

## Farmers' Willingness to Pay for the Recycling of Household Kitchen Waste: Evidence from Guanzhong Area of Shaanxi Province, China

LI, Lu

College of Economics and Management, Northwest A&F University

YABE, Mitsuyasu

Laboratory of Environmental Economics, Division of Agricultural and Resource Economics,  
Department of Agricultural and Resource Economics, Faculty of Agriculture, Kyushu University

YUAN, Yalin

College of Economics and Management, Northwest A&F University

<https://doi.org/10.5109/4772416>

---

出版情報：九州大学大学院農学研究院紀要. 67 (1), pp.103-110, 2022. Faculty of Agriculture,  
Kyushu University

バージョン：

権利関係：



## Farmers' Willingness to Pay for the Recycling of Household Kitchen Waste: Evidence from Guanzhong Area of Shaanxi Province, China

Lu LI<sup>1</sup>, Mitsuyasu YABE and Yalin YUAN<sup>1\*</sup>

Laboratory of Environmental Economics, Department of Agricultural and Resource Economics,  
Faculty of Agriculture, *Kyushu University*, 819–0395, Fukuoka, Japan  
(Received October 28, 2021 and accepted November 5, 2021)

Recycling of household kitchen waste (RHKW) is the key to realize rural resource recycling and environmental governance. However, farmers' willingness to pay (WTP) has not received widespread attention. Utilizing the survey data of farmers in Guanzhong area of Shaanxi Province in 2019, this study analyzes the impact of social capital on farmers' WTP for RHKW by using a binary logistic model. The results show that: (1) farmers' average WTP value for RHKW is \$1.52 (10.51 CNY) per household per month; (2) interpersonal trust, institutional trust, and class identity in social capital can significantly stimulate farmers' WTP for RHKW; (3) outdoor work experience, small household size, high agriculture net income, a large output of household kitchen waste, strong environmental consciousness and moral concepts are factors that increase WTP for RHKW. Based on this, it is suggested that a close-knit rural social environment be built and various kinds of thematic education activities be organized to give full play to the incentive role of social capital and accelerate the improvement of rural human settlements.

**Key words:** recycling of household kitchen waste, rural environmental governance, social capital, willingness to pay

### INTRODUCTION

Although China's agricultural and rural economy has achieved world-renowned success, it is also facing challenges such as resource shortages and severe environmental pollution. The rapid growth of rural consumption has led to a sharp increase in the discharge of domestic waste (Liao *et al.*, 2018). Littering of high-water content and perishable kitchen waste in domestic waste has become one of the major difficulties in the governance of rural villages in China (Li *et al.*, 2019). According to the Ministry of Housing and Urban–Rural Development, in 2019, approximately 177 million tons of domestic waste was generated in rural China, with kitchen waste accounting for up to 60% of the total. At present, there are many hidden dangers in the practices of kitchen waste incineration and landfill disposal in rural areas, which have polluted water bodies, the soil, and the atmosphere, endangering human health (An *et al.*, 2014; Li *et al.*, 2021). Therefore, recycling of household kitchen waste (RHKW) has become an urgent practical problem. Due to the scattered discharge of kitchen waste in rural areas of China, outdated waste treatment technology, and lack of infrastructure, urgent financial support is needed to improve the current kitchen waste management situation (Zeng *et al.*, 2016). Farmers are the makers of kitchen waste. Adhering to the principle of “polluters pay”, encouraging farmers to actively participate in RHKW is the key of solving this problem. Therefore, exploring farmers' willingness to pay (WTP) for RHKW has an important theoretical and practical significance.

The extant literature provides some results regarding the research on WTP for rural waste management. Banga *et al.* (2011) identified the determinants of households' WTP for an improvement in solid waste collection services, determining that the decision to pay was influenced by income, education, age, and home ownership. Zeng *et al.* (2016) investigated the attitudes and behaviors of rural households towards rural solid waste treatment. They found that annual household income and location significantly influenced respondents' WTP, for which they proposed countermeasures and suggestions for improvement. Han *et al.* (2019) expounded that broad and sustainable public WTP is the basis for successful management of domestic waste, demonstrating that villagers' gender, income, education level, and environmental pollution perception have a significant impact on WTP. However, empirical research results on WTP for RHKW in domestic waste are scarce. China is a relational society, especially in rural regions. Social capital is an important factor that affects the subjective wishes of farmers, and can help mobilize support for better governance of rural ecological environments (Sabet and Khaksar *et al.*, 2020). However, there are few reports on farmers' WTP for environmental governance that regard social capital as a key factor. In view of this, from the perspective of social capital, this study uses micro-survey data collected in 2019 from the Guanzhong area of Shaanxi Province, and a binary logistic regression model to analyze farmers' WTP for RHKW and its influencing factors. The study is purposed towards improving the enthusiasm of farmers to participate in the treatment of kitchen waste, formulating and improving the comprehensive management policy of kitchen waste resources, and providing theoretical and decision-making references.

