A study of farmers' willingness to separate domestic waste based on UTAUT model

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Abstract. Currently, China's economic development has shifted from the pursuit of development speed to the pursuit of development quality, and as a result, people are paying more attention to environmental issues. However, some scholars have observed the phenomenon of "high willingness but low behavior" in various aspects of rural habitat management. To this end, this paper first analyzes the factors influencing farmers' willingness to participate in household waste separation and the degree of participation using the UTAUT theoretical analysis framework, and then conducts an empirical test based on CLES2021 data using the Heckman two-stage choice model. The results show that ecological performance expectation, social performance expectation, knowledge reserve, institutional norms, technical convenience and governance foundation have a significant positive influence on the willingness to increase farmers' domestic waste separation, while the conversion of willingness to behavior is influenced by economic performance expectation, knowledge reserve, institutional norms, demonstration effect and technical convenience. Accordingly, this paper attempts to propose corresponding suggestions to promote farmers' domestic waste separation governance.

Keywords: Household waste sorting; farmers' willingness to participate; UTAUT; Heckman.

1. Introduction

In 2023, the Central Document No. 1 clearly pointed out that in order to promote the construction of livable and beautiful countryside, it is necessary to further solidly promote the improvement and upgrading of rural habitat environment, increase the improvement of village public space, continue to carry out village cleaning action, and promote the source of rural domestic waste classification and reduction, timely removal and disposal. It can be seen that the work on the classification of rural household waste management is very important, and the willingness of farmers to act on it is an important indicator that directly responds to the progress of the rural habitat environment improvement work. However, although there are currently efforts to classify waste in rural areas, there are still problems of incomplete and inefficient classification [1]. Therefore, the study of the intrinsic mechanism of farmers' behavioral willingness to sort domestic waste is beneficial to promote livability and livability as well as the construction of beautiful villages.

Academics have conducted extensive research on this issue. One is from the perspective of farmers themselves, and some scholars conclude that the salience of political identity and years of education are closely related to domestic waste sorting and management, party members and village cadres play an important leading role, and the perception of environmental pollution can have an important impact on farmers' awareness of responsibility for domestic waste sorting and management, all of which have a positive impact on farmers' domestic waste sorting and management efforts [2]. Moreover, a higher level of digital literacy is conducive to the development of farmers' environmental awareness, which is conducive to the promotion of the separate management of rural household waste [3]. Secondly, from the perspective of the social environment, some scholars point out that the mobilization of farmers' motivation for domestic waste sorting and management can be mobilized by using effective village organizational power, a better domestic waste sorting and management system, and the positive influence of relatives and friends or other rural residents. Creating an atmosphere of environmental awareness is conducive to rural domestic waste sorting and management [4]. Third, from the perspective of infrastructure, the high cost of

waste recycling, transportation, and treatment requires government intervention and more efficient waste treatment technologies have yet to be developed [5]. And the infrastructure for waste sorting and disposal is not yet well developed, the government's financial pressure is high, a unified standard for waste disposal has not yet been formed, and farmers can only carry out simple treatment of domestic waste [1].

From the above text, we can see that scholars have explored the willingness of farmers' domestic waste sorting behavior from a different perspective and have achieved richer research results, but still lack a more unified theoretical analysis framework. The integrated technology acceptance theory (UTAUT) is a model based on four core variables: performance expectation, effort expectation, social influence and convenience, as a criterion to analyze the intrinsic connection between the explained variables and the explanatory variables, and the results applied in various fields of research show that the explanatory degree of this theoretical model reaches 70% [6]. This indicates that the theoretical analysis of the UTAUT model has been relatively well constructed. The question can be asked: can we investigate the relationship between "performance expectation, effort expectation, social influence, convenience → willingness to separate waste → behavior to separate waste" by combining the UTAUT model with the willingness and participation of farmers as the explanatory variables? Based on this, this study uses the UTAUT theoretical framework and the Heckman two-stage model with the CLES2021 data to explore the factors that influence farmers' willingness to participate in household waste separation, and to find the path of converting willingness into behavior in order to provide reference suggestions for the cause of household waste separation.

