BUKTI KORESPONDENSI

ARTIKEL JURNAL INTERNASIONAL BEREPUTASI

Judul Artikel : Willingness to Pay for Water Management to Support Sustainable Food Production in Tidal Lowlands of South Sumatra, Indonesia

Jurnal : Emirates Jurnal of Food and Agriculture

Penulis : Meitry Firdha Tafarini, Muhammad Yazid, Muh. Bambang Prayitno, Muhammad Faizal, Fransiscus Xaverius Suryadi, Khairul Fahmi Purba

No.	Perihal	Tanggal
1	Submitted Manuscript	20 Oktober 2021
2	Reviewed and Resubmit Manuscript	3 Januari 2022
3	Acceptance Letter	13 Januari 2022
4	Proof and Response of Manuscript	22 and 23 Januari 2022
5	Final Manuscript	

Submitted Manuscript

(20 Oktober 2021)

Willingness to pay for water management to support sustainable food production in tidal lowlands of South Sumatra, Indonesia

Meitry Firdha Tafarini[1], Muhammad Yazid[1*], Muh. Bambang Prayitno[2], Muhammad Faizal[3], Fransiscus Xaverius Suryadi[4], and Khairul Fahmi Purba[1]

[1]Department of Agribusiness, Faculty of Agriculture, Universitas Sriwijaya, Jalan Palembang-Prabumulih KM 32, Indralaya, South Sumatra, Indonesia, [2]Department of Soil Science, Faculty of Agriculture, Universitas Sriwijaya, Jalan Palembang-Prabumulih KM 32, Indralaya, South Sumatra, Indonesia, [3]Department of Chemical Engineering, Faculty of Engineering, Universitas Sriwijaya, Jalan Palembang-Prabumulih KM 32, Indralaya, South Sumatra, Indonesia, [4]Department of Land and Water Development, Water Science and Engineering, UNESCO IHE, Delft, The Netherlands

*Corresponding author: yazid_ppmal@yahoo.com

ABSTRACT

Operations and maintenance (OM) of water infrastructure cannot be separated from the role of farmers' water users associations (WUA) or farmer groups. OM needs to be supported not only skillfully but also financially. This research aimed to assess and identify several factors affecting self-financing in water management in tidal lowlands agriculture, using the Willingness To Pay (WTP) approach. The sample size of this research was 245 respondents, all of which are active members of WUA or farmer groups. Primary data were collected using direct interviews with structured questionnaires, and secondary data were collected from some related agencies. The data were analyzed using Exploratory Factor Analysis (EFA) and Multiple Linear Regression analyses. Regression analysis formally tested the factors and identified the selected significant factors. KMO and Bartlett's Test result was 0.587 > 0.5 (alpha), indicating significance. The R^2 (0.86) showed that the independent variables simultaneously explained the dependent variable (Y_{WTP}). From seven independent variables, five variables significantly affect the willingness to pay for water management. This WTP is expected to ensure sustainable food production in tidal lowlands since water availability is crucial in tidal lowland agriculture.

Keywords: water, WTP, EFA, multiple linear regression, tidal lowlands

INTRODUCTION

Tidal lowlands are wetlands ecosystems with inundated land characteristics and are influenced by high and low water tides but not river water. Meanwhile, river water also rises as a result of the retention of river water by high tides. Tidal lowland also has valuable characteristics and potential as an agricultural resource, mostly for food crops (Noor and Rahman, 2015; Tafarini and Yazid, 2019). The tidal lowlands in South Sumatra are considered to be a food barn with an area of 266,674 hectares in 2017, including 161,908 hectares of tidal lowlands in Banyuasin Regency. Food production (rice) in tidal lowlands in Banyuasin Regency in 2017, was 1,038,489.34 tons (Central Bureau of Statistics of Banyuasin Regency, 2018). Meanwhile, the demand for food continues to increase at a rate equivalent to population increase; thus, the region continues to strive to improve food production (rice). However, rice production in 2017 decreased from the previous year (2016) by 1,302,229.7 tons (Central Bureau of Statistics of Banyuasin Regency, 2017).

Tidal lowland is highly dependent on high and low water tides, so it requires a proper plan, management (especially aspects of water management through water channels), and utilization of land management and infrastructure technology. This is to allow it to be distributed appropriately to the rice field (Imanudin et al., 2010). Water management for rice cultivation is needed to maximize productivity (Imanudin et al., 2018). However, the current problem is the improper application of water management. A land far from the main channel often experiences water shortages, especially during the dry season. Meanwhile, some lands experience flooding, due to the drainage system's handling with improper operation of floodgates in the rainy season (Mercau et al., 2016). Farmers do not implement the micro water system (quaternary channel or worm channels), even though channels' functions can regularly distribute and store water for plants in the tertiary channel's middle position. The primary key to this problem is the appropriate and sustainable water management application from micro and macro water system levels, supported by suitable infrastructure (Meijide et al., 2017). Restoration and maintenance of water infrastructures incur many costs, and this situation needs the role of farmers. Do farmers have enough capital and able to do self-financing the water management for their land, or do they need cooperation between other farmer organizations such as WUA or farmer groups' role? This study will identify whether farmers are willing to contribute to water services fees for sustainable water management by applying the Willingness to Pay (WTP) approach.

The maximum amount an individual agrees to pay for a good or service without losing its utility is the definition of WTP (Baghestany and Zibaei, 2010; Cooper, 1993; Kanninen, 1993). WTP reflects the WUA's perceptions toward the existence and importance of water resources necessary for the active participation of WUA to contribute to WTP (Whittington et al., 1990). Because there are options for restoring and maintaining water infrastructure through WUA as a sustainable agriculture scheme, the goal is to increase production. It is crucial to know whether farmers are willing to pay water management fees, as well as the factors that affect their willingness to pay (WTP). This study aimed to estimate farmers' OP self-financing potential to increase water use efficiency and estimate water services' value to support water service fee applications. To achieve these goals, the study used an exploratory factor analysis

(EFA) model to determine which indicators were the main foci of farmers willing to pay the cost of water services.

Productivity, income, and socio-economic characteristics of farmer households affect WTP's amount as a fee for water management services. In addition, the amount is also influenced by the general characteristics of farmers such as age, gender, length of education, number of family members, type of house, general environmental awareness, land area, and land ownership status, role in maintaining water infrastructure, and distance of land to rivers (Brox et al., 1996; Reflis et al., 2019; Yazid et al., 2015). A farmer's WTP depends on many interrelated factors. To assess the farmer's WTP, this study used two-approach categories that were disclosed and stated. Those approaches directly provided an unbiased estimate of WTP from respondent farmers (Shee et al., 2020). However, the water user association (WUA), which was formed to manage the system's operation and maintenance, has not implemented a water service fee for the continuity of repair and maintenance of water structures, because there is no objective measure. Thus, in this paper, the researcher describes the results of exploratory factor analysis (EFA) to obtain objective indicators that are formerly analyzed by regression equations. The multiple linear regression model results in the number of factors used, how relevant decisions are presented for interpretation. The results of the research indicated which factors affect the farmers' WTP. The conclusions help in drawing an estimate of the average amount of WTP that farmers can pay.

Scientific hypothesis

This study hypothesis is that socio-economic factors such as age, household size, farming experience, education, frequency of WTP, productivity, and distance from land to main channels, influence the farmers' WTP on a water services fee.

MATERIALS AND METHOD

Study area

This research was conducted in two villages in the tidal area, Telang Karya and Telang Rejo, Muara Telang District (Primary 8, Delta Telang I), Banyuasin Regency, South Sumatra. Those villages are the largest and have the highest rice production compared to other villages in Muara Telang District. The typology of tidal lowland in these two villages is A-type. The tidal lowland A-type is a land that can be inundated by high tide at least 4 or 5 times during the tidal cycle for 14 days, both in the rainy and dry seasons.

These areas are primarily located in basins or close to the mouth of a river (Suprianto et al., 2010; Suryadi, 1996). The research location is the most productive area for food crops (rice). Production is supported by an irrigation system using secondary and tertiary blocks, some of which are equipped with water-management infrastructure. The research location can be seen in Figure 1.

Figure 1 Tidal lowland canals condition in Muara Telang Sub District

Samples and data collection

This study used tidal lowland farmers as research subjects (respondents). Respondents are farmers who own land and organize agricultural activities in Telang Karya Village and Telang Rejo Village. The total sample was 245 respondents (n = 245) of farmers.

Data were collected between the middle and end of 2019. Data information from sample farmers was interviewed using questionnaires and purposive sampling technique or judgment sampling. Purposive sampling was undertaken deliberately, based on the requirements and quality of the respondents. The researcher had defined the criteria according to the information required (Bernard, 2011). The farmers who became respondents were tidal lowland farmers with a minimal of 0.5 Ha of rice field in Telang Karya and or Telang Rejo Villages, and members of a farmer group, with at least one year of farming experience, who were willing to pay for water management.

Data collected for factors affecting WTP were socio-economic characteristics. The socio-economic characteristics consist of age, household size, farming experience, education, frequency of WTP, land distance to main channels, and productivity. Furthermore, data collected for measuring ATP used rice production data to calculate each farmer's income every planting season.

Questionnaire preparation

The design of the questionnaire was carried out to collect exploratory information from the respondents. The number of questions in the questionnaire were 12 questions related to the variables used in this study. Respondents were given the flexibility to answer, and no answer choices provided, because the questions presented were open questionnaires. The information collected is in the form of qualitative and quantitative information. The questionnaire was a formal standard questionnaire because researchers will test and measure hypotheses and data by statistical analysis. Therefore, questions on the questionnaire were made according to the variables used to test the hypothesis. The variables used include the following:

Table 1. Variables of factors affecting WTP

No.	Variables	Unit	Explanation
1.	Age	year	Age of sample farmer
2.	Household size	person	Number of family members borne by the head of the sample farmer family
3.	Farming experience	year	The amount of time the sample farmers organize agriculture
4.	Education	year	Last formal education of sample farmer
5.	Frequency of WTP	times	A measure of the number of times the sample farmers paid WTP
6.	Land distance	meter	Land distance to main drainage channel
7.	Productivity	$ton.ha^{-1}$	The ability or carrying capacity of agricultural land in producing rice crops

Data Analysis

Water services fees in this study were costs used to carry out the operation, maintenance, and management (OMM) of agricultural water tidal lowland irrigation infrastructures. In this study, the factors of WTP were analyzed by exploratory factor analysis (EFA) to reduce the number of variables. Exploratory factor analysis (EFA) is a statistical technique commonly used in questionnaire development and analysis (Field, 2013; Sharma and Henriques, 2005). To identify whether the indicators used are sufficient for factor analysis, the value of Bartlett's

Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) test was assessed for multicollinearity. Then the selected variables will be analyzed by multiple linear regression.

Multiple linear regression was used for identifying the relationship of dependent and independent variables with more than one explanatory variable. In social sciences research, this analysis is a suitable method to solve social problems (Chiarini and Brunetti, 2019; Tranmer et al., 2020). The general equation for multiple linear regression is as follows:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_n X_{ni} + e \qquad \textbf{(1)}$$

The dependent variable (Y) in this research is the amount of WTP that a farmer pays for a year (two planting seasons). The socio-economic characteristics of rice farmers in tidal lowlands were used for independent variables (X). (Ahmed et al., 2015; Reflis et al., 2019) presented the socio-economic characteristics of farmers that influenced WTP. Therefore, age (X_1), household size (X_2), farming experience (X_3), education (X_4), frequency of WTP (X_5), productivity (X_6), and distance from land to main channels (X_7) were used. The equation of multiple regression created in this study was:

$$Y_{WTP} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e \qquad \textbf{(2)}$$

where Y_{WTP} denotes the amount of WTP (rupiah/year). β_0 is intercept of model. $\beta_1 \ldots \beta_7$ are estimated parameters. Then, X_1, X_2, X_3, X_4, X_5, X_6, and X_7 represent independent variables (socio-economic characteristics). e indicates error term. Hypotheses for the regression analysis were:

1. Simultaneous hypotheses using F value or F significance value. Simultaneous hypotheses decisions are seen from the significance value. If the significance F-value < $\alpha_{(0.05)}$, the hypothesis H_0 is accepted. Here are the hypotheses:

   H_0: Farmers' socio-economic factors simultaneously have a significant effect on their willingness to pay (WTP) for water services fees.

   H_1: Farmers' socio-economic factors simultaneously have no significant effect on their willingness to pay (WTP) for water services fees.

2. Partial hypotheses using t value or t significance value. If the significance t value of each independent variables < $\alpha_{(0.05)}$, the hypothesis H_2 is accepted. Here are the hypotheses:

   H_1: Farmers' socio-economic factors have no significant effect on their willingness to pay (WTP) for water services fees.

   H_2: Farmers' socio-economic factors have a significant effect on their willingness to pay (WTP) for water services fees.

Multiple linear regression analysis must fulfill the classical assumptions. According to (Weisberg, 2005), the classical assumptions that must be met are as follows:

1. The normality assumption is identified by looking at a histogram or a Q-Q plot.
2. Multicollinearity can be checked through the tolerance value of each independent variable—the value should be higher than 0.10 and VIF should less than 10.

Homoscedasticity assumption can be identified by a scatterplot of residuals versus predicted values.

Statistical Analysis

This study used three statistical analyses. First, the descriptive analysis was performed using Microsoft Excel 2016. The second and third analyses involved Exploratory Factor Analysis (EFA) and parametric data analyses (Multiple Linear Regression). The sample data collected were entered and screened using SPSS 23 to analyze factors affecting the WTP of rice farmers in water services fees. The significance (α) for this study used 5%. The *p*-value is expected less than 0.05 ($p < 0.05$).

RESULTS AND DISCUSSION

Socio-economic characteristics of rice farmers

The total respondents in this research were 235 farmers. The respondents are tidal land farmers in Telang Karya and Telang Rejo villages, Muara Telang sub-district, Banyuasin District, South Sumatra. The following is a diagram that presents the age range of farmers and their relationship with their old farming experience based on the results of the interview:

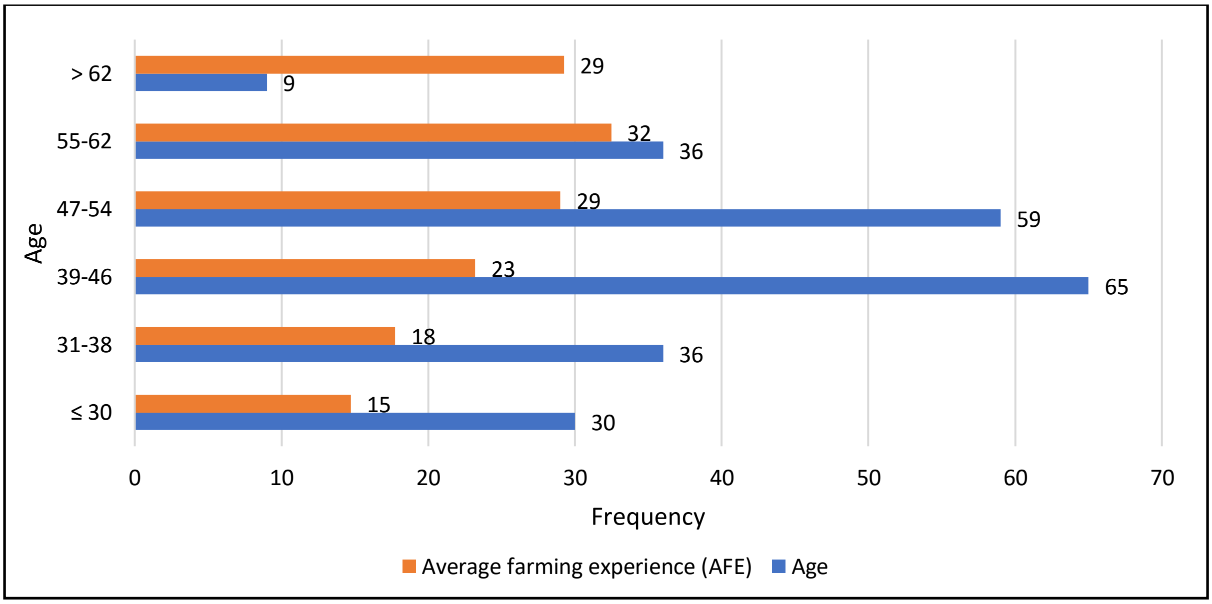

Figure 2 Age of farmers & average farming experience (AFE)

Based on Figure 2, there were 30 farmers under the age of 30 with 15 years of average farming experience. In age ranges, 31-38 years, 39-46 years, 47-54 years, 55-62 years as many as 36, 65, 59, and 36 farmers had an average farming experience of 18, 23, 29, and 32 years respectively. Meanwhile, there were 9 farmers over 62 years old with an average farming experience of 29 years. The relationship between farming experience and farmer's age as illustrated in Figure 2. The higher the age of the farmer, the longer the farmer has experience in farming.

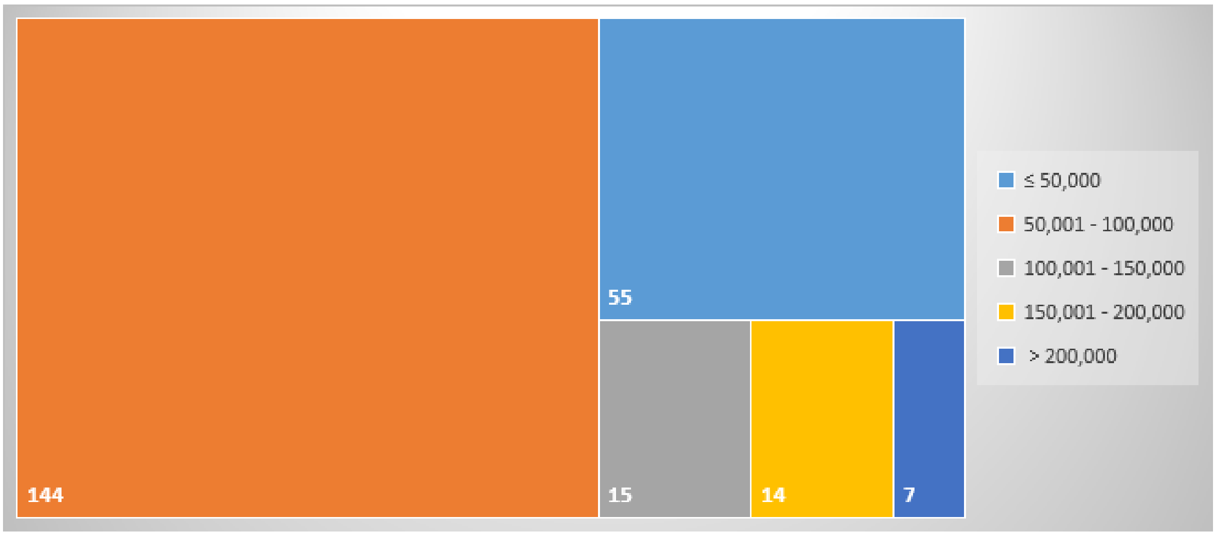

Figure 3 Willingness to Pay (Rupiah)

Figure 3 showed 235 respondents who were willing to pay water management fees (WTP). The number of fees offered by respondents varied widely. More than half of the respondents, 144 farmers, were willing to pay dues in the range of Rp 50,001 – Rp 100,000. A small proportion of respondents, 55 farmers, chose to pay a fee of ≤ Rp 50,000. Those who were willing to pay dues ranging from Rp 100,001 – Rp 150,000; Rp 150,001 – Rp 200,000; and ≥ Rp 200,001 were 15, 14, and 7 respondents respectively. This shows that, on average, farmers were more likely to pay fees ranging from Rp 50,000 to Rp 100,000. Only 15.32% of the respondents were willing to pay higher than the average value of willingness to pay (rupiah).

Exploratory factor analysis (EFA)

The factors analyzed using EFA were age, gender, household size, farming experience, education, type of WTP, frequency of WTP, farmers' role in OM, productivity, and distance from land to main channels, all of which influence the farmers' WTP on water services fee.