The rest of the study is structured as follows:

<sup>1</sup> College of Economics and Management, *Northwest A&F University*, Yangling 712100, Shaanxi, China

\* Corresponding Author (E-mail: ylyuan@nwfau.edu.cn)

Section 2 lays out the basic framework; Section 3 specifies the econometrical methodology and the data collection; Section 4 discusses the regression results; Section 5 presents the discussion; and section 6 provides a brief conclusion.

## CONCEPTUAL FRAMEWORK

The formal concept of social capital can be traced back to Hanifan (1916), who believed that social capital is a kind of trust or social connection. At present, academic circles has not yet determined a unified concept and classification of what constitutes social capital. Various scholars have defined social capital differently based on their own research categories. This study refers to the treatment method of Tong *et al.* (2016), analyzing the influence of social capital on farmers' WTP for RHKW from the two dimensions of trust and relationships, and puts forward the research hypothesis on this basis.

### Trust

Trust is generally regarded as the core requirement of social capital, which helps to promote the development and progress of community relations (Moscardo *et al.*, 2017). Luhmann (1979) divided trust into interpersonal trust and institutional trust. Interpersonal trust is a kind of relationship that often occurs between relatives or neighbors, reflecting the degree of intimacy between people. In contrast, institutional trust often relies on the legal and political environment, and is triggered by social phenomena based on "non-interpersonal" relationships (Tao *et al.*, 2014). Trust can increase the flow, exchange, and sharing of information among different social groups (Robbins, 2016), and reduce the psychological cost of farmers' WTP for waste management. Therefore, farmers can learn more about RHKW through trust, which promotes changes in WTP. Many studies have confirmed the role of trust in improving rural environmental governance. He *et al.* (2016) found that institutional trust and interpersonal trust can significantly drive farmers' willingness to reuse agricultural waste. In addition, Hou *et al.* (2019) found that trust affects the public's acceptance of waste-to-energy incinerators through risk perception. Based on the above analysis, this study puts forward the following hypotheses:

**H1:** *Interpersonal trust has a significant positive impact on farmers' WTP for RHKW.*

**H2:** *Institutional trust has a significant positive impact on farmers' WTP for RHKW.*

### Relationships

Relationships reflect the way people combine with society. Aspects of the relationship between individuals and society are important to identify, as they embody the basic principles of social order and life (Kang *et al.*, 2018). By way of summarizing previous studies, this study divides relationships into two types: horizontal and vertical (Lee *et al.*, 2013). A horizontal relationship continues to spread with the help of connection points

between individual social members, forming a horizontal structure between homogeneous groups, groups with common interests, and groups related to particular "events", which helps maintain unity and stability within individual members of society (Luo *et al.*, 2020). This study uses the social interaction as a measure of the strength of a horizontal relationship, because social interaction reflects the closeness of farmers' connections with other people to a certain extent. A vertical relationship involves resources controlled by higher-ranked social members, as well as resources outside the network, that can be mobilized to influence the relationship with lower-ranked social members (Kim, 2015). Exchanges between members can provide more resources and strategic support. This study uses class identity to express vertical relationships; the higher one's influence, the higher their position in the dialogue. Ling *et al.* (2021) proved that levels of participation were higher among residents with stronger social networks. In addition, He and Li (2020) found that active online social interaction among rural households promotes digital finance participation, increasing the depth and breadth of digital finance usage. Based on the above analysis, this study puts forward the following hypotheses:

**H3:** *Social interaction has a significant positive impact on farmers' WTP for RHKW.*

**H4:** *Class identity has a significant positive impact on farmers' WTP for RHKW.*

## MATERIALS AND METHODS

### Dependent Variable

The dependent variable in this study is farmers' WTP for RHKW, which is represented by a dual dummy variable. Combining the pre-investigation and the actual situation in rural areas, this study sets the question of measuring farmers' WTP as "RHKW can improve ecological and environmental service functions. If the government aims to improve the environment, kitchen waste will be recycled and treated in a unified manner, but a certain fee is required. As an environmental beneficiary, are you willing to accept?" The answer options are 0 = unwilling; and 1 = willing.

### Independent Variables

#### *Trust and Relationships*

In this section, our goal is to choose applicable indicators from two aspects to capture social capital: trust and relationships.

Trust is a key independent variable in this study. Based on previous analyses, two variables were selected: interpersonal trust and institutional trust. And they were measured by the following questions, respectively: "If your family recommends sorting waste, you will definitely try.", and "You strongly trust your village cadres."