2. Theoretical analysis and research hypothesis

2.1 Theoretical basis

Since the 1970s, environmental issues have been studied in psychology, sociology, economics, and other fields. The current social science research on environmental behavior has developed two main perspectives: one considers environmental behavior as an individual's "active choice" from the perspective of the actor subject; the other advocates "passive choice" from the perspective of external structure, which considers environmental behavior as determined by others and the overall external environment " [7]. Based on the integration of the factors influencing "active choice" and "passive choice" behaviors, Venkatesh et al. (2003) integrated a series of theoretical models in the field of behavioral research into four core variables: performance expectancy, effort expectancy, social influence, and facilitation. Venkatesh et al. (2003) proposed the UTAUT model by integrating a series of theoretical models in the field of behavioral research into four core variables: performance expectancy, effort expectancy, social influence, and convenience, and control variables including gender, age, experience, and voluntariness [8]. Many domestic and foreign scholars proved the validity of this model, and He Ke (2016) introduced this model from the field of information technology to the research in the direction of resource and environmental economics [9]. Currently, the theory is widely used to study behavioral intentions because of its better explanatory power for individual activities. Based on this understanding, this paper uses the UTAUT model as a framework to analyze the participation willingness of farmers to participate in domestic waste separation and its influencing factors, which has a strong prospective and feasibility.

2.2 Research Hypothesis

This paper analyzes the factors influencing farmers' willingness to participate in household waste sorting in terms of performance expectation, effort expectation, social influence, and convenience, using UTAUT as a model, and proposes the following research hypotheses.

Performance expectation is similar to "perceived value" in the perceived value theory, which is almost equivalent to "perceived usefulness" in the Technology Acceptance Model (TAM), reflecting the individual perception of the extent to which the public can improve their welfare by sorting household waste, such as improving It reflects the public's individual perception of the degree of welfare enhancement that domestic waste separation can bring, such as improving the ecological environment, bringing some economic benefits, and promoting social development. Yangling Zhou (2021) confirmed that value perception has a significant enhancing effect on public participation in domestic waste sorting [10]. Accordingly, this study specifically classified performance expectations into ecological performance expectations, economic performance expectations, and social performance expectations, which are expected to have a positive effect on farmers' willingness to participate. Accordingly, the research hypothesis was formulated as follows.

H1a: performance expectations have a significant effect on farmers' willingness to participate in domestic waste separation.

H1b: Performance expectation has a significant effect on farmers' participation in domestic waste sorting.

Effort expectation is similar to "perceived ease of use" in the technology acceptance model, reflecting the public's perceived difficulty in participating in household waste sorting. Cimperman et al. (2016) have shown that effort expectation has a significant impact on individual decision making. In this study, the "effort expectation" is reflected by the willingness to pay and the knowledge base of the rural residents on domestic waste separation from the farm households [11]. Accordingly, this study divides the effort expectation into two variables: monetary payment expectation and knowledge reserve. Based on this, the following hypothesis is proposed.

H2a: Effort expectation has a significant effect on farmers' willingness to participate in domestic waste separation

H2b: Effort expectation has a significant effect on the participation of farmers in domestic waste sorting

Social influence refers to the influence of the surrounding environment and the attitude of the group on farmers' participation behavior, which is mainly reflected in three aspects: competent norms, social factors and public image. The human body in society is highly susceptible to the influence of social groups on their ideology and willingness to act. Pan Ding et al. (2022) found that the ubiquitous social comparisons in life can have an impact on productive consumption [12]. Accordingly, this study divides social expectations into the influence of institutional norms as well as the influence of demonstration effects. The research hypothesis is proposed.

H3a: social influence has a significant effect on farmers' willingness to participate in domestic waste separation

H3b: Social influence has a significant effect on farmers' willingness to participate in domestic waste sorting

Convenience conditions are used in the UTAUT model to describe the degree of influence of existing conditions on farmers' participation in domestic waste management. Specifically, this study classifies the convenience conditions into two categories: technical convenience and geographical convenience. For the former, if there is a local professional organization to promote and publicize domestic waste separation, the technical facilitation is considered to be stronger; for the latter, if the farmers live closer to the town center location, the infrastructure is considered to be more complete and has stronger geographical facilitation. Accordingly, the following hypotheses are proposed.

H4a: Convenience has a significant effect on farmers' willingness to participate in domestic waste separation

H4b: Convenience has a significant effect on the participation of farmers' domestic waste sorting

3. Study Design

3.1 Data source and processing

The data in this paper come from the field research data of CLES (China Land Economic Survey) conducted by Nanjing Agricultural University in Jiangsu Province using PPS sampling in 2021, and the questionnaire covers various aspects such as land market, ecological environment, and rural finance. After data processing and screening, 2411 samples were finally retained in this paper.