Table 2 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.608
Bartlett's Test of Sphericity	Approx. Chi-Square	407.539
	df	66
	Sig.	0.000

Table 1 shows the results of the Exploratory Factor Analysis (EFA). The value of Bartlett's Test of Sphericity was seen from its significance of $p < 0.05$ or $0.000 < 0.05$, which means that the correlation between the indicators was acceptable for factor analysis. The KMO test was used to demonstrate multicollinearity. The KMO test also helps ensure the fitness of the indicators used for factor analysis. Factor analysis will be appropriate if the KMO value is > 0.60 (Pallant, 2016). Based on Table 1, the KMO value of 0.608 showed that the data do not have any significant multicollinearity problems, so the indicators can be used for further analysis (Kaiser, 1970; Prasetyo et al., 2019). This analysis reduced 10 variables to 7 variables, which will be used in multiple linear analyses.

Factors influencing WTP on water services fees

The amount of WTP is affected by several factors. In order to estimate the influence of the factors on WTP, a multiple linear regression is employed using the following equation. The results of the estimation are presented in Table 2.

$$Y_{WTP} = 102108.020 - 1789.067\,X_1 - 3325.846\,X_2 + 1043.242\,X_3 + 4017.617\,X_4 - 10284.346\,X_5 + 5027.343\,X_6 + 24.498\,X_7 + e \quad \textbf{(3)}$$

The coefficient of determination (R^2) is considerably high. This indicates that 86.50 percent of the variation in the amount of WTP is elaborated simultaneously by the independent variables. Based on the value of t-statistics, the independent variables that proved to contribute significantly to this variation are age (X_1), household size (X_2), farming experience (X_3), education (X_4), frequency of WTP (X_5), productivity (X_6), and distance from land to main channels (X_7).

Table 3 Results of the analysis on factors affecting WTP

Model	Unstandardized Coefficients		t	Sig.	Collinearity Statistics	
	B	Std. Error			Tolerance	VIF
(Constant)	102108.020	23544.043	4.337	0.000		
Age	-1789.067	317.625	-5.633	**0.000****	0.686	1.458
Household size	-3325.846	2398.405	-1.387	0.167	0.954	1.048
Farming experience	1043.242	298.440	3.496	**0.001****	0.701	1.427
Education (year)	4017.617	901.528	4.456	**0.000****	0.869	1.150
Frequency of WTP	-10284.346	6368.074	-1.615	0.108*	0.972	1.029
Productivity	5027.343	1893.310	2.655	**0.008****	0.886	1.128
Distance to Main Channel	24.498	7.225	3.391	**0.001****	0.941	1.062

a. Dependent Variable : WTP
b. *Significant at $\alpha = 15\%$
c. **Significant at $\alpha = 5\%$

Based on the result from Table 2, B is the estimation parameter, Sig. value is the significance value of each independent variable, and tolerance & VIF are classical assumptions of multicollinearity. Three classical assumptions in the regression analysis were made with the following results:

1. Data normality showed in Figure 4: P-P plot. The points in Figure 4 approach the straight diagonal line without any length to the right or left of the line.

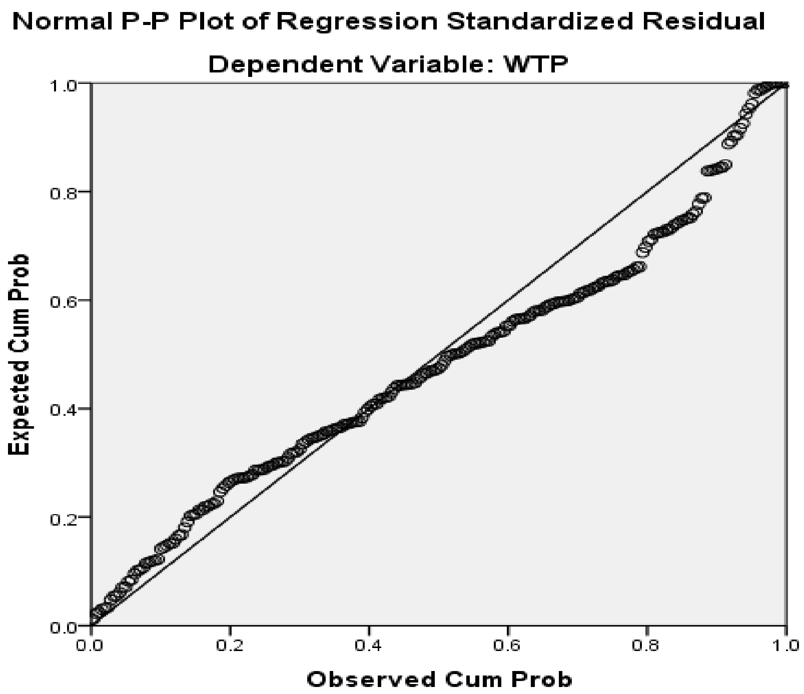

Figure 4 P-P plot for data normality

2. Multicollinearity can be checked through tolerance value and VIF showed in Table 2. In Table 2, tolerance values are higher than 0.1 and VIF values are less than 10.00. It indicates that each independent variable doesn’t occur with multicollinearity.
3. The homoscedasticity assumption scatterplot is shown in Figure 5. There is no clear pattern; the dots spread above and the number 0 is on the Y-axis below. It indicates that there is no heteroscedasticity.

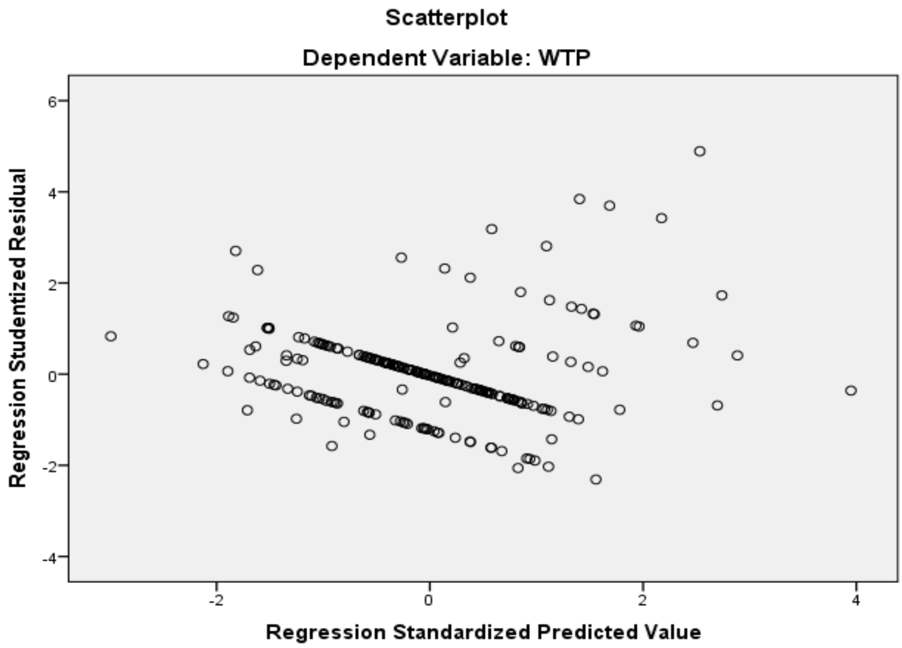

Figure 5 Scatterplot for homoscedasticity

Based on the significant value of each independent variable, from seven variables, five variables had a significant effect on the dependent variable (Y_{WTP}). The significant variables had a sig value < α (0.05). Variables that had no significant effect were the household size and frequency of WTP. Meanwhile, the independent variables age, farming experience, education, productivity, and distance to the main channel significantly affected the WTP of farmers for water services fees (Halkos and Matsiori, 2012; Makwinja et al., 2019; Reflis et al., 2019).

The independent variable of age has a significant negative influence on the dependent variable (WTP). The estimated parameter value is -1789.067. This means that the higher farmers' age, the lower the willingness to pay for water services fees. The WTP value paid will decrease by 1,789.067 rupiahs for each increase in the farmer's age unit. This contradicts with (Bell et al., 2014), research on WTP in irrigation systems in Pakistan. The results of their studies stated that the higher the age of the farmer, the higher their willingness to pay. In addition, the age variable in the study did not have a significant effect. However, the (Mezgebo and Ewnetu,

2015) study were in line with the expected hypothesis in this study. The results showed that respondents aged over 50 years in Mutale Local Municipality, South Africa, were less willing to pay higher water services fees.

Household size is the number of family members in one household. The results in Table 2 showed that the household size variable had no significant effect. This means that every unit increase in the number of family members will not greatly affect the amount of WTP. The estimated parameter value of this variable was -3325.846. This means that the WTP paid will be reduced by 3,325.846 rupiahs for each additional member of the family. A different family number normally means an additional child (or children) and therefore that this family will incur more expenses for non-agricultural activities or primary consumption (Aydogdu, 2016; Tang et al., 2013).

(Purba et al., 2021) stated that in tidal lowlands, the agricultural sustainability index was 25.53%. This means that currently, the practice of tidal farming is still unsustainable. Tidal lowlands farmers in Muara Telang had existed since the 1960s through the transmigration program. The experience of farmers in agriculture certainly plays an influential role in the improvement and sustainability of tidal lowland agricultural production. Older farmers certainly have more extended experience than younger farmers (Bloomfield and Zahari, 1982; Łukawska-Matuszewska et al., 2018). Farmers with longer experience will consider making voluntary contributions to the sustainable operation, maintenance, and management of infrastructure, including channels, water gates, and other supporting irrigation structures. Water management infrastructure is an important component of tidal management, which is highly dependent on water conditions (Chapman and Hall, 1996). In Table 2, farming experience demonstrated a significant positive effect. This means that farmers who have more farming experience will have a higher willingness to pay water service fees. An increase of 1,043.242 rupiahs will occur in one unit of increased farming experience.

Some of the tidal lowland farmers in this study location still think that formal education is not important. Some farmers did not have formal educational experience. The results showed that the independent variable of education had a significant positive effect. A total of 4,017.617-rupiah WTP was seen with longer formal farmer education experience. Research by (Bakopoulou et al., 2010; Bell et al., 2014) stated that the level of education would increase the probability of someone being willing to pay voluntarily and even being willing to pay a set fee with a specific price. Education is widely considered the most important form of human capital and can significantly influence society in terms of WTP (Kanyoka et al., 2009; Schulze, 2000). Contrary to the results of (Jones et al., 2010) study, the education variable had a negative effect. That means the higher the education, the lower a person's willingness to pay voluntarily. However, based on the specific location of the WTP of tidal land farmers, the positive influence of the education variable became more reasonable. Due to the higher education level, the awareness to pay the cost of water services fees for the operation, maintenance and management of infrastructure will certainly provide positive benefits to agricultural production (Bell et al., 2016).

WTP for water management must be carried out continuously, so management will be sustainable. At least once a year, a fee is charged to maintain water infrastructure. However, if it is undone WTP, the frequency of contributions will not be scheduled. In the (Kpadé et al., 2017; Mutaqin and Usami, 2019; Shee et al., 2020), fees for water management were ideally carried out twice a year or in every cropping season. Therefore, the groups will have savings in case of sudden damage to the water structure. The results in Table 2 showed that WTP frequency had no significant effect on alpha 5% on WTP for water. The influence of frequency was negative. This meant that the higher the frequency of payments, the lower the amount of WTP that would be paid. For every increase of one unit of WTP frequency, the money paid would decrease by 10,284.346 rupiahs.

The main income of tidal lowlands farmers in Muara Telang comes from rice farming practices. The more production is increased, the more income will increase (Bakopoulou et al., 2010; Halkos and Matsiori, 2012; Makwinja et al., 2019). The productivity of each farmer's land varies depending on the condition of the land. The average productivity of tidal lowlands farmers in Muara Telang is 4.10 to 4.43 tons per hectare. Meanwhile, the average rice production is 8 tons per hectare (Wildayana and Armanto, 2019). Table 2 showed that productivity had a significant positive effect. For every one-unit increase in productivity, the WTP will increase by 5,027.343 rupiahs. This is rational, because if productivity increases, incomes have increased, and the rice field will need more maintenance to ensure access to water. If the channels and water structures run smoothly, agricultural lands will not have a problem (Valipour et al., 2020). This will also have the opposite effect, specifically against increasing farm production. However, in the current situation, Purba (2021) concluded that rice farming practices on tidal land are still unsustainable and need to be improved.

In (Reflis et al., 2019) research, the key to farmers' participation in paying water services fees was the distance between the rice fields and the main water source (main channel). Distance from main channels (as water resources) to fields (meters) has a significant positive effect. The estimated parameter value is highly substantial. Thus, for each additional increase in land distance to the main channel by one unit, the WTP paid will increase by 24,498 rupiahs. (Koehler et al., 2015) stated that it would require more expensive service costs if the distance were further. This makes farmers unwilling to participate in paying water fees.

Table 4 The average of farmers' WTP

	N	Min	Max	Sum	Mean		Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
WTP	235	10000	375000	23805000	101297.87	3286.023	2537517730.496
Valid N (listwise)	235						

WTP estimation was calculated based on the data distribution of respondents obtained by dividing the total WTP by the number of respondents. The results of the calculation can be seen in Table 4. The estimated WTP of Rp. 101,297.87 was applied every cropping season. This value was determined by the willingness and ability of farmers by considering WTP factors that had a significant effect. The results of this WTP estimation can provide consideration for determining policies and sustainable management of water resources, especially for tidal lowland agriculture (Cheung and Jim, 2014; Hizami et al., 2014; Kolahi et al., 2013).

In this research, WTP in water services fees accounted for the operation, maintenance, and management of water infrastructures such as canals and water gates. In the research of (Purba et al., 2020) in Muara Telang, the use of agricultural inputs was excessive and inefficient, affecting rice production in tidal lowlands. Not only was production affected, but it was also polluting the soil and water. Excessively chemical soil conditions will block the air aeration and water flow in the soil. This results in the growth of plant roots being automatically disrupted. The flow of water that is not smooth causes the soil to become moist, and eventually, fungus and various germs grow. This problem causes a decrease in productivity (Ikoyi et al., 2018; Imanudin and Armanto, 2012; Zhang et al., 2018).

In tidal lowlands agriculture reclamation, there are often problems with flooding, lack of water, salinity, and pyrite content, which are dangerous to rice production. In addition to these problems, inefficient inputs also raise land fertility problems, requiring regular land washing to remove the remaining chemical content in the land. Land containing pyrite, if oxidized, will constrain rice growth. In terms of sustainable development, the 2030 agenda is expected to control water pollution as an international and national priority (Mateo-Sagasta et al., 2017; Nurita and Ar-Riza, 2014; Purba et al., 2020; Shamshuddin et al., 2004). In tidal lowlands agriculture, intensive shallow canals were built to wash acidity and toxicity from the land. Therefore, maintenance of channels and other water infrastructure needs to be carried out periodically to prevent damage that can cause any problems. In addition, the operation of the floodgates must also be carried out according to water needs and the cropping calendar (Ar-Riza and Alkasuma, 2008; Suprianto et al., 2010; Widjaja-Adhi et al., 1997). This requires a large amount of money. So, WTP can be applied to reduce problems and support sustainable production.

CONCLUSION

This study concludes that WTP for water services fees can be used sustainably. This research ultimately aimed to obtain significant factors that were used as indicators in determining the willingness of farmers to pay water service fees voluntarily (WTP). Based on the scientific hypothesis proposed, the significant factors analyzed were age, farming experience, education, productivity, and distance from land to main channels, where these factors have a significant effect on WTP for water services fees. Those factors affect 86.5%, and factors outside the equation model influence the remaining 13.5%. The estimated value of WTP that can be applied is 101,298 rupiahs (7 – 8 dollars) per cropping season. The WTP collected in each cropping season can be used for capital in the operation, maintenance, and management of channels and water gates. In addition, WTP would contribute to overcoming the threats to soil and water contamination and contribute to the achievement of food safety and quality. This would ensure that the quality of the water irrigating to the land remains sound and that soil problems such as pyrite can be resolved with routine land washing. This, in turn, would help to maintain fertile growing conditions, allowing optimal land productivity. So, when food production is safe and quality is guaranteed, sustainable food production can be realized. This study is expected that the results can be used to determine the value of WTP towards sustainability and improvement of water management in tidal lowlands agriculture and further research in order to highlight further the essential factor of WTP is productivity, because it affects farmers' income where farmers will be willing to pay contributions if they have high incomes.

AUTHORS' CONTRIBUTIONS

Meitry Firdha Tafarini (MFT) wrote the manuscript, developed the theory, and performed the computations. Muhammad Yazid (MY) was the corresponding author and MY conceived this research. Muh Bambang Prayitno (MBP) and Muhammad Faizal (MF) provided guide in collected data. F.X. Suryadi (FXS) corrected the English and typewriting. Khairul Fahmi Purba (KFB) assisted in data collection. All authors discussed the result and contributed to the final manuscript.

REFERENCES

Ahmed, A., Masud, M. M., Al-Amin, A. Q., Yahaya, S. R. B., Rahman, M., and Akhtar, R. 2015. Exploring factors influencing farmers' willingness to pay (WTP) for a planned adaptation programme to address climatic issues in agricultural sectors. Environ. Sci. Pollut. Res. 22(12): 9494–9504.

Ar-Riza, I., and Alkasuma. 2008. Pertanian lahan rawa pasang surut dan strategi pengembangannya dalam era otonomi daerah (Agricultural land tidal swamp and development strategy era of regional autonomy. J. Sumberd. Lahan. 2(2): 95–104.

Aydogdu, M. H. 2016. Evaluation of willingness to pay for irrigation water: Harran plain sampling in gap region - turkey. Appl. Ecol. Environ. Res. 14(1): 349–365.

Baghestany, M., and Zibaei, M. 2010. Measuring Willingness of Farmers to Pay for Groundwater in Ramjerd District: Application of Contingent Valuation Method. Agric. Econ. 4(3): 41–64.

Bakopoulou, S., Polyzos, S., and Kungolos, A. 2010. Investigation of farmers' willingness to pay for using recycled water for irrigation in thessaly region, greece. Desalination 250(1): 329–334.

Bell, A. R., Shah, M. A. A., and Ward, P. S. 2014. Reimagining cost recovery in Pakistan's irrigation system through willingness-to-pay estimates for irrigation water from a discrete choice experiment. Water Resour. Res. 50: 6679–6695.

Bell, A. R., Ward, P. S., and Shah, M. A. A. 2016. Increased water charges improve efficiency and equity in an irrigation system. Ecol. Soc. 21(3): 1–13.

Bernard, H. R. 2011. *Research methods in anthropology: qualitative and quantitative approaches*. British Library Cataloguing (5th ed.). Altamira Press: United Kingdom.

Bloomfield, C., and Zahari, A. B. 1982. Acid sulphate soils. Outlook Agric. 11(2): 48–54.

Brox, J. A., Kumar, R. C., and Stollery, K. R. 1996. Willingness to pay for water quality and supply enhancements in the grand river watershed. Can. Water Resour. J. 21(3): 275–288.

Central Bureau of Statistics of Banyuasin Regency. 2017. *Banyuasin dalam angka (Banyuasin in figures) 2017*. BPS-Statistics of Banyuasin Regency: South Sumatra.

Central Bureau of Statistics of Banyuasin Regency. 2018. *Banyuasin dalam angka (Banyuasin in figures) 2018*. BPS-Statistics of Banyuasin Regency: South Sumatra.

Chapman, D., and Hall. 1996. *Water quality assessments: a guide to the use of biota, sediments and water in environmental monitoring* (2nd ed.). Great Britain at the University Press: Cambridge

Cheung, L. T. O., and Jim, C. Y. 2014. Expectations and willingness-to-pay for ecotourism services in hong kong's conservation areas. Int. J. Sustain. Dev. World Ecol. 21(2): 149–159.

Chiarini, A., and Brunetti, F. 2019. What really matters for a successful implementation of lean production? A multiple linear regression model based on european manufacturing companies. Prod. Plan. Control. 30(13): 1091–1101.

Cooper, J. C. 1993. Optimal bid selection for dichotomous choice contingent valuation surveys. J. Environ. Econ. Manag. 24: 25–40.

Field, A. 2013. *Discovering statistics using ibm spss statistics* (4th Ed.). Sage Publications Ltd.: London.