Meanwhile, relationships were measured by social interaction and class identity. This study used "You often visit your neighbors.", and "You have a high prestige in the village." as measures of these two variables.

### Socio-demographic Characteristics

Following previous works that found these characteristics to influence WTP for resources and environmental protection (Han *et al.*, 2019; Yuan *et al.*, 2015a; Yuan *et al.*, 2015b), this study characterized personal characteristics (age, gender, education, and outdoor working experience), family characteristics (household size, agriculture net income, and household kitchen waste output), and village characteristics (Whether it is a pilot village for waste classification) as control variables. Several scholars have also verified the applicability of environmental protection cognition in this type of research, asserting that the inclusion of this variable can improve the model's interpretation and prediction capabilities (Yuan *et al.*, 2016). Therefore, this study includes environmental responsibility variables such as environmental consciousness and moral concepts. The definition and descriptive statistics of the above variables are shown in Table 1.

### Methodology

Traditional linear regression regards variables as cardinality, which cannot satisfy the nature of discrete data. Therefore, the logit model needs to be adopted for the discrete variables (Luo *et al.*, 2020). Specifically, this study defines farmers' WTP for RHKW as a 0–1 discrete variable using a binary logistic model. The basic form of the model is as follows:

$$P(Y_i = 1) = \alpha_0 + \beta \cdot R_i + \sum \gamma_i \cdot X_{ij} + \eta \quad (1)$$

In Equation (1),  $i$  represents the  $i$ -th farmer interviewed;  $P$  indicates the probability that the farmer pays for the cost of kitchen waste recycling;  $Y_i$  represents the dummy variable of whether the  $i$ -th farmer is willing to pay for the kitchen waste recycling cost;  $\alpha$ ,  $\beta$ , and  $\gamma$  (alpha, beta, and gamma) represent the parameters to be evaluated; and  $R_i$  represents the key explanatory variables, including interpersonal trust, institutional trust, social interaction, and class identity.  $X_{ij}$  indicates the control variables of gender, age, education, outdoor working experience, household size, agriculture net income, household kitchen waste output, waste management method, environmental consciousness, and moral concepts; and  $\eta$  is the random disturbance term.

To estimate farmers' average WTP for RHKW, the sample's WTP value can be multiplied by the proportion of the number of households corresponding to this WTP value, multiplied by the total number of households (excluding the number of households with "protest zero" payment), and then summing these (Yuan *et al.*, 2014). We set the equation as:

$$E(WTP) = \sum_{i=1}^k P_i \frac{n_i}{N} \quad (2)$$

In Equation (2),  $E(WTP)$  indicates the average level of the WTP of the respondents;  $P_i$  indicates the WTP

**Table 1.** Variable Definition and Data Description (N = 584)

Variables			Description	Mean	S.D.	Expected Sign
<i>Dependent Variable</i>						
WTP			0 = unwilling, 1 = willing	0.68	0.47	+
<i>Independent Variables</i>						
Social Capital						
Trust	Interpersonal trust	If your family recommends sorting waste, you will definitely try: A	4.45	0.68	+	
	Institutional trust	Strongly trust your village cadres: A	3.68	0.89	+	
Relation ships	Social interaction	Often visit your neighbors: A	4.39	0.62	+	
	Class identity	Have a high prestige in the village. 0 = no, 1 = yes	0.24	0.43	+	
<i>Control variables</i>						
PC	Gender	0 = female, 1 = male	0.49	0.50	—	
	Age (in years)	1 = 28 and below, 2 = 29–56, 3 = 57 and above	2.28	0.66	—	
	Education	1 = primary or below, 2 = junior high, 3 = senior high, 4 = undergraduate or above	2.11	0.89	+	
	Outdoor working experience	0 = do not have, 1 = have	0.51	0.50	+	
FC	Household size (in persons)	Actual population	3.64	1.73	+	
	Agriculture net income (USD)	Net annual household agriculture income	0.88	1.38	+	
	Household kitchen waste output (kg)	Average daily output of household kitchen waste in your home: 1 = 0–1, 2 = 1–5, 3 = more than 5	1.46	0.52	+	
VC	Waste management	Waste classification village: 0 = no, 1 = yes	0.51	0.50	+	
ER	Environmental consciousness	Collect waste classification information frequently and actively: A	2.00	1.03	+	
	Moral concepts	Piling waste willfully will gnaw your conscience: A	3.95	0.93	+	

Note: "A" means "1 = strongly disagree, 2 = disagree, 3 = generally, 4 = agree, and 5 = strongly agree".

value of the  $i$ -th respondents;  $n_i$  indicates the number of respondents whose WTP value is  $P_i$ ; and  $N$  is the total number of respondents.