3.2 Variable description and selection

According to the above theory, the corresponding explanatory variables, core explanatory variables and control variables are selected in this paper.

Explanatory variables. In the first stage of this paper, the explanatory variable is farmers' willingness to participate in waste separation, which is measured by the questionnaire "Are you willing to separate household waste?" is measured by the questionnaire. The second stage is the degree of participation in waste separation, which is measured by the question "How do you dispose of your household waste?" The second stage is the degree of participation in waste separation, which is measured by the question "How do you dispose of your household waste?

Core explanatory variables. The core explanatory variables include performance expectation, effort expectation, social influence, and convenience. Performance expectations include economic performance expectations, ecological performance expectations, and social performance expectations; effort expectations include knowledge reserves and willingness to pay; social impacts include institutional norms, demonstration effects, and governance foundations; and convenience conditions include technical convenience and geographic location.

Control variables. In addition to the above factors, farmers' participation in domestic waste separation is also influenced by individual characteristics and household characteristics. In this paper, gender, age, and education level of respondents are selected as individual-level control variables, and household income, number of agricultural laborers, and nature of household business are selected as household-level control variables to ensure the accuracy of the results.

3.3 Model Building

Previous studies have shown that when studying farmers' willingness to participate and participation behavior, it is always difficult to avoid the problem of selection bias and self-selection of the interviewed farmers by using OLS or Tobit models, which results in biased coefficient estimation, while the Heckman two-stage model is often used for good error avoidance in the face of selection bias. Therefore, this paper uses the Heckman two-stage model to analyze the factors influencing farmers' participation in domestic waste separation.

Since the willingness to participate is a binary discrete variable with two specific situations: willing to participate (taking the value of 1) and unwilling to participate (taking the value of 0), the first stage uses the Probit model to analyze the main factors influencing whether farmers are willing to separate household waste or not, and all 2411 samples will be used in this stage as follows.

$$Y_{1i} = \alpha X_{1i} + \mu\ ,\ and\ Y_{1i} = \begin{cases} 1,\ i.e.willing\ to\ participate \\ 0,\ i.e.unwillingness\ to\ participate \end{cases} \quad (1)$$

In equation (1), Y_{1i} denotes the participation intention of the ith farmer, X_{1i} denotes the factors affecting the participation of the farmer in domestic waste separation, α is the coefficient to be estimated, and the random error term μ satisfies a normal distribution with a mean value of 0.

In the second stage of regression, the samples that are unwilling to participate in the first stage will be removed, and after the removal, the remaining 2174 samples will be used. Also, to correct

for possible sample selectivity bias in the OLS regression, the Inverse Mills Ratio IMR (Inverse Mills Ratio) needs to be introduced in the second stage analysis:

$$MR = \frac{\varphi(X_{1i}/\sigma_0)}{\Phi(X_{1i}/\sigma_0)} \tag{2}$$

In equation (2), $\varphi(X_{1i}/\sigma_0)$ is the probability density of the standard normal distribution; $\Phi(X_{1i}/\sigma_0)$ is the corresponding cumulative probability distribution. So far, the equation of the modified second stage on the degree of farmers' participation in domestic waste sorting is obtained.

$$Y_{2i} = \beta_0 + \beta_1 X_{2i} + \beta_2 IMR + \varepsilon \tag{3}$$

In equation (3), Y_{2i} is the participation level of the ith household, X_{2i} indicates the factors affecting the participation level of the household in domestic waste sorting, IMR is the inverse Mills ratio, and β_0, β_1, and β_2 are the coefficients to be estimated for the constant term, the explanatory variables, and the inverse Mills ratio, respectively, where if β_2 is significant, it proves that the sample selectivity bias exists and the Heckman two-stage model is properly selected. In addition, to avoid the problem of multicollinearity due to the high correlation between IMR and other explanatory variables, the number of explanatory variables in the first-stage regression should be larger than the number of explanatory variables in the second-stage regression, and the second-stage explanatory variables are included in the first-stage regression explanatory variables.