Halkos, G., and Matsiori, S. 2012. Determinants of willingness to pay for coastal zone quality improvement. J. Socio. Econ. 41(4): 391–399.

Hizami, N., Rusli, M., and Alias, R. 2014. Valuing natural resources of ecotourism destination in taman negara sungai relau, pahang, malaysia. J. Basic Appl. Sci. 8(3): 416–425.

Ikoyi, I., Fowler, A., and Schmalenberger, A. 2018. One-time phosphate fertilizer application to grassland columns modifies the soil microbiota and limits its role in ecosystem services. Sci. Total Environ. 630: 849–858.

Imanudin, M. S., and Armanto, E. 2012. Effect of water management improvement on soil nutrient content, iron and aluminum solubility at tidal low land area. APCBEE Procedia 4: 253–258.

Imanudin, M. S., Armanto, E., Susanto, R. H., and Bernas, S. M. 2010. Water table fluctuation in tidal lowland for developing agricultural water management strategies. J. Trop. Soils. 15(3): 277–282.

Imanudin, M. S., Bakri, Armanto, E., Indra, B., and Ratmini, S. N. P. 2018. Land and water management option of tidal lowland reclamation area to support rice production (A case study in delta sugihan kanan of south sumatra indonesia). J. Wetl. Environ. Manag. 6(2): 93–111.

Jones, N., Evangelinos, K., Halvadakis, C. P., Iosifides, T., and Sophoulis, C. M. 2010. Social factors influencing perceptions and willingness to pay for a market-based policy aiming on solid waste management. Resour. Conserv. Recycl. 54(9): 533–540.

Kaiser, H. F. 1970. A second-generation little jiffy*. Psychometrika. 35(4): 401–415.

Kanninen, B. J. 1993. Optimal experimental design for double-bounded dichotomous choice contingent valuation. J. L. Econ. 69(2): 138–146.

Kanyoka, P., Farolfi, S., and Morardet, S. 2009. Households' preferences and willingness to pay for multiple use water services in rural areas of south africa: An analysis based on choice modelling. Water SA. 34(6): 715–724.

Koehler, J., Thomson, P., and Hope, R. 2015. Pump-priming payments for sustainable water services in rural africa. World Dev. 74: 397–411.

Kolahi, M., Sakai, T., and Moriya, K. 2013. Ecotourism potentials for financing parks and protected areas: A perspective from iran's parks. J. Mod. Account. Audit. 9(1): 144–152.

Kpadé, C. P., Mensah, E. R., Fok, M., and Ndjeunga, J. 2017. Cotton farmers' willingness to pay for pest management services in northern Benin. Agric. Econ. (UK). 48(1): 105–114.

Łukawska-Matuszewska, Katarzyna, Graca, B., Brocławik, O., and Zalewska, T. 2018. The impact of declining oxygen conditions on pyrite accumulation in shelf sediments (baltic sea). Biogeochemistry 142(2): 209–230.

Makwinja, R., Kosamu, I. B. M., and Kaonga, C. C. 2019. Determinants and values of willingness to pay for water quality improvement: Insights from chia lagoon, malawi. Sustain. (Switzerland). 11: 1–26.

Mateo-Sagasta, J., Zadeh, S. M., Turral, H., and Burke, J. 2017. *Water pollution from agriculture: a global review.* In The Food and Agriculture Organization of The United Nations Rome and The International Water Management Institute on Behalf of The Water Land and Ecosystem Research Program Colombo.

Meijide, A., Gruening, C., Goded, I., Seufert, G., and Cescatti, A. 2017. Water management reduces greenhouse gas emissions in a Mediterranean rice paddy field. Agric. Ecosyst. Environ. 238(1): 168–178.

Mercau, J. L., Nosetto, M. D., Bert, F., Giménez, R., and Jobbágy, E. G. 2016. Shallow groundwater dynamics in the Pampas: Climate, landscape, and crop choice effects. Agric. Water Manag. 163: 159–168.

Mezgebo, G. K., and Ewnetu, Z. 2015. Households' willingness to pay for improved water services in urban areas: A case study from nebelet town, ethiopia. J. Dev. Agric. Econ. 7(1): 12–19.

Mutaqin, D. J., and Usami, K. 2019. Smallholder farmers' willingness to pay for agricultural production cost insurance in rural west java, indonesia: A contingent valuation method (cvm) approach. Risks. 7(2): 1–18.

Noor, M., and Rahman, A. 2015. Biodiversitas dan kearifan lokal dalam budidaya tanaman pangan mendukung kedaulatan pangan: kasus di lahan rawa pasang surut. Pros. Semin. Nas. Masy. Biodivers. Indones. 1(8): 1861–1867.

Nurita, and Ar-Riza, I. 2014. Peningkatan produksi padi berkelanjutan pada lahan rawa pasang surut (Increasing of sustainable rice production on swampland). J. Teknol. Pertan. 9(1): 1–7.

Pallant, J. 2016. *Spss survival manual: a step-by-step guide to data analysis using ibm spss*. (6th Ed.). British Library: England.

Prasetyo, K., Masrukan, and Sunawan. 2019. Development of mathematical literation instruments based on class iv geometry material conservation. J. Educ. Res. Eval. 8(1): 1–13.

Purba, K. F., Yazid, M., Hasmeda, M., Adriani, D., and Tafarini, M. F. 2020. Technical efficiency and factors affecting rice production in tidal lowlands of south sumatra province Indonesia. Potravin. Slovak J. Food Sci. 14: 101–111.

Purba, K. F., Yazid, M., Hasmeda, M., Adriani, D., and Tafarini, M. F. 2021. The sustainability of rice farming practices in tidal swamplands of south sumatra indonesia. Potravin. Slovak J. Food Sci. 15: 9–17.

Reflis, Sjarkowi, F., Sriati, and Susetyo, D. 2019. Farmers' participation for irrigation water resources services fee, kapahiang regency bengkulu province-indonesia. International J. Ecol. Environ. Conserv. 25(2): 527–536.

Schulze, R. E. 2000. Modelling Hydrological Responses to Land Use and Climate Change: A Southern African Perspective. AMBIO A J. Hum. Environ. 29(1): 12–22.

Shamshuddin, J., Muhrizal, S., Fauziah, I., and Van Ranst, E. 2004. A laboratory study of pyrite oxidation in acid sulfate soils. Commun. Soil Sci. Plant Anal. 35(1–2): 117–129.

Sharma, S., and Henriques, I. 2005. Stakeholder influences on sustainability practices in the canadian forest products industry. Strateg. Manag. J. 26(2): 159–180.

Shee, A., Azzarri, C., and Haile, B. 2020. Farmers'willingness to pay for improved agricultural technologies: Evidence from a field experiment in Tanzania. Sustain. (Switzerland). 12(1): 1–13.

Suprianto, H., Ravaie, E., Irianto, S. G., Susanto, R. H., Schultz, B., Suryadi, F. X., and Eelaart, A. Van Den. 2010. Land and water management of tidal lowlands: experiences in telang and saleh, south sumatra. J. Irrig. Drain. 59: 317–335.

Suryadi, F. X. 1996. Soil and Water Management Strategies for Tidal Lowlands in Indonesia. (Doctoral dissertation), UNESCO-IHE Institute for Water Education, Delft.

Tafarini, M. F., and Yazid, M. 2019. Sustainable Water Management in Tidal Lowland Agriculture: A Research Agenda. Sriwij. J. Environ. 3(3): 102–107.

Tang, Z., Nan, Z., and Liu, J. 2013. The willingness to pay for irrigation water: A case study in northwest china. Glob. NEST J. 15(1): 76–84.

Tranmer, M., Murphy, J., Elliot, M., and Pampaka, M. 2020. *Multiple linear regression* (2nd Ed.). Cathie Marsh Institute Working Paper 2020-01.

Valipour, M., Krasilnikof, J., Yannopoulos, S., Kumar, R., Deng, J., Roccaro, P., Mays, L., Grismer, M. E., and Angelakis, A. N. 2020. The evolution of agricultural drainage from the earliest times to the present. Sustain. (Switzerland). 12(1): 1–30.

Weisberg, S. 2005. *Applied linear regression* (3rd Ed.). John Wiley & Sons, Inc.: New Jersey.

Whittington, D., Briscoe, J., Xinming Mu, and Barron, W. 1990. Estimating the willingness to pay for water services in developing countries: A case study of the use of contingent valuation surveys in southern Haiti. Econ. Dev. Cult. Chang. 38(2): 293–311.

Widjaja-Adhi, I., Ratmini, NP. S., and Swastika, I. W. 1997. *Pengelolaan tanah dan air di lahan pasang surut (Soil and water management in tidal lowlands)*. Proyek Penelitian Pengembangan Pertanian Rawa Terpadu-ISDP Badan Penelitian dan Pengembangan Pertanian.

Wildayana, E., and Armanto, M. E. 2019. The role of subsidized fertilizers on rice production and income of farmers in various land typologies. J. Ekon. Pembang. Kaji. Masal. Ekon. Pembang. 20(1): 100–107.

Yazid, M., Shamsudin, M. N., Rahim, K. A., Radam, A., and Muda, A. 2015. Water service valuation in tidal lowland agriculture. Pertanika J. Soc. Sci. Humanit. 23: 39–46.

Zhang, L., Yan, C., Guo, Q., Zhang, J., and Ruiz-Menjivar, J. 2018. The impact of agricultural chemical inputs on environment: Global evidence from informetrics analysis and visualization. Int. J. Low-Carbon Technol. 13(4): 338–352.

Acknowledgement:

The authors wish to thank the Directorate General of Science and Technology Resources and the Directorate of Research and Community Service in the Ministry of Research, Technology and Higher Education of Indonesia through PMDSU (*Pendidikan Magister Menuju Doktor Untuk Sarjana Unggul*) for funding these research grants by letter number 068/SP2H/AMD/LT/DRPM/2020. The authors also would like to express great thanks to the

IHE Delft Institute For Water Education, which facilitated the implementation of the PKPI (sandwich-like) program.

Conflict of Interest:

The authors declare no conflict of interest.

Ethical Statement:

This article does not contain any studies that would require an ethical statement.

Reviewed and Resubmit Manuscript

(3 Januari 2022)

Fwd: Article Revision Letter for Authors - (EJFA-2021-10-434)

Dari: Meitry Tafarini (meitrytafarini@student.pps.unsri.ac.id)

Kepada: yazid_ppmal@yahoo.com

Tanggal: Sabtu, 27 Mei 2023 pukul 19.11 GMT+7

Assalamu'alaikum wr.wb.
Berikut email review pertama dari artikel yang pertama. Untuk email konfirmasi submissionnya, saya tidak bisa menemukannya pak. Dan di akun pada website jurnalnya juga sudah tidak ada recordnya. Hanya ada decision letter saja Pak. Selanjutnya akan saya kirimkan secara berurutan Pak.

---------- Forwarded message ---------
From: **Emirates Journal of Food and Agriculture** <noreply@ejmanager.com>
Date: Mon, Jan 3, 2022 at 2:44 PM
Subject: Article Revision Letter for Authors - (EJFA-2021-10-434)
To: <meitrytafarini@student.pps.unsri.ac.id>

Dear Meitry Firdha Tafarini,

Your manuscript entitled \"Willingness to pay for water management to support sustainable food production in tidal lowlands of South Sumatra, Indonesia\" (Ms.Nr. EJFA-2021-10-434) was reviewed by editorial board members of the Emirates Journal of Food and Agriculture. As initial decision, your manuscript was found interesting but some revisions have to be made before it can reach a publishable value.
Please answer all the comments below point-by-point in an accompanying response letter to your revised submission.

You should send your revised manuscript via the online system of eJManager on http://my.ejmanager.com.

Sincerely yours,

Editor
Emirates Journal of Food and Agriculture
www.ejfa.me

Impact Factor: 1.04
2020 Journal Citation Reports® (Clarivate Analytics, 2021)

COMMENTS for Authors:

=> Reviewer # 1

The research topic is original and deserves to be exposed, and these results are relevant and high contributions to the field researchce and to the literature.
The author has largely succeeded in following the journal\'s instructions in almost all sections of a scientific article.
The author mention the objectives of the work, thorough literature review is undertaken in the introduction, leading to the presentation of a problem statement clear. he used a relevant literature on the subject, And the proposed approach is understandable.
The methodology is clear, accurate and complete enough. this methodology allows it to well-tried and verified the

issue of research and produced the results expected.
The author has succeeded in large measure to use recent and relevant references, diversified across books and journals and some studies that address similar issues about the article.
In the Results section, there are many statements relevant that are supported by research, and who responded to the research problem posed by the author. These results obtained by the author are presented with clarity and precision, and written according to the instructions proposed.
The author also used several methods and tools of statistical analysis and linear programming to reinforce the results obtained.
In this discussion, the author has interpreted his results in this field according to the objectives set, and he argued his interpretations of many findings of previous studies within the same area of research. And by numerous statements of experts with ties to the research topic.
The conclusion is more like a synthesis of the paper with no lessons learnt from the case study and no research perspectives.
Following our usual practice, I reviewed your paper carefully before making the decision. And I think the contribution is sufficient to justify the publication of the publication of the manuscript . although a few shortcomings recorded, but which does not diminish the quality and importance of the work.

****

JOURNAL CONTACT EMAIL: ejfa@uaeu.ac.ae

IMPORTANT: USE JOURNAL CONTACT EMAIL for your messages. Do not answer to this email. It is not checked for messages

http://www.ejmanager.com

****

Willingness to pay for water management to support sustainable food production in tidal lowlands of South Sumatra, Indonesia

Meitry Firdha Tafarini[1], Muhammad Yazid[1*], Muh. Bambang Prayitno[2], Muhammad Faizal[3], Fransiscus Xaverius Suryadi[4], and Khairul Fahmi Purba[1]

[1]Department of Agribusiness, Faculty of Agriculture, Universitas Sriwijaya, Jalan Palembang-Prabumulih KM 32, Indralaya, South Sumatra, Indonesia, [2]Department of Soil Science, Faculty of Agriculture, Universitas Sriwijaya, Jalan Palembang-Prabumulih KM 32, Indralaya, South Sumatra, Indonesia, [3]Department of Chemical Engineering, Faculty of Engineering, Universitas Sriwijaya, Jalan Palembang-Prabumulih KM 32, Indralaya, South Sumatra, Indonesia, [4]Department of Land and Water Development, Water Science and Engineering, UNESCO IHE, Delft, The Netherlands

*Corresponding author: yazid_ppmal@yahoo.com

ABSTRACT

Operations and maintenance (OM) of water infrastructure cannot be separated from the role of farmers' water users associations (WUA) or farmer groups. OM needs to be supported not only skillfully but also financially. This research aimed to assess and identify several factors affecting self-financing in water management in tidal lowlands agriculture, using the Willingness To Pay (WTP) approach. The sample size of this research was 245 respondents, all of which are active members of WUA or farmer groups. Primary data were collected using direct interviews with structured questionnaires, and secondary data were collected from some related agencies. The data were analyzed using Exploratory Factor Analysis (EFA) and Multiple Linear Regression analyses. Regression analysis formally tested the factors and identified the selected significant factors. KMO and Bartlett's Test result was 0.587 > 0.5 (alpha), indicating significance. The R^2 (0.86) showed that the independent variables simultaneously explained the dependent variable (Y_{WTP}). From seven independent variables, five variables significantly affect the willingness to pay for water management. This WTP is expected to ensure sustainable food production in tidal lowlands since water availability is crucial in tidal lowland agriculture.

Keywords: water, WTP, EFA, multiple linear regression, tidal lowlands

INTRODUCTION

Tidal lowlands are wetlands ecosystems with inundated land characteristics and are influenced by high and low water tides but not river water. Meanwhile, river water also rises as a result of the retention of river water by high tides. Tidal lowland also has valuable characteristics and potential as an agricultural resource, mostly for food crops (Noor and Rahman, 2015; Tafarini and Yazid, 2019) . The tidal lowlands in South Sumatra are considered to be a food barn with an area of 266,674 hectares in 2017, including 161,908 hectares of tidal lowlands in Banyuasin Regency. Food production (rice) in tidal lowlands in Banyuasin Regency in 2017, was 1,038,489.34 tons (Central Bureau of Statistics of Banyuasin Regency, 2018). Meanwhile, the demand for food continues to increase at a rate equivalent to population increase; thus, the region continues to strive to improve food production (rice). However, rice production in 2017 decreased from the previous year (2016) by 1,302,229.7 tons (Central Bureau of Statistics of Banyuasin Regency, 2017).

Tidal lowland is highly dependent on high and low water tides, so it requires a proper plan, management (especially aspects of water management through water channels), and utilization of land management and infrastructure technology. This is to allow it to be distributed appropriately to the rice field (Imanudin et al., 2010). Water management for rice cultivation is needed to maximize productivity (Imanudin et al., 2018). However, the current problem is the improper application of water management. A land far from the main channel often experiences water shortages, especially during the dry season. Meanwhile, some lands experience flooding, due to the drainage system's handling with improper operation of floodgates in the rainy season (Mercau et al., 2016). Farmers do not implement the micro water system (quaternary channel or worm channels), even though channels' functions can regularly distribute and store water for plants in the tertiary channel's middle position. The primary key to this problem is the appropriate and sustainable water management application from micro and macro water system levels, supported by suitable infrastructure (Meijide et al., 2017). Restoration and maintenance of water infrastructures incur many costs, and this situation needs the role of farmers. Do farmers have enough capital and able to do self-financing the water management for their land, or do they need cooperation between other farmer organizations such as WUA or farmer groups' role? This study will identify whether farmers are willing to contribute to water services fees for sustainable water management by applying the Willingness to Pay (WTP) approach.

The maximum amount an individual agrees to pay for a good or service without losing its utility is the definition of WTP (Baghestany and Zibaei, 2010; Cooper, 1993; Kanninen, 1993). WTP reflects the WUA's perceptions toward the existence and importance of water resources necessary for the active participation of WUA to contribute to WTP (Whittington et al., 1990). Because there are options for restoring and maintaining water infrastructure through WUA as a sustainable agriculture scheme, the goal is to increase production. It is crucial to know whether farmers are willing to pay water management fees, as well as the factors that affect their willingness to pay (WTP). This study aimed to estimate farmers' OP self-financing potential to increase water use efficiency and estimate water services' value to support water service fee applications. To achieve these goals, the study used an exploratory factor analysis (EFA) model to determine which indicators were the main foci of farmers willing to pay the cost of water services.

Productivity, income, and socio-economic characteristics of farmer households affect WTP's amount as a fee for water management services. In addition, the amount is also influenced by the general characteristics of farmers such as age, gender, length of education, number of family members, type of house, general environmental awareness, land area, and land ownership status, role in maintaining water infrastructure, and distance of land to rivers (Brox et al., 1996; Reflis et al., 2019; Yazid et al., 2015) . A farmer's WTP depends on many interrelated factors. To assess the farmer's WTP, this study used two-approach categories that were disclosed and stated. Those approaches directly provided an unbiased estimate of WTP from respondent farmers (Shee et al., 2020) . However, the water user association (WUA), which was formed to manage the system's operation and maintenance, has not implemented a water service fee for the continuity of repair and maintenance of water structures, because there is no objective measure. Thus, in this paper, the researcher describes the results of exploratory factor analysis (EFA) to obtain objective indicators that are formerly analyzed by regression equations. The multiple linear regression model results in the number of factors used, how relevant decisions are presented for interpretation. The results of the research indicated which factors affect the farmers' WTP. The conclusions help in drawing an estimate of the average amount of WTP that farmers can pay.

Scientific hypothesis

This study hypothesis is that socio-economic factors such as age, household size, farming experience, education, frequency of WTP, productivity, and distance from land to main channels, influence the farmers' WTP on a water services fee.

MATERIALS AND METHOD

Study area

This research was conducted in two villages in the tidal area, Telang Karya and Telang Rejo, Muara Telang District (Primary 8, Delta Telang I), Banyuasin Regency, South Sumatra. Those villages are the largest and have the highest rice production compared to other villages in Muara Telang District. The typology of tidal lowland in these two villages is A-type. The tidal lowland A-type is a land that can be inundated by high tide at least 4 or 5 times during the tidal cycle for 14 days, both in the rainy and dry seasons.