### Data Collection and Description

The Guanzhong area is the region with the best agricultural conditions in Shaanxi Province, accounting for 80% of the total agricultural population in the province. Therefore, the Guanzhong area was selected as a more representative sample to study the problem of rural waste management. A large-scale survey was carried out in the Shaanxi Province from July to August 2019. Considering the geographical location, economic development level, and the population distribution of the areas, we chose four counties (districts): Yangling District of Xianyang City; Dali County and Chengcheng County of Weinan City; and Taibai County of Baoji City. A random survey method was employed. The survey team distributed 600 copies of the questionnaire, 592 of which were returned. Questionnaires with missing values or identical answers on all different items were discarded. Finally, a sample of 584 usable responses was utilized for further analysis, representing a response rate of 98.65%.

The demographic data of the sample are listed in Table 2. The ratio of male to female respondents was balanced. In terms of age, only 11.8% of the respondents were under 28; most were middle-aged and elderly, with relatively few young people. This may be because a large number of young and middle-aged rural laborers flock to cities in search of better opportunities. The education level of the respondents was relatively low: 73.1% had a middle school education or below, and only 9.1% had a college education or above, which may affect the farmers' awareness of environmental protection responsibilities. Of all the respondents, 7% were in the village cadres. Agriculture net income was generally low: 43% had yearly earnings of less than \$2,900 (20,000 CNY), 39% earned between \$2,900 and \$7,250, and 8.55% earned above \$7,250 (50,000 CNY). Most of the respondents had experience of outdoor work. A cultivated area of 0.33 ha or less was reported by 53.1%. It can be seen that the respondents were mostly small and medium-sized farmers. In terms of household kitchen waste output, the daily average household kitchen waste output of rural households was found to be less than 1 (one) kg, accounting for 55.3%. 43.7% of households whose daily average household kitchen waste output was 1–5 kg. Only 1% of households had a daily average household kitchen waste output above 5 kg. According to the population development report released by the Shaanxi Provincial Bureau of Statistics in March 2020, the rural population of Shaanxi Province was 15.726 million in 2019, accounting for 40.57% of the total population. Among them, the number of migrant laborers exceeded 5.32 million, and they were mainly young and middle-aged laborers, accounting for about 1/3 of the total rural population. The sample data is more consistent with the current status of rural areas in Shaanxi Province, so it can be inferred that the demographic data

**Table 2.** Demographic Characteristics of Samples (N = 584)

Demographics	Categories	Freq.	%
Gender	Female	305	51.6
	Male	286	48.4
Age (in years)	Less than 28	70	11.8
	29–56	286	48.4
	over 57	235	39.8
	Primary or below	150	25.4
Education	Junior middle school	282	47.7
	High school	105	17.8
	College or above	54	9.1
Village cadres	No	543	93.0
	Yes	41	7.0
Agriculture net income (Annual in USD)	Under 2,900	251	43.0
	2,900–7,250	228	39.0
	More than 7,250	105	18.0
Outdoor working experience	Do not have	287	48.6
	Have	304	51.4
Household farming area (ha)	0.33 or below	310	53.1
	0.33–0.67	194	33.2
	0.67 or above	80	13.7
Household kitchen waste output (kg)	Under 1	327	55.3
	1–5	258	43.7
	More than 5	6	1.0

resembles the characteristics of rural residents in Shaanxi Province.

## RESULTS

### Farmers' Willingness to Pay for Recycling of Household Kitchen Waste

This study investigated the farmers' WTP for RHKW. In the 584 valid questionnaires, 400 farmers entered non-zero WTP values, accounting for 68.5%, while 184 farmers entered a zero WTP value, accounting for 31.5%, indicating that most farmers are willing to pay for RHKW. The degree of WTP was measured via an open question and answer in the open questionnaire of Contingent Valuation Method (CVM): the highest response was \$43.49 per household per month, and the lowest was only \$0.14. The largest proportion of WTP was \$0.72–\$1.44 per household per month, accounting for 41.9%; followed by \$0.14–\$0.72 per household per month, accounting for 13.4%; farmers who were willing to pay \$1.44–\$2.90 per month accounted for 6.4% of rural households, and 7.8% of the farmers had a WTP more than \$2.90.