4. Results and Analysis

4.1 Analysis of farmers' willingness to participate in domestic waste separation and the degree of participation

Among the 2411 valid questionnaires, 90.17% of the farmers were willing to participate in domestic waste separation, while only 9.83% were unwilling to participate. However, among the farmers who are willing to participate, the largest proportion is still "no sorting" (43.40% of the total sample) or "two types of sorting" (31.65% of the total sample), i.e., it is observed that The problem of the deviation of farmers' willingness to participate and their participation behavior was observed in "willingness without behavior" or "high willingness but low behavior". Previous literature has also observed a similar phenomenon in green behavior, which is considered to be related to farmers' perceptions of equity, social relations and grassroots governance [13][14]. For this reason, we further discuss the factors that influence the level of participation and involvement of farm households.

4.2 Empirical analysis based on the Heckman two-stage selection model

In this paper, using Stata17.0, the Heckman two-stage sample selection model was used to analyze the factors influencing farmers' willingness to participate in domestic waste separation and participation behavior, and the estimation results are shown in Table 3. from Table 1, Prob > chi2 = 0.000 and Prob > F = 0.000, both reaching the 1% significant level, indicating that the overall estimation of the model is good; IMR inverse Missius ratio is 0.370, which is significant at the 10% level, indicating that the Heckman two-stage selection model is chosen reasonably; before the second stage, the remaining variables are tested for multicollinearity with IMR, and the test results VIF values are less than 3.20, which means that the variables are properly selected and the model does not have multicollinearity problems.

From the regression estimation results, it can be obtained that among the performance expectation variables, ecological performance expectation and social performance expectation significantly affect farmers' willingness to participate at the 1% level, while economic performance expectation significantly affects the degree of farmers' participation at the 10% level. This indicates

that farmers' participation in domestic waste management is more related to their expected returns, and the environmental improvement and social praise that can be brought by domestic waste separation can increase farmers' willingness to participate, but a certain degree of in-kind incentive is needed to convert the willingness into behavior.

Among the effort expectation variables, the knowledge reserve affects farmers' willingness to participate in household waste separation and participation behavior at the 1% level of significance. This indicates that when farmers are aware of domestic waste separation, they are more likely to translate it into action.

Among the social influences, institutional norms and governance foundations affect the willingness to participate at 10% significant level, and furthermore, institutional norms and demonstration effects affect farmers' participation in domestic waste separation at 1% and 5% significant levels, respectively. This indicates that the environmental system and good governance by village cadres can make farmers more willing to participate, while the demonstration by the system and neighbors can facilitate this willingness to turn into concrete actions.

In terms of convenience, technical convenience affects both the willingness and participation of farmers in domestic waste sorting at 1% significant level, while geographical location has less influence on farmers' participation in domestic waste sorting. This suggests that good domestic waste sorting promotion is an effective means to increase farmers' willingness and behavior to participate in domestic waste sorting.

Table 1. Heckman two-stage model estimation results

Variable Name	Phase I: Probit Model Willingness to participate in domestic waste sorting			Phase 2: OLS model The degree of participation of farm households in domestic waste separation		
	Coefficient	Standard error	z-value	Coefficient	Standard Error	t-value
Economic Performance Expectations	0.076	0.055	1.38	0.044*	0.025	1.79
Ecological Performance Expectations	0.253***	0.054	4.66	0.021	0.028	0.74
Social Performance Expectations	0.264***	0.061	4.36	—	—	—
Knowledge Base	0.331***	0.046	7.13	0.213***	0.023	9.20
Economic willingness to pay	0.001	0.001	0.95	—	—	—
System Specification	0.095*	0.057	1.68	0.104***	0.023	4.53
Demonstration effect	0.119	0.090	1.32	0.086**	0.036	2.38
Governance Foundation	0.110*	0.062	1.79	—	—	—
Technology Convenience	0.351***	0.110	3.19	0.238***	0.066	3.59
Location	-0.008	0.005	-1.47	—	—	—
Individual characteristics variables	Control	Control	Control	Control	Control	Control
Household characteristics variables	Control	Control	Control	Control	Control	Control
Constant	-2.966***	0.74	-4.01	0.237	0.347	0.68
IMR	—	—	—	0.370*	0.201	1.83
Model Testing	Prob > chi2 = 0.000			Prob > F = 0.000		

Note: *,**,*** represent variables significant at the 10%, 5% and 1% levels, respectively.

5. Summary

This paper analyzes the factors influencing farmers' willingness to participate in household waste separation and the degree of participation based on the UTAUT model, and uses the Heckman two-stage selection model to conduct an empirical test using CLES2021 data. The results show that

farmers in the survey area generally have a high willingness to participate, but there is a more serious problem of willingness-behavior paradox. From the perspective of influencing factors, ecological performance expectation, social performance expectation, knowledge reserve, institutional norms, technical convenience and governance foundation have a significant positive influence on enhancing farmers' willingness to separate household waste, while the conversion of willingness to behavior is influenced by economic performance expectation, knowledge reserve, institutional norms, demonstration effect and technical convenience.