These areas are primarily located in basins or close to the mouth of a river (Suprianto et al., 2010; Suryadi, 1996). The research location is the most productive area for food crops (rice). Production is supported by an irrigation system using secondary and tertiary blocks, some of which are equipped with water-management infrastructure. The research location can be seen in Figure 1.

Figure 1 Tidal lowland canals condition in Muara Telang Sub District

Samples and data collection

This study used tidal lowland farmers as research subjects (respondents). Respondents are farmers who own land and organize agricultural activities in Telang Karya Village and Telang Rejo Village. The total sample was 245 respondents (n = 245) of farmers.

Formatted: Font: 12 pt, Highlight

Deleted: In this study, tidal lowland farmers were used as research subjects (respondents)

Formatted: Highlight

Deleted: Respondents are farmers who own land and organize an agricultural activity in Telang Karya Village and Telang Rejo Village

Data were collected between the middle and end of 2019. Data information from sample farmers was interviewed using questionnaires and purposive sampling technique or judgment sampling. Purposive sampling was undertaken deliberately, based on the requirements and quality of the respondents. The researcher had defined the criteria according to the information required (Bernard, 2011) . The farmers who became respondents were tidal lowland farmers with a minimal of 0.5 Ha of rice field in Telang Karya and or Telang Rejo Villages, and members of a farmer group, with at least one year of farming experience, who were willing to pay for water management.

Formatted: Highlight

Data collected for factors affecting WTP were socio-economic characteristics. The socio-economic characteristics consist of age, household size, farming experience, education, frequency of WTP, land distance to main channels, and productivity. Furthermore, data collected for measuring ATP used rice production data to calculate each farmer's income every planting season.

Questionnaire preparation

The design of the questionnaire was carried out to collect exploratory information from the respondents. The number of questions in the questionnaire were 12 questions related to the variables used in this study. Respondents were given the flexibility to answer, and no answer choices provided, because the questions presented were open questionnaires. The information collected is in the form of qualitative and quantitative information. The questionnaire was a formal standard questionnaire because researchers will test and measure hypotheses and data by statistical analysis. Therefore, questions on the questionnaire were made according to the variables used to test the hypothesis. The variables used include the following:

Table 1. Variables of factors affecting WTP

No.	Variables	Unit	Explanation
1.	Age	year	Age of sample farmer
2.	Household size	person	Number of family members borne by the head of the sample farmer family
3.	Farming experience	year	The amount of time the sample farmers organize agriculture
4.	Education	year	Last formal education of sample farmer
5.	Frequency of WTP	times	A measure of the number of times the sample farmers paid WTP
6.	Land distance	meter	Land distance to main drainage channel
7.	Productivity	$ton.ha^{-1}$	The ability or carrying capacity of agricultural land in producing rice crops

Data Analysis

Water services fees in this study were costs used to carry out the operation, maintenance, and management (OMM) of agricultural water tidal lowland irrigation infrastructures. In this study, the factors of WTP were analyzed by exploratory factor analysis (EFA) to reduce the number of variables. Exploratory factor analysis (EFA) is a statistical technique commonly used in questionnaire development and analysis (Field, 2013; Sharma and Henriques, 2005). To identify whether the indicators used are sufficient for factor analysis, the value of

Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) test was assessed for multicollinearity. Then the selected variables will be analyzed by multiple linear regression.

Multiple linear regression was used for identifying the relationship of dependent and independent variables with more than one explanatory variable. In social sciences research, this analysis is a suitable method to solve social problems (Chiarini and Brunetti, 2019; Tranmer et al., 2020). The general equation for multiple linear regression is as follows:

$$Yi = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_n X_{ni} + e \quad \textbf{(1)}$$

The dependent variable (Y) in this research is the amount of WTP that a farmer pays for a year (two planting seasons). The socio-economic characteristics of rice farmers in tidal lowlands were used for independent variables (X). (Ahmed et al., 2015; Reflis et al., 2019) presented the socio-economic characteristics of farmers that influenced WTP. Therefore, age (X_1), household size (X_2), farming experience (X_3), education (X_4), frequency of WTP (X_5), productivity (X_6), and distance from land to main channels (X_7) were used. The equation of multiple regression created in this study was:

$$Y_{WTP} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e \quad \textbf{(2)}$$

where Y_{WTP} denotes the amount of WTP (rupiah/year). β_0 is intercept of model. $\beta_1 \ldots \beta_7$ are estimated parameters. Then, X_1, X_2, X_3, X_4, X_5, X_6, and X_7 represent independent variables (socio-economic characteristics). e indicates error term. Hypotheses for the regression analysis were:

1. Simultaneous hypotheses using F value or F significance value. Simultaneous hypotheses decisions are seen from the significance value. If the significance F-value < $\alpha_{(0.05)}$, the hypothesis H_0 is accepted. Here are the hypotheses:

   H_0: Farmers' socio-economic factors simultaneously have a significant effect on their willingness to pay (WTP) for water services fees.

   H_1: Farmers' socio-economic factors simultaneously have no significant effect on their willingness to pay (WTP) for water services fees.

2. Partial hypotheses using t value or t significance value. If the significance t value of each independent variables < $\alpha_{(0.05)}$, the hypothesis H_2 is accepted. Here are the hypotheses:

   H_1: Farmers' socio-economic factors have no significant effect on their willingness to pay (WTP) for water services fees.

   H_2: Farmers' socio-economic factors have a significant effect on their willingness to pay (WTP) for water services fees.

Multiple linear regression analysis must fulfill the classical assumptions. According to (Weisberg, 2005), the classical assumptions that must be met are as follows:

1. The normality assumption is identified by looking at a histogram or a Q-Q plot.
2. Multicollinearity can be checked through the tolerance value of each independent variable—the value should be higher than 0.10 and VIF should less than 10.

Homoscedasticity assumption can be identified by a scatterplot of residuals versus predicted values.

Statistical Analysis

This study used three statistical analyses. First, the descriptive analysis was performed using Microsoft Excel 2016. The second and third analyses involved Exploratory Factor Analysis (EFA) and parametric data analyses (Multiple Linear Regression). The sample data collected were entered and screened using SPSS 23 to analyze factors affecting the WTP of rice farmers in water services fees. The significance (α) for this study used 5%. The *p*-value is expected less than 0.05 ($p < 0.05$).

RESULTS AND DISCUSSION

Socio-economic characteristics of rice farmers

The total respondents in this research were 235 farmers. The respondents are tidal land farmers in Telang Karya and Telang Rejo villages, Muara Telang sub-district, Banyuasin District, South Sumatra. The following is a diagram that presents the age range of farmers and their relationship with their old farming experience based on the results of the interview:

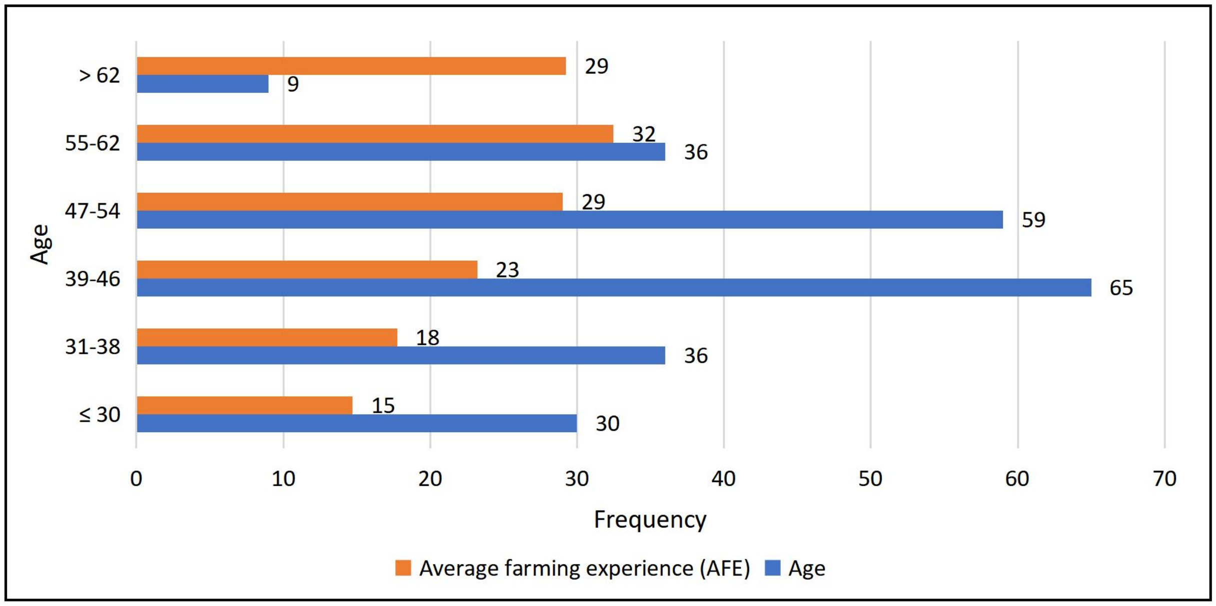

Figure 2 Age of farmers & average farming experience (AFE)

Based on Figure 2, there were 30 farmers under the age of 30 with 15 years of average farming experience. In age ranges, 31-38 years, 39-46 years, 47-54 years, 55-62 years as many as 36, 65, 59, and 36 farmers had an average farming experience of 18, 23, 29, and 32 years respectively. Meanwhile, there were 9 farmers over 62 years old with an average farming experience of 29 years. The relationship between farming experience and farmer's age as illustrated in Figure 2. The higher the age of the farmer, the longer the farmer has experience in farming.

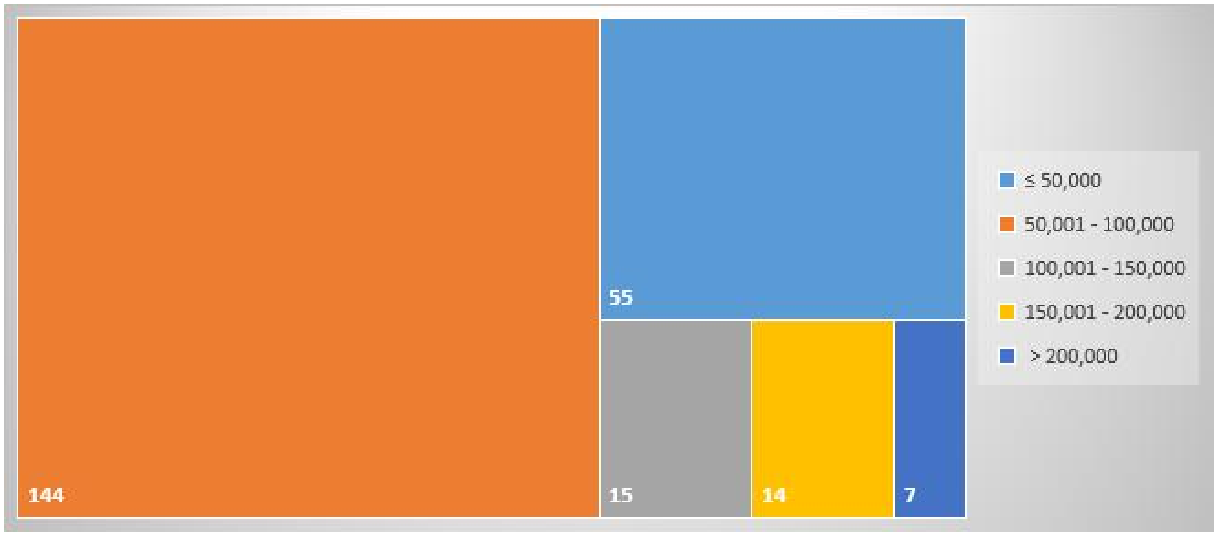

Figure 3 Willingness to Pay (Rupiah)

Figure 3 showed 235 respondents who were willing to pay water management fees (WTP). The number of fees offered by respondents varied widely. More than half of the respondents, 144 farmers, were willing to pay dues in the range of Rp 50,001 – Rp 100,000. A small proportion of respondents, 55 farmers, chose to pay a fee of ≤ Rp 50,000. Those who were willing to pay dues ranging from Rp 100,001 – Rp 150,000; Rp 150,001 – Rp 200,000; and ≥ Rp 200,001 were 15, 14, and 7 respondents respectively. This shows that, on average, farmers were more likely to pay fees ranging from Rp 50,000 to Rp 100,000. Only 15.32% of the respondents were willing to pay higher than the average value of willingness to pay (rupiah).

Formatted: Highlight
Deleted: showed
Deleted: a willingness
Deleted: amount
Formatted: Highlight

Exploratory factor analysis (EFA)

The factors analyzed using EFA were age, gender, household size, farming experience, education, type of WTP, frequency of WTP, farmers' role in OM, productivity, and distance from land to main channels, all of which influence the farmers' WTP on water services fee.

Table 2 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.608
Bartlett's Test of Sphericity	Approx. Chi-Square	407.539
	df	66
	Sig.	0.000

Table 1 shows the results of the Exploratory Factor Analysis (EFA). The value of Bartlett's Test of Sphericity was seen from its significance of $p < 0.05$ or $0.000 < 0.05$, which means that the correlation between the indicators was acceptable for factor analysis. The KMO test was used to demonstrate multicollinearity. The KMO test also helps ensure the fitness of the indicators used for factor analysis. Factor analysis will be appropriate if the KMO value is > 0.60 (Pallant, 2016). Based on Table 1, the KMO value of 0.608 showed that the data do not have any significant multicollinearity problems, so the indicators can be used for further analysis (Kaiser, 1970; Prasetyo et al., 2019) . This analysis reduced 10 variables to 7 variables, which will be used in multiple linear analyses.

Factors influencing WTP on water services fees

The amount of WTP is affected by several factors. In order to estimate the influence of the factors on WTP, a multiple linear regression is employed using the following equation. The results of the estimation are presented in Table 2.

$$Y_{WTP} = 102108.020 - 1789.067\,X_1 - 3325.846\,X_2 + 1043.242\,X_3 + 4017.617\,X_4 - 10284.346\,X_5 + 5027.343\,X_6 + 24.498\,X_7 + e \quad \textbf{(3)}$$

The coefficient of determination (R^2) is considerably high. This indicates that 86.50 percent of the variation in the amount of WTP is elaborated simultaneously by the independent variables. Based on the value of t-statistics, the independent variables that proved to contribute significantly to this variation are age (X_1), household size (X_2), farming experience (X_3), education (X_4), frequency of WTP (X_5), productivity (X_6), and distance from land to main channels (X_7).

Table 3 Results of the analysis on factors affecting WTP

	Unstandardized Coefficients				Collinearity Statistics	
Model	B	Std. Error	t	Sig.	Tolerance	VIF
(Constant)	102108.020	23544.043	4.337	0.000		
Age	-1789.067	317.625	-5.633	**0.000****	0.686	1.458
Household size	-3325.846	2398.405	-1.387	0.167	0.954	1.048
Farming experience	1043.242	298.440	3.496	**0.001****	0.701	1.427
Education (year)	4017.617	901.528	4.456	**0.000****	0.869	1.150
Frequency of WTP	-10284.346	6368.074	-1.615	0.108*	0.972	1.029
Productivity	5027.343	1893.310	2.655	**0.008****	0.886	1.128

Distance to Main Channel	24.498	7.225	3.391	**0.001****	0.941	1.062

a. Dependent Variable : WTP
b. *Significant at α = 15%
c. **Significant at α = 5%

Based on the result from Table 2, B is the estimation parameter, Sig. value is the significance value of each independent variable, and tolerance & VIF are classical assumptions of multicollinearity. Three classical assumptions in the regression analysis were made with the following results:

1. Data normality showed in Figure 4: P-P plot. The points in Figure 4 approach the straight diagonal line without any length to the right or left of the line.

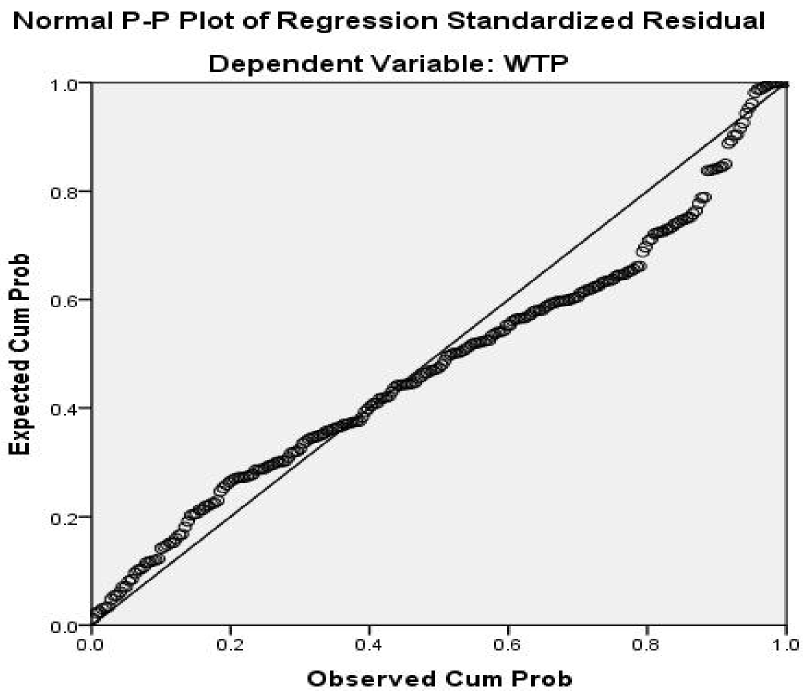

Figure 4 P-P plot for data normality

2. Multicollinearity can be checked through tolerance value and VIF showed in Table 2. In Table 2, tolerance values are higher than 0.1 and VIF values are less than 10.00. It indicates that each independent variable doesn't occur with multicollinearity.

3. The homoscedasticity assumption scatterplot is shown in Figure 5. There is no clear pattern; the dots spread above and the number 0 is on the Y-axis below. It indicates that there is no heteroscedasticity.

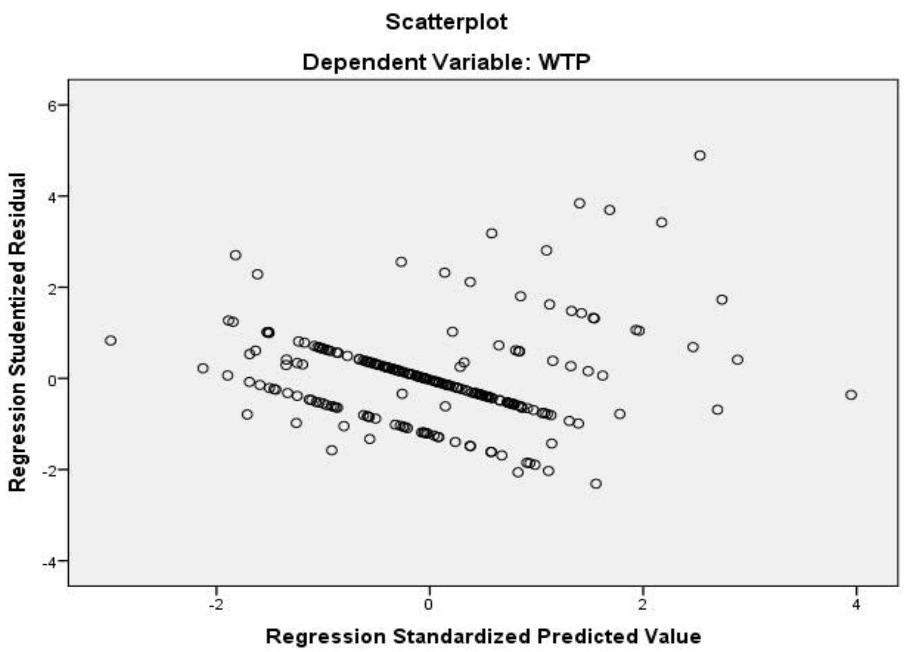

Figure 5 Scatterplot for homoscedasticity

Based on the significant value of each independent variable, from seven variables, five variables had a significant effect on the dependent variable (Y_{WTP}). The significant variables had a sig value < α (0.05). Variables that had no significant effect were the household size and frequency of WTP. Meanwhile, the independent variables age, farming experience, education, productivity, and distance to the main channel significantly affected the WTP of farmers for water services fees (Halkos and Matsiori, 2012; Makwinja et al., 2019; Reflis et al., 2019).