In addition, there were 184 farmers who entered the value of 0 (zero) WTP; that is, they refuse to pay for RHKW, accounting for 31.5%. The main reasons involve the following six aspects: a) the government is responsible for recycling and farmers should not pay (27.3%); b) insufficient economic capacity (23.5%); c) the amount of household kitchen waste is small and does not need to



be recycled (23%); d) family will independently recycle waste (18.7%); e) little pollution results from kitchen waste and recycling are not important (2.7%); and f) other reasons (4.8%). According to the classification criteria of Strazzeria *et al.* (2003), respondents who select a, c, and e are defined as the “protest zero” sample, and those who choose b and d are defined as the “real zero” sample. In the protest payment sample, 51.5% of the respondents believe that recycling is the responsibility of the government and farmers do not need to pay extra. This indicates that the respondents’ subjective awareness of governance is the main cause of protest payment; in the zero-payment sample, economic ability is the primary reason for real zero-payment. Approximately 55.7% of the respondents believe they lack sufficient financial ability to pay for recycling and are thus unwilling to pay.

Substituting the sample data into equation (2), this study estimates that the average farmers’ WTP for RHKW is \$1.52 (10.51 CNY) per month, and the standard deviation of the farmers’ WTP is 73.23; there is a large individual difference.

### Multicollinearity Test

Before conducting an empirical analysis, considering that there may be collinearity problems among farmers’ environmental awareness, moral values, interpersonal trust, institutional trust, social connections, and class identity, this study conducted multiple collinearity tests on the respective variables. Based on all the results, the

maximum variance inflation factor (VIF) is 1.255, far less than 10, and the minimum tolerance is 0.797, much greater than 0.1. Therefore, the degree of collinear correlation between the respective variables is within a reasonable range.

### Regression Results

This study uses SPSS 21.0 software to carry out a binary logistic regression analysis, and process the survey data. Table 3 is the regression result of the model of influencing factors of farmers’ WTP for kitchen waste recycling. First, the benchmark model is introduced, with the explanatory variables of input including only individual characteristics, family characteristics, and village characteristics, namely Regression I. Subsequently, social capital (Regression II) and environmental protection responsibility (Regression III) are added for estimation. The Nagelkerke  $R^2$  of the model rose from 0.121 to 0.184, an increase of 52%, indicating that the model’s explanatory ability improved. Therefore, this study focuses on the analysis of the Regression III. In addition, the  $P$  values of the chi<sup>2</sup> test are all significant at the 1% level. It shows that the model fitting results are more consistent with the data. Overall, the regression model built has a good estimation effect.

### Regression Results of Social Capital (Trust and Relationships) on Farmers’ WTP

In terms of trust, interpersonal trust and institutional trust have a significant positive impact on farmers’

**Table 3.** Binary Logistic Regression Estimates

Variables		Regression I		Regression II		Regression III	
		B	S.D.	B	S.D.	B	S.D.
Social capital	Interpersonal trust			0.309**	0.141	0.254*	0.142
	Institutional trust			0.336***	0.112	0.324***	0.113
	Social interaction			−0.210	0.164	−0.174	0.167
	Class identity			0.382	0.233	0.489**	0.238
PC	Gender	−0.303*	0.192	−0.356*	0.197	−0.324	0.199
	Age	−0.506***	0.167	−0.522***	0.175	−0.417**	0.179
	Education	0.099	0.112	0.059	0.125	0.032	0.127
	Outdoor working experience	0.448**	0.189	0.430**	0.194	0.410**	0.196
FC	Household size	−0.107**	0.055	−0.113**	0.055	−0.112**	0.056
	Agriculture net income	0.161 **	0.08	0.142*	0.080	0.134*	0.081
	Household kitchen waste output	0.369**	0.188	0.350*	0.191	0.353**	0.193
VC	Waste management method	−0.583***	0.187	−0.581***	0.191	−0.567***	0.194
ER	Environmental consciousness					0.312***	0.111
	Moral concepts					0.187*	0.103
Constant		1.716***	0.651	−0.023	1.124	−1.505	1.210
Wald chi <sup>2</sup>		46.592***		62.738***		74.968***	
−2 log likelihood		684.259		668.113		655.883	
Nagelkerke $R^2$		0.107		0.143		0.169	

Note: \*\*\*, \*\*, and \* denote significance at 1%, 5%, and 10%, respectively.

WTP for RHKW at significance levels of 10% and 1%, respectively, indicating that trust in family members and trust in village officials can improve farmers' WTP for RHKW. Out of a strong sense of trust in their relatives, farmers often comply when their relatives suggest paying for RHKW. The high level of farmers' trust in the village cadres indicates their strong confidence with regards to obtaining policy support and technical guidance, as well as their high acceptance of the relevant policies implemented in the village, thereby increasing their WTP for RHKW.

In terms of relationships, the class identity of farmers' WTP for RHKW is positively significant at the 5% level; that is, the stronger the sense of class identity, the more likely an individual is to pay for the RHKW. Influential people will prompt them to set an example for other villagers by paying for the cost of kitchen waste recycling. Notably, however, social interaction has no significant impact on farmers' WTP for RHKW. One possible reason is the massive loss of the rural population, and the transformation of the rural social structure from an acquaintance society to a semi-acquaintance society. The influence of neighbors' wishes on farmers' own wishes has weakened; therefore, the influence of social interaction is not significant.

