on the framework of sustainable livelihoods of farmers, this paper constructs the theoretical framework of "livelihood capital → farmers' value perception → IAS adoption behaviour", applies the binary logit model and the intermediary effect test [53], and explores the role of the intermediary effect by combining it with the micro research sample of 505 farmers. The main research contribution of this paper mainly includes the following points: (1) At present, the development of IASs is still in its infancy, and the farmers' adoption rate is low. Farmers do not have a good understanding of IAS, and the difference between IAS and ordinary agricultural services is not clear. (2) Livelihood capital has different degrees of influence on the adoption behaviour of farmers. Among them, natural, human, and social capital have a significant positive influence on farmers' adoption of IASs; material capital has a negative effect on farmers' adoption of IASs, but it does not pass the significance test; economic capital positively affects the adoption of IASs, but the effect is also not significant. (3) Perceived economic value and perceived ecological value have a mediating effect on livelihood capital adoption behaviour.

Based on the above conclusions, this paper gains the following policy insights:

(1) Emphasis has been placed on fostering and promoting IASs and strengthening policy support for these services. With the development of urbanisation and industrialisation, the outflow of rural labour and the ageing of the farming population, agricultural socialisation services are an important channel for solving the dilemma of "who will grow the land", and comprehensive agricultural services are a necessary way to improve the efficiency of land use and realise the sustainable development of agricultural production. By strengthening policy support and publicity for IASs and clarifying the registration process and labelling of integrated agricultural service centres, farmers' understanding of IASs will be enhanced.

(2) The level of livelihood capital of farming households should be improved, and they should be guided to break through the current constraints on livelihood capital. Breaking through the livelihood constraints will help farmers broaden their livelihood choices, encourage them to make more favourable agricultural decisions to increase their incomes, and help farmers in agricultural production countries to leave poverty. Therefore, the cultivation of new management subjects should be strengthened, the land transfer mechanism should be standardised, the orderly transfer of farmers' arable land should be guided, the status quo of arable land fragmentation should be improved, and moderate scale operation should be realised. Moreover, the training of farmers in agricultural technology should be increased, production and management skills should be improved, and farmers should be guided to break through the status quo of human capital constraints. Farmers should also be encouraged to cooperate with new management subjects, enhance

the level of their own social capital, realise mutual benefits, and actively play a leading role in the cooperative of village cadres and cooperatives. The government has also actively played the leading role of village cadres and cooperatives, encouraging village collectives to assume intermediary responsibilities in the process of IASs and promoting the effective implementation of these services.

(3) Farmers' value perceptions should be enhanced, and they should be encouraged to take the initiative to participate. Training for diversified agricultural machinery services should be conducted, the economic and ecological value of IASs should be actively publicised, and farmers' own capital endowment should be improved. At the same time, farmers should be encouraged to understand the role of IASs in business income and sustainable development. In this way, policy subsidies for farmers' adoption of socialised services can be promoted, the cost of IAS adoption can be reduced, and the motivation of farmers to adopt IAS can be promoted, shortening the path of realisation of the organic connection between small farmers and modern agriculture.

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