The independent variable of age has a significant negative influence on the dependent variable (WTP). The estimated parameter value is -1789.067. This means that the higher farmers' age, the lower the willingness to pay for water services fees. The WTP value paid will decrease by 1,789.067 rupiahs for each increase in the farmer's age unit. This contradicts with (Bell et al., 2014) , research on WTP in irrigation systems in Pakistan. The results of their studies stated that the higher the age of the farmer, the higher their willingness to pay. In addition, the age variable in the study did not have a significant effect. However, the (Mezgebo and Ewnetu, 2015) study were in line with the expected hypothesis in this study. The results showed that respondents aged over 50 years in Mutale Local Municipality, South Africa, were less willing to pay higher water services fees.

Household size is the number of family members in one household. The results in Table 2 showed that the household size variable had no significant effect. This means that every unit increase in the number of family members will not greatly affect the amount of WTP. The estimated parameter value of this variable was -3325.846. This means that the WTP paid will be reduced by 3,325.846 rupiahs for each additional member of the family. A different family number normally means an additional child (or children) and therefore that this family will incur more expenses for non-agricultural activities or primary consumption (Aydogdu, 2016; Tang et al., 2013).

(Purba et al., 2021) stated that in tidal lowlands, the agricultural sustainability index was 25.53%. This means that currently, the practice of tidal farming is still unsustainable. Tidal lowlands farmers in Muara Telang had existed since the 1960s through the transmigration program. The experience of farmers in agriculture certainly plays an influential role in the improvement and sustainability of tidal lowland agricultural production. Older farmers certainly have more extended experience than younger farmers (Bloomfield and Zahari, 1982; Łukawska-Matuszewska et al., 2018). Farmers with longer experience will consider making voluntary contributions to the sustainable operation, maintenance, and management of infrastructure, including channels, water gates, and other supporting irrigation structures.

Water management infrastructure is an important component of tidal management, which is highly dependent on water conditions (Chapman and Hall, 1996) . In Table 2, farming experience demonstrated a significant positive effect. This means that farmers who have more farming experience will have a higher willingness to pay water service fees. An increase of 1,043.242 rupiahs will occur in one unit of increased farming experience.

Some of the tidal lowland farmers in this study location still think that formal education is not important. Some farmers did not have formal educational experience. The results showed that the independent variable of education had a significant positive effect. A total of 4,017.617-rupiah WTP was seen with longer formal farmer education experience. Research by (Bakopoulou et al., 2010; Bell et al., 2014) stated that the level of education would increase the probability of someone being willing to pay voluntarily and even being willing to pay a set fee with a specific price. Education is widely considered the most important form of human capital and can significantly influence society in terms of WTP (Kanyoka et al., 2009; Schulze, 2000) . Contrary to the results of (Jones et al., 2010) study, the education variable had a negative effect. That means the higher the education, the lower a person's willingness to pay voluntarily. However, based on the specific location of the WTP of tidal land farmers, the positive influence of the education variable became more reasonable. Due to the higher education level, the awareness to pay the cost of water services fees for the operation, maintenance and management of infrastructure will certainly provide positive benefits to agricultural production (Bell et al., 2016).

WTP for water management must be carried out continuously, so management will be sustainable. At least once a year, a fee is charged to maintain water infrastructure. However, if it is undone WTP, the frequency of contributions will not be scheduled. In the (Kpadé et al., 2017; Mutaqin and Usami, 2019; Shee et al., 2020), fees for water management were ideally carried out twice a year or in every cropping season. Therefore, the groups will have savings in case of sudden damage to the water structure. The results in Table 2 showed that WTP frequency had no significant effect on alpha 5% on WTP for water. The influence of frequency was negative. This meant that the higher the frequency of payments, the lower the amount of WTP that would be paid. For every increase of one unit of WTP frequency, the money paid would decrease by 10,284.346 rupiahs.

The main income of tidal lowlands farmers in Muara Telang comes from rice farming practices. The more production is increased, the more income will increase (Bakopoulou et al., 2010; Halkos and Matsiori, 2012; Makwinja et al., 2019) . The productivity of each farmer's land varies depending on the condition of the land. The average productivity of tidal lowlands farmers in Muara Telang is 4.10 to 4.43 tons per hectare. Meanwhile, the average rice production is 8 tons per hectare (Wildayana and Armanto, 2019). Table 2 showed that productivity had a significant positive effect. For every one-unit increase in productivity, the WTP will increase by 5,027.343 rupiahs. This is rational, because if productivity increases, incomes have increased, and the rice field will need more maintenance to ensure access to water. If the channels and water structures run smoothly, agricultural lands will not have a problem (Valipour et al., 2020). This will also have the opposite effect, specifically against increasing farm production. However, in the current situation, Purba (2021) concluded that rice farming practices on tidal land are still unsustainable and need to be improved.

In (Reflis et al., 2019) research, the key to farmers' participation in paying water services fees was the distance between the rice fields and the main water source (main channel). Distance from main channels (as water resources) to fields (meters) has a significant positive effect. The estimated parameter value is highly substantial. Thus, for each additional increase in land distance to the main channel by one unit, the WTP paid will increase by 24,498 rupiahs. (Koehler et al., 2015) stated that it would require more expensive service costs if the distance were further. This makes farmers unwilling to participate in paying water fees.

Table 4 The average of farmers' WTP

	N	Min	Max	Sum	Mean		Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
WTP	235	10000	375000	23805000	101297.87	3286.023	2537517730.496
Valid N (listwise)	235						

WTP estimation was calculated based on the data distribution of respondents obtained by dividing the total WTP by the number of respondents. The results of the calculation can be seen in Table 4. The estimated WTP of Rp. 101,297.87 was applied every cropping season. This value was determined by the willingness and ability of farmers by considering WTP factors that had a significant effect. The results of this WTP estimation can provide consideration for determining policies and sustainable management of water resources, especially for tidal lowland agriculture (Cheung and Jim, 2014; Hizami et al., 2014; Kolahi et al., 2013).

Formatted: Highlight

Deleted: 3

In this research, WTP in water services fees accounted for the operation, maintenance, and management of water infrastructures such as canals and water gates. In the research of (Purba et al., 2020) in Muara Telang, the use of agricultural inputs was excessive and inefficient, affecting rice production in tidal lowlands. Not only was production affected, but it was also polluting the soil and water. Excessively chemical soil conditions will block the air aeration and water flow in the soil. This results in the growth of plant roots being automatically disrupted. The flow of water that is not smooth causes the soil to become moist, and eventually, fungus and various germs grow. This problem causes a decrease in productivity (Ikoyi et al., 2018; Imanudin and Armanto, 2012; Zhang et al., 2018).

In tidal lowlands agriculture reclamation, there are often problems with flooding, lack of water, salinity, and pyrite content, which are dangerous to rice production. In addition to these problems, inefficient inputs also raise land fertility problems, requiring regular land washing to remove the remaining chemical content in the land. Land containing pyrite, if oxidized, will constrain rice growth. In terms of sustainable development, the 2030 agenda is expected to control water pollution as an international and national priority (Mateo-Sagasta et al., 2017; Nurita and Ar-Riza, 2014; Purba et al., 2020; Shamshuddin et al., 2004). In tidal lowlands agriculture, intensive shallow canals were built to wash acidity and toxicity from the land. Therefore, maintenance of channels and other water infrastructure needs to be carried out periodically to prevent damage that can cause any problems. In addition, the operation of the floodgates must also be carried out according to water needs and the cropping calendar (Ar-Riza and Alkasuma, 2008; Suprianto et al., 2010; Widjaja-Adhi et al., 1997). This requires a large amount of money. So, WTP can be applied to reduce problems and support sustainable production.

Formatted: Highlight

Formatted: Highlight

CONCLUSION

This study concludes that WTP for water services fees can be used sustainably. This research ultimately aimed to obtain significant factors that were used as indicators in determining the willingness of farmers to pay water service fees voluntarily (WTP). Based on the scientific hypothesis proposed, the significant factors analyzed were age, farming experience, education, productivity, and distance from land to main channels, where these factors have a significant effect on WTP for water services fees. Those factors affect 86.5%, and factors outside the equation model influence the remaining 13.5%. The estimated value of WTP that can be applied is 101,298 rupiahs (7 – 8 dollars) per cropping season. The WTP collected in each cropping season can be used for capital in the operation, maintenance, and management of channels and water gates. In addition, WTP would contribute to overcoming the threats to soil and water contamination and contribute to the achievement of food safety and quality. This would ensure that the quality of the water irrigating to the land remains sound and that soil problems such as pyrite can be resolved with routine land washing. This, in turn, would help to maintain fertile growing conditions, allowing optimal land productivity. So, when food production is safe and quality is guaranteed, sustainable food production can be realized. This study is expected that the results can be used to determine the value of WTP towards sustainability and improvement of water management in tidal lowlands agriculture and further research in order to highlight further the essential factor of WTP is productivity, because it affects farmers' income where farmers will be willing to pay contributions if they have high incomes.

AUTHORS' CONTRIBUTIONS

Meitry Firdha Tafarini (MFT) wrote the manuscript, developed the theory, and performed the computations. Muhammad Yazid (MY) was the corresponding author and MY conceived this research. Muh Bambang Prayitno (MBP) and Muhammad Faizal (MF) provided guide in collected data. F.X. Suryadi (FXS) corrected the English and typewriting. Khairul Fahmi Purba (KFB) assisted in data collection. All authors discussed the result and contributed to the final manuscript.

REFERENCES

Ahmed, A., Masud, M. M., Al-Amin, A. Q., Yahaya, S. R. B., Rahman, M., and Akhtar, R. 2015. Exploring factors influencing farmers' willingness to pay (WTP) for a planned adaptation programme to address climatic issues in agricultural sectors. Environ. Sci. Pollut. Res. 22(12): 9494–9504.

Ar-Riza, I., and Alkasuma. 2008. Pertanian lahan rawa pasang surut dan strategi pengembangannya dalam era otonomi daerah (Argicultural land tidal swamp and development strategy era of regional autonomy. J. Sumberd. Lahan. 2(2): 95–104.

Formatted: Highlight

Aydogdu, M. H. 2016. Evaluation of willingness to pay for irrigation water: Harran plain sampling in gap region - turkey. Appl. Ecol. Environ. Res. 14(1): 349–365.

Baghestany, M., and Zibaei, M. 2010. Measuring Willingness of Farmers to Pay for Groundwater in Ramjerd District: Application of Contingent Valuation Method. Agric. Econ. 4(3): 41–64.

Bakopoulou, S., Polyzos, S., and Kungolos, A. 2010. Investigation of farmers' willingness to pay for using recycled water for irrigation in thessaly region, greece. Desalination 250(1): 329–334.

Bell, A. R., Shah, M. A. A., and Ward, P. S. 2014. Reimagining cost recovery in Pakistan's irrigation system through willingness-to-pay estimates for irrigation water from a discrete choice experiment. Water Resour. Res. 50: 6679–6695.

Bell, A. R., Ward, P. S., and Shah, M. A. A. 2016. Increased water charges improve efficiency and equity in an irrigation system. Ecol. Soc. 21(3): 1–13.

Bernard, H. R. 2011. *Research methods in anthropology: qualitative and quantitative approaches*. British Library Cataloguing (5th ed.). Altamira Press: United Kingdom.

Bloomfield, C., and Zahari, A. B. 1982. Acid sulphate soils. Outlook Agric. 11(2): 48–54.

Brox, J. A., Kumar, R. C., and Stollery, K. R. 1996. Willingness to pay for water quality and supply enhancements in the grand river watershed. Can. Water Resour. J. 21(3): 275–288.

Central Bureau of Statistics of Banyuasin Regency. 2017. *Banyuasin dalam angka (Banyuasin in figures) 2017*. BPS-Statistics of Banyuasin Regency: South Sumatra.

Central Bureau of Statistics of Banyuasin Regency. 2018. *Banyuasin dalam angka (Banyuasin in figures) 2018*. BPS-Statistics of Banyuasin Regency: South Sumatra.

Chapman, D., and Hall. 1996. *Water quality assessments: a guide to the use of biota, sediments and water in environmental monitoring* (2nd ed.). Great Britain at the University Press: Cambridge

Cheung, L. T. O., and Jim, C. Y. 2014. Expectations and willingness-to-pay for ecotourism services in hong kong's conservation areas. Int. J. Sustain. Dev. World Ecol. 21(2): 149–159.

Chiarini, A., and Brunetti, F. 2019. What really matters for a successful implementation of lean production? A multiple linear regression model based on european manufacturing companies. Prod. Plan. Control. 30(13): 1091–1101.

Cooper, J. C. 1993. Optimal bid selection for dichotomous choice contingent valuation surveys. J. Environ. Econ. Manag. 24: 25–40.

Field, A. 2013. *Discovering statistics using ibm spss statistics* (4th Ed.). Sage Publications Ltd.: London.

Halkos, G., and Matsiori, S. 2012. Determinants of willingness to pay for coastal zone quality improvement. J. Socio. Econ. 41(4): 391–399.

Hizami, N., Rusli, M., and Alias, R. 2014. Valuing natural resources of ecotourism destination in taman negara sungai relau, pahang, malaysia. J. Basic Appl. Sci. 8(3): 416–425.

Ikoyi, I., Fowler, A., and Schmalenberger, A. 2018. One-time phosphate fertilizer application to grassland columns modifies the soil microbiota and limits its role in ecosystem services. Sci. Total Environ. 630: 849–858.

Imanudin, M. S., and Armanto, E. 2012. Effect of water management improvement on soil nutrient content, iron and aluminum solubility at tidal low land area. APCBEE Procedia 4: 253–258.

Imanudin, M. S., Armanto, E., Susanto, R. H., and Bernas, S. M. 2010. Water table fluctuation in tidal lowland for developing agricultural water management strategies. J. Trop. Soils. 15(3): 277–282.

Imanudin, M. S., Bakri, Armanto, E., Indra, B., and Ratmini, S. N. P. 2018. Land and water management option of tidal lowland reclamation area to support rice production (A case study in delta sugihan kanan of south sumatra indonesia). J. Wetl. Environ. Manag. 6(2): 93–111.

Jones, N., Evangelinos, K., Halvadakis, C. P., Iosifides, T., and Sophoulis, C. M. 2010. Social factors influencing perceptions and willingness to pay for a market-based policy aiming on solid waste management. Resour. Conserv. Recycl. 54(9): 533–540.

Kaiser, H. F. 1970. A second-generation little jiffy*. Psychometrika. 35(4): 401–415.

Kanninen, B. J. 1993. Optimal experimental design for double-bounded dichotomous choice contingent valuation. J. L. Econ. 69(2): 138–146.

Kanyoka, P., Farolfi, S., and Morardet, S. 2009. Households' preferences and willingness to pay for multiple use water services in rural areas of south africa: An analysis based on choice modelling. Water SA. 34(6): 715–724.

Koehler, J., Thomson, P., and Hope, R. 2015. Pump-priming payments for sustainable water services in rural africa. World Dev. 74: 397–411.

Kolahi, M., Sakai, T., and Moriya, K. 2013. Ecotourism potentials for financing parks and protected areas: A perspective from iran's parks. J. Mod. Account. Audit. 9(1): 144–152.

Kpadé, C. P., Mensah, E. R., Fok, M., and Ndjeunga, J. 2017. Cotton farmers' willingness to pay for pest management services in northern Benin. Agric. Econ. (UK). 48(1): 105–114.

Lukawska-Matuszewska, Katarzyna, Graca, B., Brocławik, O., and Zalewska, T. 2018. The impact of declining oxygen conditions on pyrite accumulation in shelf sediments (baltic sea). Biogeochemistry 142(2): 209–230.

Makwinja, R., Kosamu, I. B. M., and Kaonga, C. C. 2019. Determinants and values of willingness to pay for water quality improvement: Insights from chia lagoon, malawi. Sustain. (Switzerland). 11: 1–26.

Mateo-Sagasta, J., Zadeh, S. M., Turral, H., and Burke, J. 2017. *Water pollution from agriculture: a global review.* In The Food and Agriculture Organization of The United Nations Rome and The International Water Management Institute on Behalf of The Water Land and Ecosystem Research Program Colombo.

Meijide, A., Gruening, C., Goded, I., Seufert, G., and Cescatti, A. 2017. Water management reduces greenhouse gas emissions in a Mediterranean rice paddy field. Agric. Ecosyst. Environ. 238(1): 168–178.

Mercau, J. L., Nosetto, M. D., Bert, F., Giménez, R., and Jobbágy, E. G. 2016. Shallow groundwater dynamics in the Pampas: Climate, landscape, and crop choice effects. Agric. Water Manag. 163: 159–168.

Mezgebo, G. K., and Ewnetu, Z. 2015. Households' willingness to pay for improved water services in urban areas: A case study from nebelet town, ethiopia. J. Dev. Agric. Econ. 7(1): 12–19.

Mutaqin, D. J., and Usami, K. 2019. Smallholder farmers' willingness to pay for agricultural production cost insurance in rural west java, indonesia: A contingent valuation method (cvm) approach. Risks. 7(2): 1–18.

Noor, M., and Rahman, A. 2015. Biodiversitas dan kearifan lokal dalam budidaya tanaman pangan mendukung kedaulatan pangan: kasus di lahan rawa pasang surut. Pros. Semin. Nas. Masy. Biodivers. Indones. 1(8): 1861–1867.

Nurita, and Ar-Riza, I. 2014. Peningkatan produksi padi berkelanjutan pada lahan rawa pasang surut (Increasing of sustainable rice production on swampland). J. Teknol. Pertan. 9(1): 1–7.

Pallant, J. 2016. *Spss survival manual: a step-by-step guide to data analysis using ibm spss*. (6th Ed.). British Library: England.

Prasetyo, K., Masrukan, and Sunawan. 2019. Development of mathematical literation instruments based on class iv geometry material conservation. J. Educ. Res. Eval. 8(1): 1–13.

Purba, K. F., Yazid, M., Hasmeda, M., Adriani, D., and Tafarini, M. F. 2020. Technical efficiency and factors affecting rice production in tidal lowlands of south sumatra province Indonesia. Potravin. Slovak J. Food Sci. 14: 101–111.

Purba, K. F., Yazid, M., Hasmeda, M., Adriani, D., and Tafarini, M. F. 2021. The sustainability of rice farming practices in tidal swamplands of south sumatra indonesia. Potravin. Slovak J. Food Sci. 15: 9–17.

Reflis, Sjarkowi, F., Sriati, and Susetyo, D. 2019. Farmers' participation for irrigation water resources services fee, kapahiang regency bengkulu province-indonesia. International J. Ecol. Environ. Conserv. 25(2): 527–536.

Schulze, R. E. 2000. Modelling Hydrological Responses to Land Use and Climate Change: A Southern African Perspective. AMBIO A J. Hum. Environ. 29(1): 12–22.

Shamshuddin, J., Muhrizal, S., Fauziah, I., and Van Ranst, E. 2004. A laboratory study of pyrite oxidation in acid sulfate soils. Commun. Soil Sci. Plant Anal. 35(1–2): 117–129.

Sharma, S., and Henriques, I. 2005. Stakeholder influences on sustainability practices in the canadian forest products industry. Strateg. Manag. J. 26(2): 159–180.

Shee, A., Azzarri, C., and Haile, B. 2020. Farmers'willingness to pay for improved agricultural technologies: Evidence from a field experiment in Tanzania. Sustain. (Switzerland). 12(1): 1–13.

Formatted: Highlight

Suprianto, H., Ravaie, E., Irianto, S. G., Susanto, R. H., Schultz, B., Suryadi, F. X., and Eelaart, A. Van Den. 2010. Land and water management of tidal lowlands: experiences in telang and saleh, south sumatra. J. Irrig. Drain. 59: 317–335.

Suryadi, F. X. 1996. Soil and Water Management Strategies for Tidal Lowlands in Indonesia. (Doctoral dissertation), UNESCO-IHE Institute for Water Education, Delft.