#### *Regression Results of Subsamples Split by Various Socio-demographic Factors*

In terms of personal characteristics, the respondents' age and outdoor working experience have a significant impact on the WTP for RHKW. Among them, the estimated coefficient of age is negatively significant at the 5% level, indicating that young people have stronger cognitive abilities, stronger acceptance of new ideas, and higher WTP; outdoor working experience significantly promotes farmers' WTP for RHKW (significant at the 5% level), indicating that migrant workers' WTP is higher than that of non-migrant workers. This may be due to the fact that most migrant workers move to cities, where they are exposed to environmental protection publicity, thereby increasing environmental awareness and WTP for RHKW. Gender and education have no significant influence on farmers' WTP for RHKW, most likely because the existing garbage management education has reduced gender differences, and formal education cannot improve personal payment level.

In terms of family characteristics, household size significantly negatively affects farmers' WTP (significant at the 5% level). One possible reason is that large-scale households have a heavier burden in terms of education, medical care, and living expenses, so their WTP is lower. Agriculture net income is positively significant at the 10% level. The focus on family life with high agricultural net income is mainly seen in rural areas, and more attention is paid to the problem of waste pollution in their own living environment, so they are willing to pay a certain fee for RHKW. Household kitchen waste output has a significant positive impact on farmers' WTP for RHKW (significant at the 5% level), which means the higher the daily average output of household kitchen waste, the

greater the impact on the family environment. The greater the pollution, the more necessary it is to dispose of kitchen waste reasonably, and the stronger the farmers' WTP.

It is worth noting that in terms of village characteristics, the waste management method is negatively significant at the 1% level, which is contrary to the expected result. A possible explanation is that villages which do not implement garbage classification create a stench and generate breeding grounds for mosquitoes in the summer (due to the perishable characteristics of kitchen waste), which affects the environment. Farmers have a high demand for environmental governance in the village and are willing to accept RHKW to improve the village environment. However, once the environment of the villages that implement waste separation treatment has improved, farmers are unwilling to pay increased costs for kitchen waste treatment.

In terms of environmental responsibilities, both environmental consciousness and moral concepts play a significant role in promoting farmers' WTP for RHKW (significant at the 1% and 10% levels, respectively). The stronger the farmers' environmental consciousness and moral concepts, the higher their WTP for RHKW. The stronger the farmers' awareness of the necessity of resource disposal for kitchen waste, the greater the possibility of behavioral response.

#### **Robustness Test**

In order to further test the robustness of the estimation results of the above models, the method of variable substitution is used. Using the two questions in the questionnaire corresponding to the respondents' trust in their neighbors and their willingness to learn RHKW technology, a new measure of interpersonal trust and moral values was created, and two new variables were constructed, which were recorded as trust neighbors or not and willingness to learn. For the two answers, the variables were assigned values of 1–5, with 1 = completely disagree to 5 = completely agree. These two new variables were used to estimate the influencing factors of farmers' WTP for the resource treatment of kitchen waste. The results are shown in Table 4. By comparing the estimated results of regression 3 in Table 3 with the key variables in Table 4, Table 4 is basically consistent with regression 3 in Table 3 in terms of influence direction, size, and significance, indicating that the results of this study are relatively robust.

#### **DISCUSSION**

The study calculates the value of farmers' RHKW payment levels, and the results show that farmers are willing to pay, on average, \$1.52 for RHKW per month. Although this is low compared to studies in developed countries that show \$30.42 per household per year for RHKW (Benyam *et al.*, 2020), it is high compared to \$0.34 per household per month (Zeng *et al.*, 2016), the monthly household domestic waste disposal fee paid in rural areas in China. This result shows that the level of

**Table 4.** Robustness Test

Variables	Regression IV	Regression V
Interpersonal trust		0.282**
Institutional trust	0.332***	0.345***
Social interaction	-0.234	-0.198
Class identity	0.517**	0.523**
Environmental consciousness	0.318***	0.302***
Moral concepts	0.167*	
Trust neighbors	0.321**	
Willingness to learn		0.135*
Controlled variable	Yes	Yes
Constant	-1.392	-1.318
Wald chi <sup>2</sup>	79.352	76.898
-2 log likelihood	651.499	653.953
Nagelkerke R <sup>2</sup>	0.178	0.173

Note: \*\*\*, \*\*, and \* denote significance at 1%, 5%, and 10%, respectively.

both economic development and RHKW management level are not balanced between rural and urban areas. The level of kitchen waste treatment in cities and people's income levels are higher than those in rural areas, and their WTP is relatively high. However, in recent years, China has implemented various policies and systems such as rural revitalization strategies and construction of beautiful villages. People have gradually begun to pay attention to the living environment and care about environmental issues, which has increased the willingness of farmers to pay for recycling to a certain extent. The empirical results in the study validate this point.