Based on this, this paper proposes the following recommendations.

(1) Continuously promote the propaganda work related to domestic waste sorting to enhance farmers' knowledge reserve. Knowledge reserve is an important factor to enhance farmers' willingness to participate in domestic wastewater sorting, and also an important factor to turn farmers' willingness to participate into willingness degree. The improvement of farmers' knowledge reserve is conducive to the formation of farmers' environmental protection awareness, as well as knowledge to guide action.

(2) Improve the governance system related to the classification of domestic waste in each village. Develop a unified and standardized system of domestic waste classification governance and a system of rewards and punishments, with clear rewards and punishments, to systematically limit the framework of farmers' domestic waste classification and disposal behavior. The use of rewards to stimulate the action of farmers to classify domestic waste can better put their will into practice; the use of punishment will regulate the behavior of farmers who do not cooperate with the management of domestic waste classification, and promote farmers to carry out the management of domestic waste classification work.

(3) Promote the role of village cadres as the mainstay to implement the promotion and implementation of various governance systems and enhance farmers' sense of ownership. The village cadres take the lead in implementing the management of household waste separation, which will help set an example for farmers and promote the process of household waste separation and management; the cultivation of farmers' independent awareness of household waste separation and management will make farmers better and more willing to participate in the action of household waste separation and management.

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References

[1] Zhou Min. Study on the current situation and improvement strategy of rural household waste classification and treatment under the perspective of rural revitalization [J]. China Resource Comprehensive Utilization,2022,40(05):154-156+159.

[2] Jia Yajuan,Zhao Minjuan. The influence of environmental pollution perception on rural residents' willingness to source-separate domestic waste--and the mediating effect of responsibility awareness[J]. Journal of Jiangsu University (Social Science Edition),2022,24(04):54-65+124.

[3] Zhu Honggen, Shan Hui, Shen Yu et al. Study on the influence of digital literacy on farmers' willingness and behavior of domestic waste separation[J]. Journal of Jiangsu University (Social Science Edition),2022,24(04):35-53.

[4] Jia Yajuan, Ye Lingyun, Zhao Minjuan. Research on the influence of village system on rural residents' behavior of domestic waste classification and management--an analysis based on the theory of planned behavior [J/OL]. Ecological Economy:1-14[2023-03-01].

[5] Sun Yinghong. The current situation and countermeasures of rural domestic waste management in China[J]. Rural Science and Technology,2022,13(11):125-128.

[6] Ding Yao,Xu Fang. Study on the willingness of new professional farmers in western region to use science and technology information services[J]. Librarianship Research,2019,No.453(10):58-67.

[7] Chen Shaojun,Li Ruchun,Ma Yongbin. The paradox of willingness and behavior:A study on the mechanism of urban residents' domestic waste separation[J]. China Population-Resources and Environment,2015,25(09):168-176.

[8] Venkatesh V, Morris M G, Davis G B, et al. User acceptance of information technology:towards a unified view[J]. MIS quarterly, 2003,27(3): 425-478.

[9] He Ke. Research on the value assessment of agricultural waste resourceization and its ecological compensation mechanism[D]. Huazhong Agricultural University, 2016.

[10] Zhou Yangling. Research on the influence of value perception and social capital on farmers' participation in centralized domestic waste treatment[D]. Hubei University of Technology,2021.

[11] Cimperman M, Makovec B M, Trkman P. Analyzing older users' home telehealth servicesacceptance behavior-applying an extended UTAUT model[J]. International Journal ofMedical Informatics, 2016, 90(6):22-31.

[12] Pan Ding,Xie Han,Liu Z-Ying,Yang D-F. The impact of social comparison on productive consumption: a compensatory consumption perspective [J]. Management Review,2022,34(04):162-172.

[13] Zhang Shuhe,Wang Chengjun. Research on the mechanism of farmers' participation in the behavior of rural household waste separation and disposal[J]. Ecological Economics,2020,36(05):188-193+199.

[14] Xu Zenwei. Research on the cooperative behavior of farmers in centralized rural household waste treatment[D]. Northwest Agriculture and Forestry University of Science and Technology,2016.