Tafarini, M. F., and Yazid, M. 2019. Sustainable Water Management in Tidal Lowland Agriculture: A Research Agenda. Sriwij. J. Environ. 3(3): 102–107.

Tang, Z., Nan, Z., and Liu, J. 2013. The willingness to pay for irrigation water: A case study in northwest china. Glob. NEST J. 15(1): 76–84.

Tranmer, M., Murphy, J., Elliot, M., and Pampaka, M. 2020. *Multiple linear regression* (2nd Ed.). Cathie Marsh Institute Working Paper 2020-01.

Valipour, M., Krasilnikof, J., Yannopoulos, S., Kumar, R., Deng, J., Roccaro, P., Mays, L., Grismer, M. E., and Angelakis, A. N. 2020. The evolution of agricultural drainage from the earliest times to the present. Sustain. (Switzerland). 12(1): 1–30.

Weisberg, S. 2005. *Applied linear regression* (3rd Ed.). John Wiley & Sons, Inc.: New Jersey.

Whittington, D., Briscoe, J., Xinming Mu, and Barron, W. 1990. Estimating the willingness to pay for water services in developing countries: A case study of the use of contingent valuation surveys in southern Haiti. Econ. Dev. Cult. Chang. 38(2): 293–311.

Widjaja-Adhi, I., Ratmini, NP. S., and Swastika, I. W. 1997. *Pengelolaan tanah dan air di lahan pasang surut (Soil and water management in tidal lowlands)*. Proyek Penelitian Pengembangan Pertanian Rawa Terpadu-ISDP Badan Penelitian dan Pengembangan Pertanian.

Wildayana, E., and Armanto, M. E. 2019. The role of subsidized fertilizers on rice production and income of farmers in various land typologies. J. Ekon. Pembang. Kaji. Masal. Ekon. Pembang. 20(1): 100–107.

Yazid, M., Shamsudin, M. N., Rahim, K. A., Radam, A., and Muda, A. 2015. Water service valuation in tidal lowland agriculture. Pertanika J. Soc. Sci. Humanit. 23: 39–46.

Zhang, L., Yan, C., Guo, Q., Zhang, J., and Ruiz-Menjivar, J. 2018. The impact of agricultural chemical inputs on environment: Global evidence from informetrics analysis and visualization. Int. J. Low-Carbon Technol. 13(4): 338–352.

Acknowledgement:

The authors wish to thank the Directorate General of Science and Technology Resources and the Directorate of Research and Community Service in the Ministry of Research, Technology and Higher Education of Indonesia through PMDSU (*Pendidikan Magister Menuju Doktor Untuk Sarjana Unggul*) for funding these research grants by letter number

068/SP2H/AMD/LT/DRPM/2020. The authors also would like to express great thanks to the IHE Delft Institute For Water Education, which facilitated the implementation of the PKPI (sandwich-like) program.

Conflict of Interest:

The authors declare no conflict of interest.

Ethical Statement:

This article does not contain any studies that would require an ethical statement.

Deleted: **Contact Address:**

Meitry Firdha Tafarini, Universitas Sriwijaya, Faculty of Agriculture, Department of Agribusiness, Jl. Palembang-Prabumulih KM. 32, 30662, Indralaya, South Sumatra, Indonesia, Tel. + 6281369699331,
E-mail: meitrytafarini@student.pps.unsri.ac.id
ORCID: https://orcid.org/0000-0002-9857-1367

*Muhammad Yazid, Universitas Sriwijaya, Faculty of Agriculture, Department of Agribusiness, Jl. Palembang-Prabumulih KM. 32, 30662, Indralaya, South Sumatra, Indonesia, Tel. + 628153800550,
E-mail: yazid_ppmal@yahoo.com
ORCID: https://orcid.org/0000-0003-0374-9132

Muh Bambang Prayitno, Universitas Sriwijaya, Faculty of Agriculture, Department of Soil Sciences, Jl. Palembang-Prabumulih KM. 32, 30662, Indralaya, South Sumatra, Indonesia, Tel. + 6281373291625,
E-mail: muhbambang_prayitno@yahoo.com
ORCID: https://orcid.org/0000-0002-1517-3065

Muhammad Faizal, Universitas Sriwijaya, Faculty of Agriculture, Department of Chemical Engineering, Jl. Palembang-Prabumulih KM. 32, 30662, Indralaya, South Sumatra, Indonesia, Tel. + 62811712582,
E-mail: mfaizal1405@gmail.com
ORCID: https://orcid.org/0000-0002-1256-1150

Fransiscus Xaverius Suryadi, IHE Delft Institute for Water Education, Department of Land and Water Development, Westvest 7, 2611 AX, Delft, The Netherlands, Tel. +31615262368,
E-mail: f.suryadi@un-ihe.org
ORCID: https://orcid.org/0000-0003-2643-9241

Khairul Fahmi Purba, Universitas Sriwijaya, Faculty of Agriculture, Department of Agribusiness, Jl. Palembang-Prabumulih KM. 32, 30662, Indralaya, South Sumatra, Indonesia, Tel. + 6283196328464,
E-mail: khairulfahmi@student.pps.unsri.ac.id
ORCID: https://orcid.org/0000-0003-2982-5041

Corresponding author: *

Acceptance Letter

(13 Januari 2022)

January 13, 2022

Dear Meitry Firdha Tafarini

I am pleased to inform you that your manuscript titled as "Willingness to pay for water management to support sustainable food production in tidal lowlands of South Sumatra, Indonesia" (Manuscript Number: EJFA-2021-10-434 was accepted for publication in the Emirates Journal of Food and Agriculture.
As we declared in "Instructions for Authors", you need to contribute to Emirates Journal of Food and Agriculture for Publication Fee (APC).

For this purpose you should pay the following amount: 1000 AED .

In order to make payment, login to https://cfa.uaeu.ac.ae/en/research/ejfa/journal_payment/journal_payment.shtml and make your payment by your credit/debit card.
After successful payment, kindly send the receipt to ejfa@uaeu.ac.ae in order to process article for online publication.

Sincerely yours,

Editor
Emirates Journal of Food and Agriculture
www.ejfa.me

Impact Factor: 1.04
2020 Journal Citation ReportsÂ® (Clarivate Analytics, 2021)

Proof and Response of Manuscript

(22-23 Januari 2022)

proof of article

Dari: Asha Antony (ashaantony99@uaeu.ac.ae)

Kepada: yazid_ppmal@yahoo.com

Cc: ejfa@uaeu.ac.ae

Tanggal: Sabtu, 22 Januari 2022 03.49 GMT+7

Dear Author,

The proof of your article, to be published in Emirates Journal of Food and Agriculture, is attached to this e-mail as a 'PDF' file.

Please carefully check highlighted areas in proof (if any).

If there is already published source like tables or figures in your article, we need permission letter from the previous publisher. Submit the letter together with the proof, without which the article will not be published.

Author (s) is (are) solely responsible for authenticity of cited literature and originality of data being reported. Editorial office will not be responsible for any conflicts. Please see the Editorial Policies here http://www.ejfa.me/?page=policyjournal

Also, please crosscheck the reference list with cited ones in the text, if some missing or incorrect, the article publication will be delayed.

Method of returning proof corrections: You may list the corrections in an e-mail and return them to us using the 'reply' button to this e-mail. Please list your corrections quoting line/page number. If, for any reason, this is not possible, mark the corrections and any other comments on a printout of your proof and scan and attach using the 'reply' button to this e-mail. Please use this proof for checking the typesetting, editing, completeness, and correctness of the text, tables, and figures. For your help a checklist is given below. Significant changes to the article as accepted for publication will only be considered at this stage with permission from the Editor.

Checklist

1. Spelling mistakes
2. Check the author names and affiliations
3. Any deletion during editing
4. Shifting of paragraphs on wrong place etc.
5. All figures and tables are cited in text and also provide in paper
6. All references cited in text are present in list and vise versa
7. References are according to format of journal
8. Scientific names are in italic format
9. Any other mistake to be corrected before publication.

We prefer to receive your corrections by e-mail so that we can process your article quickly and efficiently. We will do everything possible to get your article published quickly and accurately.

Therefore, please approve the proof, or return any corrections in one communication within five days of the sending (not receipt) of this email. In the case that you find no problems and agree with the publication of this attached version, you are also expected to let us know by sending us a message. Any delay in responding means that you totally accept the present form of and all the modifications involved in your manuscript; then editorial office reserve the right in publication of your article without further corrections / or shifting to another issue.

Please check carefully before replying, as inclusion of any subsequent corrections cannot be guaranteed.

After this stage author (s) will be responsible for any mistake in the final manuscript.

With Regards,

Editorial Office
Emirates Journal of Food and Agriculture
College of Agriculture & Veterinary Medicine
PO Box 15551, Al-Ain, UAE
T +971 3 713 4576, F+971 3 763 2384
ejfa@uaeu.ac.ae; www.uaeu.ac.ae

Dr. Asha Antony
BVSc & AH, MVSc.

Instructor

Department of Veterinary Medicine,

College of Agriculture & Veterinary Medicine,

United Arab Emirates University,

P.O. Box No. 15551, Al Ain, UAE

Tel: 03-7134572

Email: ashaantony99@uaeu.ac.ae

اشا انطوني

محاضر

قسم الطب البيطري

ص ب 15551، العين، الإمارات العربية المتحدة

هاتف: 03-7134572

EJFA_2021_10_434_Meitry_20220121_V0.pdf
1.2MB

Re: proof of article

Dari: M Yazid (yazid_ppmal@yahoo.com)

Kepada: ashaantony99@uaeu.ac.ae

Tanggal: Minggu, 23 Januari 2022 22.22 GMT+7

Dear Editorial Office
Emirates Journal of Food and Agriculture

Thank you for the proof of our article. We have carefully checked the highlighted areas in proof and made some corrections as suggested. Here are the responses to author queries and other corrections:
Authors' Responses:
AQ1: Kindly provide article type
Research Article

AQ2: Kindly provide Received and Accepted date
Received: October 20, 2021
Accepted: January 13, 2022

AQ3: Kindly cite figure 3 in the text part
Figure 3 has been cited on page 11, line 239

AQ4: Kindly cite table 4 in the text part.
The text has been corrected and Table 4 has been cited in the text on page 19, line 390

AQ5: Kindly check the placement of the text part
The authors' affiliation has been written on the page 1, line 7

AQ6: Kindly provide author initial
AQ6 a has been corrected on page 21, line 456. It had been cited on page 20, line 415
AQ6 b, the author's name has no initial. It had been cited on page 20, line 411

Other corrections:

- On page 2, line 31, The last sentence of the abstract is followed by a dot
- The sentences on page 5, lines 123-125 have been corrected to be "This study used tidal lowland farmers as research subjects (respondents). Respondents are farmers who own land and organize agricultural activities in Telang Karya Village and Telang Rejo Village"
- The word "was" has been added on page 6, line 127
- The word "amount" has been corrected to be "number" on page 11, line 240
- On page 12, line 249, the word "gender" is followed by comma

The revised manuscript is attached in this email. We are looking forward for the final proof of our article before publishing. Please let us know if there is anything else needed.

With Regards,

Muhammad Yazid

Pada Sabtu, 22 Januari 2022 03.49.14 GMT+7, Asha Antony <ashaantony99@uaeu.ac.ae> menulis:

Dear Author,
The proof of your article, to be published in Emirates Journal of Food and Agriculture, is attached to this e-mail as a 'PDF' file.
Please carefully check highlighted areas in proof (if any).
If there is already published source like tables or figures in your article, we need permission letter from the previous publisher. Submit the letter together with the proof, without which the article will not be published.
Author (s) is (are) solely responsible for authenticity of cited literature and originality of data being reported. Editorial office will not be responsible for any conflicts. Please see the Editorial Policies here http://www.ejfa.me/?page=policyjournal
Also, please crosscheck the reference list with cited ones in the text, if some missing or incorrect, the article publication will be delayed.
Method of returning proof corrections: You may list the corrections in an e-mail and return them to us using the 'reply' button to this e-mail. Please list your corrections quoting line/page number. If, for any reason, this is not possible, mark the corrections and any other comments on a printout of your proof and scan and attach using the 'reply' button to this e-mail. Please use this proof for checking the typesetting, editing, completeness, and correctness of the text, tables, and figures. For your help a checklist is given below. Significant changes to the article as accepted for publication will only be considered at this stage with permission from the Editor.
Checklist
1. Spelling mistakes
2. Check the author names and affiliations
3. Any deletion during editing
4. Shifting of paragraphs on wrong place etc.
5. All figures and tables are cited in text and also provide in paper
6. All references cited in text are present in list and vise versa
7. References are according to format of journal
8. Scientific names are in italic format
9. Any other mistake to be corrected before publication.
We prefer to receive your corrections by e-mail so that we can process your article quickly and efficiently. We will do everything possible to get your article published quickly and accurately.
Therefore, please approve the proof, or return any corrections in one communication within five days of the sending (not receipt) of this email. In the case that you find no problems and agree with the publication of this attached version, you are also expected to let us know by sending us a message.
Any delay in responding means that you totally accept the present form of and all the modifications involved in your manuscript; then editorial office reserve the right in publication of your article without further corrections / or shifting to another issue.
Please check carefully before replying, as inclusion of any subsequent corrections cannot be guaranteed. After this stage author (s) will be responsible for any mistake in the final manuscript.
With Regards,
Editorial Office
Emirates Journal of Food and Agriculture
College of Agriculture & Veterinary Medicine
PO Box 15551, Al-Ain, UAE
T +971 3 713 4576, F+971 3 763 2384

ejfa@uaeu.ac.ae; www.uaeu.ac.ae

Dr. Asha Antony
BVSc & AH, MVSc.
Instructor
Department of Veterinary Medicine,
College of Agriculture & Veterinary Medicine,
United Arab Emirates University,
P.O. Box No. 15551, Al Ain, UAE

Tel: 03-7134572

Email: ashaantony99@uaeu.ac.ae

اشا انطوني

محاضر

قسم الطب البيطري

ص ب 15551، العين، الإمارات العربية المتحدة

هاتف: 03-7134572

137-1634706550.docx
1.8MB

Final Manuscript

Emirates Journal of Food and Agriculture. 2021. 33(12): 1008-1017
doi: 10.9755/ejfa.2021.v33.i12.2789
http://www.ejfa.me/

RESEARCH ARTICLE

Willingness to pay for water management to support sustainable food production in tidal lowlands of South Sumatra, Indonesia

Meitry Firdha Tafarini[1], Muhammad Yazid[1]*, Muh. Bambang Prayitno[2], Muhammad Faizal[3], Fransiscus Xaverius Suryadi[4], and Khairul Fahmi Purba[1]

[1]Department of Agribusiness, Faculty of Agriculture, Universitas Sriwijaya, Jalan Palembang-Prabumulih KM 32, Indralaya, South Sumatra, Indonesia, [2]Department of Soil Science, Faculty of Agriculture, Universitas Sriwijaya, Jalan Palembang-Prabumulih KM 32, Indralaya, South Sumatra, Indonesia, [3]Department of Chemical Engineering, Faculty of Engineering, Universitas Sriwijaya, Jalan Palembang-Prabumulih KM 32, Indralaya, South Sumatra, Indonesia, [4]Department of Land and Water Development, Water Science and Engineering, UNESCO IHE, Delft, The Netherlands

ABSTRACT

Operations and maintenance (OM) of water infrastructure cannot be separated from the role of farmers' water users associations (WUA) or farmer groups. OM needs to be supported not only skillfully but also financially. This research aimed to assess and identify several factors affecting self-financing in water management in tidal lowlands agriculture, using the Willingness To Pay (WTP) approach. The sample size of this research was 245 respondents, all of which are active members of WUA or farmer groups. Primary data were collected using direct interviews with structured questionnaires, and secondary data were collected from some related agencies. The data were analyzed using Exploratory Factor Analysis (EFA) and Multiple Linear Regression analyses. Regression analysis formally tested the factors and identified the selected significant factors. KMO and Bartlett's Test result was 0.587 > 0.5 (alpha), indicating significance. The R^2 (0.86) showed that the independent variables simultaneously explained the dependent variable (Y_{WTP}). From seven independent variables, five variables significantly affect the willingness to pay for water management. This WTP is expected to ensure sustainable food production in tidal lowlands since water availability is crucial in tidal lowland agriculture.

Keywords: Water; WTP; EFA; multiple linear regression; tidal lowlands.

INTRODUCTION

Tidal lowlands are wetlands ecosystems with inundated land characteristics and are influenced by high and low water tides but not river water. Meanwhile, river water also rises as a result of the retention of river water by high tides. Tidal lowland also has valuable characteristics and potential as an agricultural resource, mostly for food crops (Noor and Rahman, 2015; Tafarini and Yazid, 2019). The tidal lowlands in South Sumatra are considered to be a food barn with an area of 266,674 hectares in 2017, including 161,908 hectares of tidal lowlands in Banyuasin Regency. Food production (rice) in tidal lowlands in Banyuasin Regency in 2017, was 1,038,489.34 tons (Central Bureau of Statistics of Banyuasin Regency, 2018). Meanwhile, the demand for food continues to increase at a rate equivalent to population increase; thus, the region continues to strive to improve food production (rice). However, rice production in 2017 decreased from the previous year (2016) by 1,302,229.7 tons (Central Bureau of Statistics of Banyuasin Regency, 2017).

Tidal lowland is highly dependent on high and low water tides, so it requires a proper plan, management (especially aspects of water management through water channels), and utilization of land management and infrastructure technology. This is to allow it to be distributed appropriately to the rice field (Imanudin et al., 2010). Water management for rice cultivation is needed to maximize productivity (Imanudin et al., 2018). However, the current problem is the improper application of water management. A land far from the main channel often experiences water shortages, especially during the dry season. Meanwhile, some lands

***Corresponding author:**
Muhammad Yazid, Universitas Sriwijaya, Faculty of Agriculture, Department of Agribusiness, Jl. Palembang-Prabumulih KM. 32, 30662, Indralaya, South Sumatra, Indonesia. **E-mail:** yazid_ppmal@yahoo.com

Received: 20 October 2021; **Accepted:** 14 December 2021

experience flooding, due to the drainage system's handling with improper operation of floodgates in the rainy season (Mercau et al., 2016). Farmers do not implement the micro water system (quaternary channel or worm channels), even though channels' functions can regularly distribute and store water for plants in the tertiary channel's middle position. The primary key to this problem is the appropriate and sustainable water management application from micro and macro water system levels, supported by suitable infrastructure (Meijide et al., 2017). Restoration and maintenance of water infrastructures incur many costs, and this situation needs the role of farmers. Do farmers have enough capital and able to do self-financing the water management for their land, or do they need cooperation between other farmer organizations such as WUA or farmer groups' role? This study will identify whether farmers are willing to contribute to water services fees for sustainable water management by applying the Willingness to Pay (WTP) approach.

The maximum amount an individual agrees to pay for a good or service without losing its utility is the definition of WTP (Baghestany and Zibaei, 2010; Cooper, 1993; Kanninen, 1993). WTP reflects the WUA's perceptions toward the existence and importance of water resources necessary for the active participation of WUA to contribute to WTP (Whittington et al., 1990). Because there are options for restoring and maintaining water infrastructure through WUA as a sustainable agriculture scheme, the goal is to increase production. It is crucial to know whether farmers are willing to pay water management fees, as well as the factors that affect their willingness to pay (WTP). This study aimed to estimate farmers' OP self-financing potential to increase water use efficiency and estimate water services' value to support water service fee applications. To achieve these goals, the study used an exploratory factor analysis (EFA) model to determine which indicators were the main foci of farmers willing to pay the cost of water services.