In addition, the existing empirical research on the objective factors that affect WTP for RHKW rarely takes into account the "social person" attributes of farmers. In this study, incorporating social capital into the model is an effective supplement to the current research on the RHKW problem. The results of the model operation show that interpersonal trust, institutional trust, and class identity in social capital can positively affect rural residents' WTP for RHKW. This is consistent with the conclusions of rural residents' WTP for environmental governance to a certain extent (He *et al.*, 2016; Hou *et al.*, 2019).

The research conclusions of this study provide a certain realistic reference for the implementation of RHKW in rural areas of China.

## CONCLUSIONS

Based on the survey data of 584 farmer households in Shaanxi Province using the binary logistic regression model, farmers' WTP for RHKW and its influencing factors were discussed. The main conclusions are as follows: first, farmers' average WTP for RHKW is \$1.52 per month; second, interpersonal trust, institutional trust, and class identity in social capital can significantly stim-

ulate farmers' WTP for RHKW; third, in general, farmers with outdoor working experience, small household size, high agriculture net income, a large output of household kitchen waste, and strong environmental consciousness and moral concepts are more willing to pay for RHKW.

The above research conclusions have important policy implications. At the policy and system level, we can improve the system of rural domestic waste management through cooperation between government and residents, and strengthen the construction of kitchen waste resource treatment facilities to meet the urgent needs of farmers and improve the rural environment. At the village collective and grass-roots government level, we can build a highly trusted and intimate rural social environment. Through collective learning and holding various collective activities, the role of social capital can be fully utilized and farmers' WTP for RHKW can be improved. At the level of farmers, through radio, television, and the Internet, we can further increase the importance of rural environmental protection and the promotion of the RHKW, so as to improve farmers' awareness of environmental protection.

## AUTHOR CONTRIBUTIONS

L. Li analyzed the data, wrote and modified the manuscript. M. Yabe participated in the design of the study, modified the manuscript, supervised the work and provided financial support. Y. L. Yuan designed the study, analyzed the data, modified the manuscript, supervised the work and provided financial and data support. All authors assisted in editing of the manuscript and approved the final version.

## ACKNOWLEDGMENTS

This research was supported by National Natural Science Foundation of China (Grant No. 72103164), Project of Humanities and Social Sciences of the Ministry of Education of China (Grant No. 20YJC790171), Fundamental Research Funds for the Central Universities (Grant No. 2452019118), China Postdoctoral Science Foundation (Grant No. 2018M631213), Natural Science Basic Research Program of Shaanxi Province (Grant No. 2019JQ-644), Scientific Research Foundation for Talents of Shaanxi Province (Grant No. F2020221010) and JSPS-CAS Joint Research Project (Grant No. JSPS-BP120207202). And we would like to thank Editage (www.editage.com) for English language editing.

## REFERENCES

- An, Y., G. M. Li, W. Q. Wu, J. W. Huang, W. Z. He and H. C. Zhu 2014 Generation, Collection and Transportation, Disposal and Recycling of Kitchen Waste: A Case Study in Shanghai. *Waste Management and Research*, **32**: 245–248
- Banga, M., R. B. Lokina and A. F. Mkenda 2011 Households' Willingness to Pay for Improved Solid Waste Collection Services in Kampala City, Uganda. *Journal of Environment and Development*, **20**: 428–448



- Benyam, A., J. Rolfe and S. Kinnear 2020 Willingness to Pay for a Domestic Food Waste Diversion Policy Option in Regional Queensland, Australia. *Journal of Cleaner Production*, **270**
- Hanifan, L. J. 1916 The Rural School Community Centre. *Annals of the American Academy of Political and Social Sciences*, **67**: 130–138
- He, K., J. B. Zhang, J. H. Feng, T. Hu and L. Zhang 2016 The Impact of Social Capital on Farmers' Willingness to Reuse Agricultural Waste for Sustainable Development. *Sustainable Development*, **24**: 101–108
- Han, Z. Y., D. Zeng, Q. B. Li, C. Cheng, G. Z. Shi and Z. S. Mou 2019 Public Willingness to Pay and Participate in Domestic Waste Management in Rural Areas of China. *Resources, Conservation and Recycling*, **140**: 166–174
- Hou, G. H., T. Chen, K. Ma, Z. M. Liao, H. M. Xia and T. Z. Yao 2019 Improving Social Acceptance of Waste-to-Energy Incinerators in China: Role of Place Attachment, Trust, and Fairness. *Sustainability*, **11**
- He, J. and Q. H. Li 2020 Can Online Social Interaction Improve the Digital Finance Participation of Rural Households? *China Agricultural Economic Review*, **12**: 295–313
- Kang, S. M. and Y. K. Na 2018 The Effect of the Relationship Characteristics and Social Capital of the Sharing Economy Business on the Social Network, Relationship Competitive Advantage, and Continuance Commitment. *Sustainability*, **10**
- Kim, U. 2015 The Relationship among Vertical Social Order, Multiple Networks, and Bribery in Korea. *Korean Corruption Studies Review*, **20**: 161–183
- Luhmann, N. 1979 Trust and Power. *New York: John Wiley and Sons*
- Lee, K. and H. Oh 2013 The Influence of Social Relationships with Senior Leaders on Employee Performance. *Korean Journal of Management*, **21**: 145–180
- Liao, C. H., D. T. Zhao, S. Zhang and L. F. Chen 2018 Determinants and the Moderating Effect of Perceived Policy Effectiveness on Residents' Separation Intention for Rural Household Solid Waste. *International Journal of Environmental Research and Public Health*, **15**
- Li, X. R., D. Bi, Z. D. Han, Y. Qin, H. S. Wang and W. X. Wu 2019 Garbage Source Classification Performance, Impact Factor, and Management Strategy in Rural Areas of China: A Case Study in Hangzhou China. *Waste Management*, **89**: 313–321
- Luo, H., L. G. Zhao and Z. J. Zhang 2020 The Impacts of Social Interaction-Based Factors on Household Waste-Related Behaviors. *Waste Management*, **118**: 270–280
- Li, Y. Y., L. E. Wang, G. Liu and S. K. Cheng 2021 Rural Household Food Waste Characteristics and Driving Factors in China. *Resources, Conservation and Recycling*, **164**
- Ling, M. L., L. Xu and L. Z. Xiang 2021 Social-Contextual Influences on Public Participation in Incentive Programs of Household Waste Separation. *Journal of Environmental Management*, **281**
- Moscardo, G., E. Konovalov, L. Murphy, N. G. McGehee and A. Schurmann 2017 Linking Tourism to Social Capital in Destination Communities. *Journal of Destination Marketing and Management*, **6**: 286–295
- Robbins, B. G. 2016 From the General to the Specific: How Social Trust Motivates Relational Trust. *Social Science Research*, **55**: 16–30
- Sabet, N. S. and S. Khaksar 2020 The Performance of Local Government, Social Capital and Participation of Villagers in Sustainable Rural Development. *Social Science Journal*
- Strazzera, E., R. Scarpa, P. Calia, G. D. Garrod and K. G. Willis 2003 Modelling Zero Values and Protest Responses in Contingent Valuation Surveys. *Applied Economics*, **35**: 133–138
- Tao, R., D. L. Yang, M. Li and X. Lu 2014 How Does Political Trust Affect Social Trust? An Analysis of Survey Data from Rural China Using an Instrumental Variables Approach. *International Political Science Review*, **35**: 237–253
- Tong, Q. M., J. B. Zhang, L. Zhang 2016 Social Capital, Political Efficacy and Environmental Rights Protection in Rural Places: An Empirical Study Based on the CGSS 2010. *Journal of Huazhong Agricultural University (Social Sciences Edition)*, **5**: 28–35+144. (In Chinese)
- Yuan, Y. L. and M. Yabe 2014 Residents' Willingness to Pay for Household Kitchen Waste Separation Services in Haidian and Dongcheng Districts, Beijing City. *Environments*, **1**: 190–207
- Yuan, Y. L., Y. Takahashi and M. Yabe 2015a Preferences for the Attributes of Household Kitchen Waste Source Separation Services in China Using Latent Class Approach. *Journal of the Faculty of Agriculture Kyushu University*, **60**: 511–518
- Yuan, Y. L. and M. Yabe 2015b Residents' Preferences for Household Kitchen Waste Source Separation Services in Beijing: A Choice Experiment Approach. *International Journal of Environmental Research and Public Health*, **12**: 176–190
- Yuan, Y. L., H. Nomura, Y. Takahashi and M. Yabe 2016 Model of Chinese Household Kitchen Waste Separation Behavior: A Case Study in Beijing City. *Sustainability*, **8**
- Zeng, C., D. J. Niu, H. F. Li, T. Zhou and Y. C. Zhao 2016 Public Perceptions and Economic Values of Source-Separated Collection of Rural Solid Waste: A Pilot Study in China. *Resources, Conservation and Recycling*, **107**: 166–173