Productivity, income, and socio-economic characteristics of farmer households affect WTP's amount as a fee for water management services. In addition, the amount is also influenced by the general characteristics of farmers such as age, gender, length of education, number of family members, type of house, general environmental awareness, land area, and land ownership status, role in maintaining water infrastructure, and distance of land to rivers (Brox et al., 1996; Reflis et al., 2019; Yazid et al., 2015). A farmer's WTP depends on many interrelated factors. To assess the farmer's WTP, this study used two-approach categories that were disclosed and stated. Those approaches directly provided an unbiased estimate of WTP from respondent farmers (Shee et al., 2020). However, the water user association (WUA), which was formed to manage the system's operation and maintenance, has not implemented a water service fee for the continuity of repair and maintenance of water structures, because there is no objective measure. Thus, in this paper, the researcher describes the results of exploratory factor analysis (EFA) to obtain objective indicators that are formerly analyzed by regression equations. The multiple linear regression model results in the number of factors used, how relevant decisions are presented for interpretation. The results of the research indicated which factors affect the farmers' WTP. The conclusions help in drawing an estimate of the average amount of WTP that farmers can pay.

Scientific hypothesis

This study hypothesis is that socio-economic factors such as age, household size, farming experience, education, frequency of WTP, productivity, and distance from land to main channels, influence the farmers' WTP on a water services fee.

MATERIALS AND METHOD

Study area

This research was conducted in two villages in the tidal area, Telang Karya and Telang Rejo, Muara Telang District (Primary 8, Delta Telang I), Banyuasin Regency, South Sumatra. Those villages are the largest and have the highest rice production compared to other villages in Muara Telang District. The typology of tidal lowland in these two villages is A-type. The tidal lowland A-type is a land that can be inundated by high tide at least 4 or 5 times during the tidal cycle for 14 days, both in the rainy and dry seasons.

These areas are primarily located in basins or close to the mouth of a river (Suprianto et al., 2010; Suryadi, 1996). The research location is the most productive area for food crops (rice). Production is supported by an irrigation system using secondary and tertiary blocks, some of which are equipped with water-management infrastructure. The research location can be seen in Fig. 1.

Samples and data collection

This study used tidal lowland farmers as research subjects (respondents). Respondents are farmers who own land and organize agricultural activities in Telang Karya Village and Telang Rejo Village. The total sample was 245 respondents (n = 245) of farmers.

Data were collected between the middle and end of 2019. Data information from sample farmers was interviewed using questionnaires and purposive sampling technique or judgment sampling. Purposive sampling was undertaken deliberately, based on the requirements and quality of the respondents. The researcher had defined the criteria according to the information required (Bernard, 2011).

Fig 1. Tidal lowland canals condition in Muara Telang Sub District.

The farmers who became respondents were tidal lowland farmers with a minimal of 0.5 Ha of rice field in Telang Karya and or Telang Rejo Villages, and members of a farmer group, with at least one year of farming experience, who were willing to pay for water management.

Data collected for factors affecting WTP were socio-economic characteristics. The socio-economic characteristics consist of age, household size, farming experience, education, frequency of WTP, land distance to main channels, and productivity. Furthermore, data collected for measuring ATP used rice production data to calculate each farmer's income every planting season.

Questionnaire preparation

The design of the questionnaire was carried out to collect exploratory information from the respondents. The number of questions in the questionnaire were 12 questions related to the variables used in this study. Respondents were given the flexibility to answer, and no answer choices provided, because the questions presented were open questionnaires. The information collected is in the form of qualitative and quantitative information. The questionnaire was a formal standard questionnaire because researchers will test and measure hypotheses and data by statistical analysis. Therefore, questions on the questionnaire were made according to the variables used to test the hypothesis. The variables used include the following:

Data Analysis

Water services fees in this study were costs used to carry out the operation, maintenance, and management (OMM) of agricultural water tidal lowland irrigation infrastructures. In this study, the factors of WTP were analyzed by exploratory factor analysis (EFA) to reduce the number of variables. Exploratory factor analysis (EFA) is a statistical technique commonly used in questionnaire development and analysis (Field, 2013; Sharma and Henriques, 2005). To identify whether the indicators used are sufficient for factor analysis, the value of Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) test was assessed for multicollinearity. Then the selected variables will be analyzed by multiple linear regression.

Multiple linear regression was used for identifying the relationship of dependent and independent variables with more than one explanatory variable. In social sciences research, this analysis is a suitable method to solve social problems (Chiarini and Brunetti, 2019; Tranmer et al., 2020). The general equation for multiple linear regression is as follows:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_n X_{ni} + e \qquad (1)$$

The dependent variable (Y) in this research is the amount of WTP that a farmer pays for a year (two planting seasons). The socio-economic characteristics of rice farmers in tidal lowlands were used for independent variables (X). (Ahmed et al., 2015; Reflis et al., 2019) presented the socio-economic characteristics of farmers that influenced WTP. Therefore, age (X_1), household size (X_2), farming experience (X_3), education (X_4), frequency of WTP (X_5), productivity (X_6), and distance from land to main channels (X_7) were used. The equation of multiple regression created in this study was:

$$Y_{WTP} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e \qquad (2)$$

where Y_{WTP} denotes the amount of WTP (rupiah/year). β_0 is intercept of model. $\beta_1 \ldots \beta_7$ are estimated parameters. Then, X_1, X_2, X_3, X_4, X_5, X_6, and X_7 represent independent variables (socio-economic characteristics). e indicates error term. Hypotheses for the regression analysis were:

1. Simultaneous hypotheses using F value or F significance value. Simultaneous hypotheses decisions are seen from the significance value. If the significance F-value $< \alpha_{(0.05)}$, the hypothesis H_0 is accepted. Here are the hypotheses:
   H_0: Farmers' socio-economic factors simultaneously have a significant effect on their willingness to pay (WTP) for water services fees.
   H_1: Farmers' socio-economic factors simultaneously have no significant effect on their willingness to pay (WTP) for water services fees.

2. Partial hypotheses using t value or t significance value. If the significance t value of each independent

variables < $\alpha_{(0.05)}$, the hypothesis H_2 is accepted. Here are the hypotheses:

H_1: Farmers' socio-economic factors have no significant effect on their willingness to pay (WTP) for water services fees.

H_2: Farmers' socio-economic factors have a significant effect on their willingness to pay (WTP) for water services fees.

Multiple linear regression analysis must fulfill the classical assumptions. According to (Weisberg, 2005), the classical assumptions that must be met are as follows:

1. The normality assumption is identified by looking at a histogram or a Q-Q plot.
2. Multicollinearity can be checked through the tolerance value of each independent variable—the value should be higher than 0.10 and VIF should less than 10.

Homoscedasticity assumption can be identified by a scatterplot of residuals versus predicted values.

Statistical Analysis

This study used three statistical analyses. First, the descriptive analysis was performed using Microsoft Excel 2016. The second and third analyses involved Exploratory Factor Analysis (EFA) and parametric data analyses (Multiple Linear Regression). The sample data collected were entered and screened using SPSS 23 to analyze factors affecting the WTP of rice farmers in water services fees. The significance (α) for this study used 5%. The *p*-value is expected less than 0.05 ($p < 0.05$).

RESULTS AND DISCUSSION

Socio-economic characteristics of rice farmers

The total respondents in this research were 235 farmers. The respondents are tidal land farmers in Telang Karya and Telang Rejo villages, Muara Telang sub-district, Banyuasin District, South Sumatra. The following is a diagram that presents the age range of farmers and their relationship with their old farming experience based on the results of the interview:

Based on Fig. 2, there were 30 farmers under the age of 30 with 15 years of average farming experience. In age ranges, 31-38 years, 39-46 years, 47-54 years, 55-62 years as many as 36, 65, 59, and 36 farmers had an average farming experience of 18, 23, 29, and 32 years respectively. Meanwhile, there were 9 farmers over 62 years old with an average farming experience of 29 years. The relationship between farming experience and farmer's age as illustrated in Fig. 2. The higher the age of the farmer, the longer the farmer has experience in farming.

Fig. 3 showed 235 respondents who willing to pay water management fees (WTP). The amount of fees offered by respondents varied widely. More than half of the respondents, 144 farmers, were willing to pay dues in the range of Rp 50,001 – Rp 100,000. A small proportion of respondents, 55 farmers, chose to pay a fee of ≤ Rp 50,000. Those who were willing to pay dues ranging from Rp 100,001 – Rp 150,000; Rp 150,001 – Rp 200,000; and ≥ Rp 200,001 were 15, 14, and 7 respondents respectively. This shows that, on average, farmers were more likely to pay fees ranging from Rp 50,000 to Rp 100,000. Only 15.32% of the respondents were willing to pay higher than the average value of willingness to pay (rupiah).

Exploratory factor analysis (EFA)

The factors analyzed using EFA were age, gender, household size, farming experience, education, type of WTP, frequency of WTP, farmers' role in OM, productivity, and distance from land to main channels, all of which influence the farmers' WTP on water services fee.

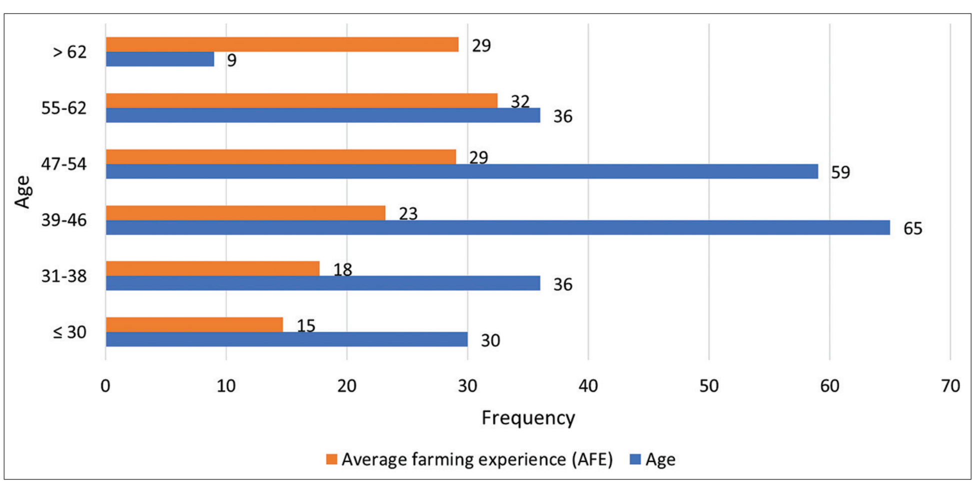

Fig 2. Age of farmers & average farming experience (AFE).

Table 1 shows the results of the Exploratory Factor Analysis (EFA). The value of Bartlett's Test of Sphericity was seen from its significance of $p < 0.05$ or $0.000 < 0.05$, which means that the correlation between the indicators was acceptable for factor analysis. The KMO test was used to demonstrate multicollinearity. The KMO test also helps ensure the fitness of the indicators used for factor analysis. Factor analysis will be appropriate if the KMO value is > 0.60 (Pallant, 2016). Based on Table 1, the KMO value of 0.608 showed that the data do not have any significant multicollinearity problems, so the indicators can be used for further analysis (Kaiser, 1970; Prasetyo et al., 2019). This analysis reduced 10 variables to 7 variables, which will be used in multiple linear analyses.

Factors influencing WTP on water services fees

The amount of WTP is affected by several factors. In order to estimate the influence of the factors on WTP, a multiple linear regression is employed using the following equation. The results of the estimation are presented in Table 2.

$$Y_{WTP} = 102108.020 - 1789.067\,X_1 - 3325.846\,X_2 + 1043.242\,X_3 + 4017.617\,X_4 - 10284.346\,X_5 + 5027.343\,X_6 + 24.498\,X_7 + e \quad (3)$$

The coefficient of determination (R^2) is considerably high. This indicates that 86.50 percent of the variation in the amount of WTP is elaborated simultaneously by the independent variables. Based on the value of t-statistics, the independent variables that proved to contribute significantly to this variation are age (X_1), household size (X_2), farming experience (X_3), education (X_4), frequency of WTP (X_5), productivity (X_6), and distance from land to main channels (X_7).

Based on the result from Table 2, B is the estimation parameter, Sig. value is the significance value of each independent variable, and tolerance & VIF are classical assumptions of multicollinearity. Three classical assumptions in the regression analysis were made with the following results:

1. Data normality showed in Fig. 4: P-P plot. The points in Fig. 4 approach the straight diagonal line without any length to the right or left of the line.
2. Multicollinearity can be checked through tolerance value and VIF showed in Table 2. In Table 2, tolerance values are higher than 0.1 and VIF values are less than 10.00. It indicates that each independent variable doesn't occur with multicollinearity.
3. The homoscedasticity assumption scatterplot is shown in Fig. 5. There is no clear pattern; the dots spread above and the number 0 is on the Y-axis below. It indicates that there is no heteroscedasticity.

Table 1: Variables of factors affecting WTP

No.	Variables	Unit	Explanation
1.	Age	year	Age of sample farmer
2.	Household size	person	Number of family members borne by the head of the sample farmer family
3.	Farming experience	year	The amount of time the sample farmers organize agriculture
4.	Education	year	Last formal education of sample farmer
5.	Frequency of WTP	times	A measure of the number of times the sample farmers paid WTP
6.	Land distance	meter	Land distance to main drainage channel
7.	Productivity	$ton.ha^{-1}$	The ability or carrying capacity of agricultural land in producing rice crops

Table 2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.608
Bartlett's Test of Sphericity	
Approx. Chi-Square	407.539
df	66
Sig.	0.000

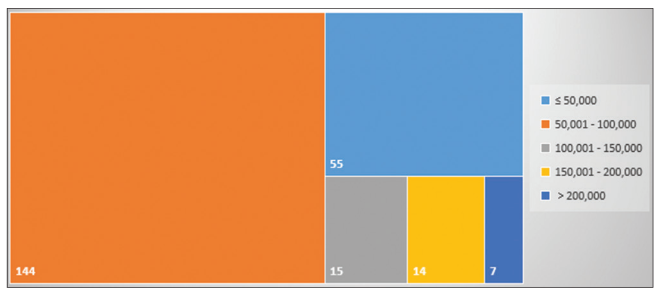

Fig 3. Willingness to Pay (Rupiah).

Based on the significant value of each independent variable, from seven variables, five variables had a significant effect on the dependent variable (Y_{WTP}). The significant variables had a sig value < α (0.05). Variables that had no significant effect were the household size and frequency of WTP. Meanwhile, the independent variables age, farming experience, education, productivity, and distance to the main channel significantly affected the WTP of farmers for water services fees (Halkos and Matsiori, 2012; Makwinja et al., 2019; Reflis et al., 2019).

The independent variable of age has a significant negative influence on the dependent variable (WTP). The estimated parameter value is -1789.067. This means that the higher farmers' age, the lower the willingness to pay for water services fees. The WTP value paid will decrease by 1,789.067 rupiahs for each increase in the farmer's age unit. This contradicts with (Bell et al., 2014), research on WTP in irrigation systems in Pakistan. The results of their studies stated that the higher the age of the farmer, the

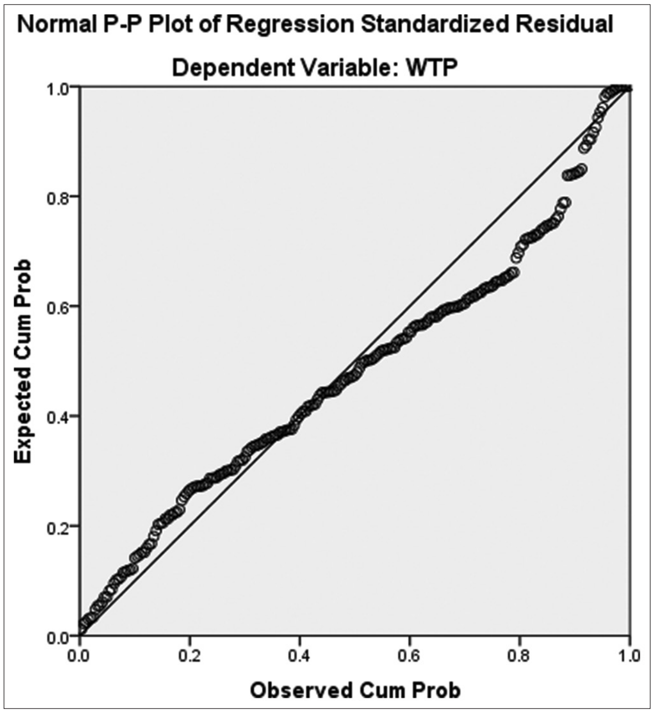

Fig 4. P-P plot for data normality.

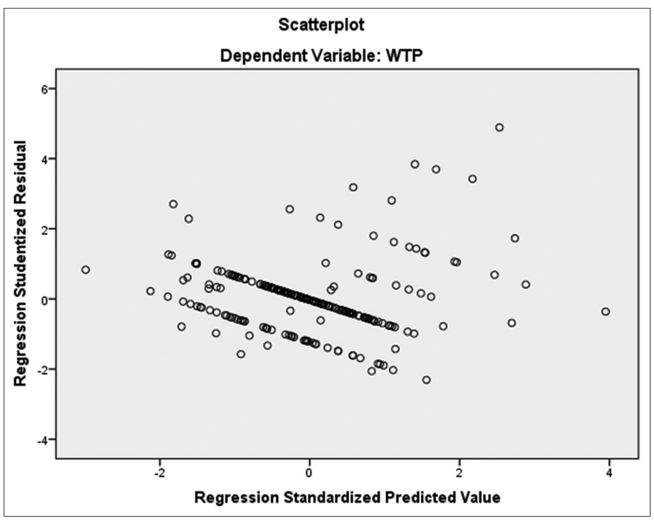

Fig 5. Scatterplot for homoscedasticity.

higher their willingness to pay. In addition, the age variable in the study did not have a significant effect. However, the (Mezgebo and Ewnetu, 2015) study were in line with the expected hypothesis in this study. The results showed that respondents aged over 50 years in Mutale Local Municipality, South Africa, were less willing to pay higher water services fees.

Household size is the number of family members in one household. The results in Table 2 showed that the household size variable had no significant effect. This means that every unit increase in the number of family members will not greatly affect the amount of WTP. The estimated parameter value of this variable was -3325.846. This means that the WTP paid will be reduced by 3,325.846 rupiahs for each additional member of the family. A different family number normally means an additional child (or children) and therefore that this family will incur more expenses for non-agricultural activities or primary consumption (Aydogdu, 2016; Tang et al., 2013).

(Purba et al., 2021) stated that in tidal lowlands, the agricultural sustainability index was 25.53%. This means that currently, the practice of tidal farming is still unsustainable. Tidal lowlands farmers in Muara Telang had existed since the 1960s through the transmigration program. The experience of farmers in agriculture certainly plays an influential role in the improvement and sustainability of tidal lowland agricultural production. Older farmers certainly have more extended experience than younger farmers (Bloomfield and Zahari, 1982; Łukawska-Matuszewska et al., 2018). Farmers with longer experience will consider making voluntary contributions to the sustainable operation, maintenance, and management of infrastructure, including channels, water gates, and other supporting irrigation structures. Water management infrastructure is an important component of tidal management, which is highly dependent on water conditions (Chapman and Hall, 1996). In Table 2, farming experience demonstrated a significant positive effect. This means that farmers who have more farming experience will have a higher willingness to pay water service fees. An increase of 1,043.242 rupiahs will occur in one unit of increased farming experience.

Some of the tidal lowland farmers in this study location still think that formal education is not important. Some farmers did not have formal educational experience. The results showed that the independent variable of education had a significant positive effect. A total of 4,017.617-rupiah WTP was seen with longer formal farmer education experience. Research by (Bakopoulou et al., 2010; Bell et al., 2014) stated that the level of education would increase the probability of someone being willing to pay voluntarily and even being willing to pay a set fee with a specific price. Education is widely considered the most important form of human capital and can significantly influence society in terms of WTP (Kanyoka et al., 2009; Schulze, 2000). Contrary to the results of (Jones et al., 2010) study, the education variable had a negative effect. That means the higher the education, the lower a person's willingness to pay voluntarily. However, based on the specific location of the WTP of tidal land farmers, the positive influence of the education variable became more reasonable. Due to the higher education level, the awareness to pay the cost of water services fees for the operation, maintenance and management of infrastructure will certainly provide positive benefits to agricultural production (Bell et al., 2016).

WTP for water management must be carried out continuously, so management will be sustainable. At least once a year, a fee is charged to maintain water infrastructure. However, if it is undone WTP, the frequency of contributions will not be scheduled. In the (Kpadé et al., 2017; Mutaqin and Usami, 2019; Shee et al., 2020), fees for water management were ideally carried out twice a year or in every cropping season. Therefore, the groups will have savings in case of sudden damage to the water structure. The results in Table 2 showed that WTP frequency had no significant effect on alpha 5% on WTP for water. The influence of frequency was negative. This meant that the higher the frequency of payments, the lower the amount of WTP that would be paid. For every increase of one unit of WTP frequency, the money paid would decrease by 10,284.346 rupiahs.

The main income of tidal lowlands farmers in Muara Telang comes from rice farming practices. The more production is increased, the more income will increase (Bakopoulou et al., 2010; Halkos and Matsiori, 2012; Makwinja et al., 2019). The productivity of each farmer's land varies depending on the condition of the land. The average productivity of tidal lowlands farmers in Muara Telang is 4.10 to 4.43 tons per hectare. Meanwhile, the average rice production is 8 tons per hectare (Wildayana and Armanto, 2019). Table 2 showed that productivity had a significant positive effect. For every one-unit increase in productivity, the WTP will increase by 5,027.343 rupiahs. This is rational, because if productivity increases, incomes have increased, and the rice field will need more maintenance to ensure access to water. If the channels and water structures run smoothly, agricultural lands will not have a problem (Valipour et al., 2020). This will also have the opposite effect, specifically against increasing farm production. However, in the current situation, Purba (2021) concluded that rice farming practices on tidal land are still unsustainable and need to be improved.

In (Reflis et al., 2019) research, the key to farmers' participation in paying water services fees was the distance between the rice fields and the main water source (main channel). Distance from main channels (as water resources) to fields (meters) has a significant positive effect. The estimated parameter value is highly substantial. Thus, for each additional increase in land distance to the main channel by one unit, the WTP paid will increase by 24,498 rupiahs. (Koehler et al., 2015) stated that it would require more expensive service costs if the distance were further. This makes farmers unwilling to participate in paying water fees.

WTP estimation was calculated based on the data distribution of respondents obtained by dividing the total WTP by the number of respondents. The results of the calculation can be seen in Table 4. The estimated WTP of Rp. 101,297.87 was applied every cropping season. This value was determined by the willingness and ability of farmers by considering WTP factors that had a significant effect. The results of this WTP estimation can provide consideration for determining policies and sustainable management of water resources, especially for tidal lowland agriculture (Cheung and Jim, 2014; Hizami et al., 2014; Kolahi et al., 2013).

In this research, WTP in water services fees accounted for the operation, maintenance, and management of water infrastructures such as canals and water gates. In the research of (Purba et al., 2020) in Muara Telang, the use of agricultural inputs was excessive and inefficient, affecting rice production in tidal lowlands. Not only was

Table 3: Results of the analysis on factors affecting WTP

Model	Unstandardized Coefficients		t	Sig.	Collinearity Statistics	
	B	Std. Error			Tolerance	VIF
(Constant)	102108.020	23544.043	4.337	0.000		
Age	-1789.067	317.625	-5.633	0.000**	0.686	1.458
Household size	-3325.846	2398.405	-1.387	0.167	0.954	1.048
Farming experience	1043.242	298.440	3.496	0.001**	0.701	1.427
Education (year)	4017.617	901.528	4.456	0.000**	0.869	1.150
Frequency of WTP	-10284.346	6368.074	-1.615	0.108*	0.972	1.029
Productivity	5027.343	1893.310	2.655	0.008**	0.886	1.128
Distance to Main Channel	24.498	7.225	3.391	0.001**	0.941	1.062

a. Dependent Variable : WTP
b. *Significant at $\alpha = 15\%$
c. **Significant at $\alpha = 5\%$

Table 4: The average of farmers' WTP

	N	Min	Max	Sum	Mean		Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
WTP	235	10000	375000	23805000	101297.87	3286.023	2537517730.496
Valid N (listwise)	235						

production affected, but it was also polluting the soil and water. Excessively chemical soil conditions will block the air aeration and water flow in the soil. This results in the growth of plant roots being automatically disrupted. The flow of water that is not smooth causes the soil to become moist, and eventually, fungus and various germs grow. This problem causes a decrease in productivity (Ikoyi et al., 2018; Imanudin and Armanto, 2012; Zhang et al., 2018).

In tidal lowlands agriculture reclamation, there are often problems with flooding, lack of water, salinity, and pyrite content, which are dangerous to rice production. In addition to these problems, inefficient inputs also raise land fertility problems, requiring regular land washing to remove the remaining chemical content in the land. Land containing pyrite, if oxidized, will constrain rice growth. In terms of sustainable development, the 2030 agenda is expected to control water pollution as an international and national priority (Mateo-Sagasta et al., 2017; Nurita and Ar-Riza, 2014; Purba et al., 2020; Shamshuddin et al., 2004). In tidal lowlands agriculture, intensive shallow canals were built to wash acidity and toxicity from the land. Therefore, maintenance of channels and other water infrastructure needs to be carried out periodically to prevent damage that can cause any problems. In addition, the operation of the floodgates must also be carried out according to water needs and the cropping calendar (Ar-Riza and Alkasuma, 2008; Suprianto et al., 2010; Widjaja-Adhi et al., 1997). This requires a large amount of money. So, WTP can be applied to reduce problems and support sustainable production.

CONCLUSION

This study concludes that WTP for water services fees can be used sustainably. This research ultimately aimed to obtain significant factors that were used as indicators in determining the willingness of farmers to pay water service fees voluntarily (WTP). Based on the scientific hypothesis proposed, the significant factors analyzed were age, farming experience, education, productivity, and distance from land to main channels, where these factors have a significant effect on WTP for water services fees. Those factors affect 86.5%, and factors outside the equation model influence the remaining 13.5%. The estimated value of WTP that can be applied is 101,298 rupiahs (7 – 8 dollars) per cropping season. The WTP collected in each cropping season can be used for capital in the operation, maintenance, and management of channels and water gates. In addition, WTP would contribute to overcoming the threats to soil and water contamination and contribute to the achievement of food safety and quality. This would ensure that the quality of the water irrigating to the land remains sound and that soil problems such as pyrite can be resolved with routine land washing. This, in turn, would help to maintain fertile growing conditions, allowing optimal land productivity. So, when food production is safe and quality is guaranteed, sustainable food production can be realized. This study is expected that the results can be used to determine the value of WTP towards sustainability and improvement of water management in tidal lowlands agriculture and further research in order to highlight further the essential factor of WTP is productivity, because it affects farmers' income where farmers will be willing to pay contributions if they have high incomes.

ACKNOWLEDGEMENT

The authors wish to thank the Directorate General of Science and Technology Resources and the Directorate of Research and Community Service in the Ministry of Research, Technology and Higher Education of Indonesia through PMDSU (*Pendidikan Magister Menuju Doktor Untuk Sarjana Unggul*) for funding these research grants by letter number 068/SP2H/AMD/LT/DRPM/2020. The authors also would like to express great thanks to the IHE Delft Institute For Water Education, which facilitated the implementation of the PKPI (sandwich-like) program.

Authors' Contributions

Meitry Firdha Tafarini (MFT) wrote the manuscript, developed the theory, and performed the computations. Muhammad Yazid (MY) was the corresponding author and MY conceived this research. Muh Bambang Prayitno (MBP) and Muhammad Faizal (MF) provided guide in collected data. F.X. Suryadi (FXS) corrected the English and typewriting. Khairul Fahmi Purba (KFB) assisted in data collection. All authors discussed the result and contributed to the final manuscript.

Conflict of Interest

The authors declare no conflict of interest.

Ethical Statement

This article does not contain any studies that would require an ethical statement.

REFERENCES

Ahmed, A., M. M. Masud, A. Q. Al-Amin, S. R. B. Yahaya, M. Rahman and R. Akhtar. 2015. Exploring factors influencing farmers' willingness to pay (WTP) for a planned adaptation programme to address climatic issues in agricultural sectors. Environ. Sci. Pollut. Res. 22: 9494-9504.

Ar-Riza I, and Alkasuma. 2008. Pertanian lahan rawa pasang surut dan strategi pengembangannya dalam era otonomi daerah (Argicultural land tidal swamp and development strategy era of regional autonomy. J. Sumberd. Lahan. 2: 95-104.

Aydogdu, M. H. 2016. Evaluation of willingness to pay for irrigation water: Harran plain sampling in gap region Turkey. Appl. Ecol. Environ. Res. 14: 349-365.

Baghestany, M. and M. Zibaei. 2010. Measuring willingness of farmers to pay for groundwater in Ramjerd district: Application of contingent valuation method. Agric. Econ. 4: 41-64.

Bakopoulou, S., S. Polyzos and A. Kungolos. 2010. Investigation of farmers' willingness to pay for using recycled water for irrigation in Thessaly Region, Greece. Desalination. 250: 329-334.

Bell, A. R., M. A. A. Shah and P. S. Ward. 2014. Reimagining cost recovery in Pakistan's irrigation system through willingness-to-pay estimates for irrigation water from a discrete choice experiment. Water Resour. Res. 50: 6679-6695.

Bell, A. R., P. S. Ward and M. A. A. Shah. 2016. Increased water charges improve efficiency and equity in an irrigation system. Ecol. Soc. 21: 1-13.

Bernard, H. R. 2011. Research methods in anthropology: Qualitative and quantitative approaches. In: British Library Cataloguing. 5th ed. Altamira Press, United Kingdom.

Bloomfield, C. and A. B. Zahari. 1982. Acid sulphate soils. Outlook Agric. 11: 48-54.

Brox, J. A., R. C. Kumar and K. R. Stollery. 1996. Willingness to pay for water quality and supply enhancements in the Grand River watershed. Can. Water Resour. J. 21: 275-288.

Central Bureau of Statistics of Banyuasin Regency. 2017. Banyuasin dalam angka (Banyuasin in figures) 2017. BPS-Statistics of Banyuasin Regency, South Sumatra.

Central Bureau of Statistics of Banyuasin Regency. 2018. Banyuasin dalam angka (Banyuasin in figures) 2018. BPS-Statistics of Banyuasin Regency, South Sumatra.

Chapman, D. and Hall. 1996. Water Quality Assessments: A Guide to the Use of Biota, Sediments and Water in Environmental Monitoring. 2nd ed. Great Britain at the University Press, Cambridge.

Cheung, L. T. O. and C. Y. Jim. 2014. Expectations and willingness-to-pay for ecotourism services in Hong Kong's conservation areas. Int. J. Sustain. Dev. World Ecol. 21: 149-159.

Chiarini, A. and F. Brunetti. 2019. What really matters for a successful implementation of lean production? A multiple linear regression model based on European manufacturing companies. Prod. Plan. Control. 30: 1091-1101.

Cooper, J. C. 1993. Optimal bid selection for dichotomous choice contingent valuation surveys. J. Environ. Econ. Manag. 24: 25-40.

Field, A. 2013. Discovering Statistics Using IBM SPSS Statistics. 4th ed. Sage Publications Ltd., London.

Halkos, G. and S. Matsiori. 2012. Determinants of willingness to pay for coastal zone quality improvement. J. Soc. Econ. 41: 391-399.

Hizami, N., M. Rusli and R. Alias. 2014. Valuing natural resources of ecotourism destination in Taman Negara Sungai Relau, Pahang, Malaysia. J. Basic Appl. Sci. 8: 416-425.

Ikoyi, I., A. Fowler and A. Schmalenberger. 2018. One-time phosphate fertilizer application to grassland columns modifies the soil microbiota and limits its role in ecosystem services. Sci. Total Environ. 630: 849-858.

Imanudin, M. S. and E. Armanto. 2012. Effect of water management improvement on soil nutrient content, iron and aluminum solubility at tidal low land area. APCBEE Proc. 4: 253-258.

Imanudin, M. S., E. Armanto, R. H. Susanto and S. M. Bernas. 2010. Water table fluctuation in tidal lowland for developing agricultural water management strategies. J. Trop. Soils. 15: 277-282.

Imanudin, M. S., Bakri, E. Armanto, B. Indra and S. N. P. Ratmini. 2018. Land and water management option of tidal lowland reclamation area to support rice production (A case study in delta Sugihan Kanan of South Sumatra Indonesia). J. Wetl. Environ. Manag. 6: 93-111.

Jones, N., K. Evangelinos, C. P. Halvadakis, T. Iosifides and C. M. Sophoulis. 2010. Social factors influencing perceptions and willingness to pay for a market-based policy aiming on solid waste management. Resour. Conserv. Recycl. 54: 533-540.

Kaiser, H. F. 1970. A second-generation little jiffy*. Psychometrika. 35: 401-415.

Kanninen, B. J. 1993. Optimal experimental design for double-bounded dichotomous choice contingent valuation. J. L. Econ. 69: 138-146.

Kanyoka, P., S. Farolfi and S. Morardet. 2009. Households' preferences and willingness to pay for multiple use water services in rural areas of South Africa: An analysis based on choice modelling. Water SA. 34: 715-724.

Koehler, J., Thomson, P., and Hope, R. 2015. Pump-priming payments for sustainable water services in Rural Africa. World Dev. 74: 397-411.

Kolahi, M., T. Sakai and K. Moriya. 2013. Ecotourism potentials for financing parks and protected areas: A perspective from Iran's Parks. J. Mod. Account. Audit. 9: 144-152.

Kpadé, C. P., E. R. Mensah, M. Fok and J. Ndjeunga. 2017. Cotton farmers' willingness to pay for pest management services in northern Benin. Agric. Econ. (UK). 48: 105-114.

Łukawska-Matuszewska, K., B. Graca, O. Brocławik and T. Zalewska. 2018. The impact of declining oxygen conditions on pyrite accumulation in shelf sediments (Baltic Sea). Biogeochemistry. 142: 209-230.

Makwinja, R., I. B. M. Kosamu and C. C. Kaonga. 2019. Determinants and values of willingness to pay for water quality improvement: Insights from Chia Lagoon, Malawi. Sustain. (Switzerland). 11: 1-26.

Mateo-Sagasta, J., S. M. Zadeh, H. Turral and J. Burke. 2017. Water Pollution from Agriculture: A Global Review. In: The Food and Agriculture Organization of the United Nations Rome and the International Water Management Institute on Behalf of the Water Land and Ecosystem Research Program Colombo.

Meijide, A., C. Gruening, I. Goded, G. Seufert and A. Cescatti. 2017. Water management reduces greenhouse gas emissions in a Mediterranean rice paddy field. Agric. Ecosyst. Environ. 238: 168-178.

Mercau, J. L., M. D. Nosetto, F. Bert, R. Giménez and E. G. Jobbágy. 2016. Shallow groundwater dynamics in the Pampas: Climate, landscape, and crop choice effects. Agric. Water Manag. 163: 159-168.

Mezgebo, G. K. and Z. Ewnetu. 2015. Households' willingness to pay for improved water services in urban areas: A case study from nebelet town, Ethiopia. J. Dev. Agric. Econ. 7: 12-19.

Mutaqin, D. J. and K. Usami. 2019. Smallholder farmers' willingness to pay for agricultural production cost insurance in Rural West Java, Indonesia: A contingent valuation method (CVM) approach. Risks. 7: 1-18.

Noor, M. and A. Rahman. 2015. Biodiversitas dan kearifan lokal dalam budidaya tanaman pangan mendukung kedaulatan pangan: Kasus di lahan rawa pasang surut. Pros. Semin. Nas. Masy. Biodivers. Indones. 1: 1861-1867.

Nurita, and I. Ar-Riza. 2014. Peningkatan produksi padi berkelanjutan pada lahan rawa pasang surut (Increasing of sustainable rice production on swampland). J. Teknol. Pertan. 9: 1-7.

Pallant, J. 2016. *S*pss Survival Manual: A Step-by-step Guide to Data Analysis Using IBM SPSS. 6th ed. British Library, England.

Prasetyo, K., M. Masrukan and S. Sunawan. 2019. Development of mathematical literation instruments based on Class IV geometry material conservation. J. Educ. Res. Eval. 8: 1-13.

Purba, K. F., M. Yazid, M. Hasmeda, D. Adriani and M. F. Tafarini. 2020. Technical efficiency and factors affecting rice production in tidal lowlands of South Sumatra Province Indonesia. Potravin. Slovak J. Food Sci. 14: 101-111.

Purba, K. F., M. Yazid, M. Hasmeda, D. Adriani and M. F. Tafarini. 2021. The sustainability of rice farming practices in tidal swamplands of South Sumatra Indonesia. Potravin. Slovak J. Food Sci. 15: 9-17.

Reflis, F. Sjarkowi, Sriati, and D. Susetyo. 2019. Farmers' participation for irrigation water resources services fee, Kapahiang Regency Bengkulu Province-Indonesia. Int. J. Ecol. Environ. Conserv. 25: 527-536.

Schulze, R. E. 2000. Modelling hydrological responses to land use and climate change: A Southern African perspective. AMBIO A J. Hum. Environ. 29: 12-22.

Shamshuddin, J., S. Muhrizal, I. Fauziah and E. Van Ranst. 2004. A laboratory study of pyrite oxidation in acid sulfate soils. Commun. Soil Sci. Plant Anal. 35: 117-129.

Sharma, S. and I. Henriques. 2005. Stakeholder influences on sustainability practices in the Canadian forest products industry. Strateg. Manag. J. 26: 159-180.

Shee, A., C. Azzarri and B. Haile. 2020. Farmers' Willingness to pay for improved agricultural technologies: Evidence from a field experiment in Tanzania. Sustain. (Switzerland). 12: 1-13.

Suprianto, H., E. Ravaie, S. G. Irianto, R. H. Susanto, B. Schultz, F. X. Suryadi and A. Van Den Eelaart. 2010. Land and water management of tidal lowlands: Experiences in Telang and Saleh, South Sumatra. J. Irrig. Drain. 59: 317-335.

Suryadi, F. X. 1996. Soil and Water Management Strategies for Tidal Lowlands in Indonesia. (Doctoral Dissertation), UNESCO-IHE Institute for Water Education, Delft.

Tafarini, M. F. and M. Yazid. 2019. Sustainable water management in tidal lowland agriculture: A research Agenda. Sriwij. J. Environ. 3: 102-107.

Tang, Z., Z. Nan and J. Liu. 2013. The willingness to pay for irrigation water: A case study in northwest china. Glob. NEST J. 15: 76-84.

Tranmer, M., J. Murphy, M. Elliot and M. Pampaka. 2020. Multiple Linear Regression. 2nd ed. Cathie Marsh Institute Working Paper 2020-01.

Valipour, M., J. Krasilnikof, S. Yannopoulos, R. Kumar, J. Deng, P. Roccaro, L. Mays, M. E. Grismer and A. N. Angelakis. 2020. The evolution of agricultural drainage from the earliest times to the present. Sustain. (Switzerland). 12: 1-30.

Weisberg, S. 2005. Applied Linear Regression. 3rd ed. John Wiley and Sons, Inc., New Jersey.

Whittington, D., J. Briscoe, M. Xinming and W. Barron. 1990. Estimating the willingness to pay for water services in developing countries: A case study of the use of contingent valuation surveys in Southern Haiti. Econ. Dev. Cult. Chang. 38: 293-311.

Widjaja-Adhi, I., N. P. S. Ratmini and I. W. Swastika. 1997. Pengelolaan Tanah dan air di Lahan Pasang Surut (Soil and Water Management in Tidal Lowlands). Proyek Penelitian Pengembangan Pertanian Rawa Terpadu-ISDP Badan Penelitian dan Pengembangan Pertanian.

Wildayana, E. and M. E. Armanto. 2019. The role of subsidized fertilizers on rice production and income of farmers in various land typologies. J. Ekon. Pembang. Kaji. Masal. Ekon. Pembang. 20: 100-107.

Yazid, M., M. N. Shamsudin, K. A. Rahim, A. Radam and A. Muda. 2015. Water service valuation in tidal lowland agriculture. Pertanika J. Soc. Sci. Humanit. 23: 39-46.

Zhang, L., C. Yan, Q. Guo, J. Zhang and J. Ruiz-Menjivar. 2018. The impact of agricultural chemical inputs on environment: Global evidence from informetrics analysis and visualization. Int. J. Low Carbon Technol. 13: 338-352.