

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

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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)**

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

3  
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15  
16 **ABSTRACT**

17 Operations and maintenance (OM) of water infrastructure cannot be separated from the role of  
18 farmers' water users associations (WUA) or farmer groups. OM needs to be supported not only  
19 skillfully but also financially. This research aimed to assess and identify several factors  
20 affecting self-financing in water management in tidal lowlands agriculture, using the  
21 Willingness To Pay (WTP) approach. The sample size of this research was 245 respondents,  
22 all of which are active members of WUA or farmer groups. Primary data were collected using  
23 direct interviews with structured questionnaires, and secondary data were collected from some  
24 related agencies. The data were analyzed using Exploratory Factor Analysis (EFA) and  
25 Multiple Linear Regression analyses. Regression analysis formally tested the factors and

26 identified the selected significant factors. KMO and Bartlett's Test result was  $0.587 > 0.5$   
27 (alpha), indicating significance. The  $R^2$  (0.86) showed that the independent variables  
28 simultaneously explained the dependent variable ( $Y_{WTP}$ ). From seven independent variables,  
29 five variables significantly affect the willingness to pay for water management. This WTP is  
30 expected to ensure sustainable food production in tidal lowlands since water availability is  
31 crucial in tidal lowland agriculture.

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

33

## 34 INTRODUCTION

35 Tidal lowlands are wetlands ecosystems with inundated land characteristics and are influenced  
36 by high and low water tides but not river water. Meanwhile, river water also rises as a result of  
37 the retention of river water by high tides. Tidal lowland also has valuable characteristics and  
38 potential as an agricultural resource, mostly for food crops (Noor and Rahman, 2015; Tafarini  
39 and Yazid, 2019). The tidal lowlands in South Sumatra are considered to be a food barn with  
40 an area of 266,674 hectares in 2017, including 161,908 hectares of tidal lowlands in Banyuasin  
41 Regency. Food production (rice) in tidal lowlands in Banyuasin Regency in 2017, was  
42 1,038,489.34 tons (Central Bureau of Statistics of Banyuasin Regency, 2018). Meanwhile, the  
43 demand for food continues to increase at a rate equivalent to population increase; thus, the  
44 region continues to strive to improve food production (rice). However, rice production in 2017  
45 decreased from the previous year (2016) by 1,302,229.7 tons (Central Bureau of Statistics of  
46 Banyuasin Regency, 2017).

47 Tidal lowland is highly dependent on high and low water tides, so it requires a proper plan,  
48 management (especially aspects of water management through water channels), and utilization  
49 of land management and infrastructure technology. This is to allow it to be distributed  
50 appropriately to the rice field (Imanudin et al., 2010). Water management for rice cultivation

51 is needed to maximize productivity (Imanudin et al., 2018). However, the current problem is  
52 the improper application of water management. A land far from the main channel often  
53 experiences water shortages, especially during the dry season. Meanwhile, some lands  
54 experience flooding, due to the drainage system's handling with improper operation of  
55 floodgates in the rainy season (Mercau et al., 2016). Farmers do not implement the micro water  
56 system (quaternary channel or worm channels), even though channels' functions can regularly  
57 distribute and store water for plants in the tertiary channel's middle position. The primary key  
58 to this problem is the appropriate and sustainable water management application from micro  
59 and macro water system levels, supported by suitable infrastructure (Meijide et al., 2017).  
60 Restoration and maintenance of water infrastructures incur many costs, and this situation needs  
61 the role of farmers. Do farmers have enough capital and able to do self-financing the water  
62 management for their land, or do they need cooperation between other farmer organizations  
63 such as WUA or farmer groups' role? This study will identify whether farmers are willing to  
64 contribute to water services fees for sustainable water management by applying the Willingness  
65 to Pay (WTP) approach.

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

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

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

95

### 96 **Scientific hypothesis**

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

100

101 **MATERIALS AND METHOD**

102 **Study area**

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

109 These areas are primarily located in basins or close to the mouth of a river (Suprianto et al.,  
110 2010; Suryadi, 1996). The research location is the most productive area for food crops (rice).  
111 Production is supported by an irrigation system using secondary and tertiary blocks, some of  
112 which are equipped with water-management infrastructure. The research location can be seen  
113 in Figure 1.



120 **Figure 1** Tidal lowland canals condition in Muara Telang Sub District

121

122 **Samples and data collection**

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

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

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

139

#### 140 **Questionnaire preparation**

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

149

150

151 **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 <sup>-1</sup>	The ability or carrying capacity of agricultural land in producing rice crops

152

153

154 **Data Analysis**

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

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

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

167

$$168 \quad Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_n X_{ni} + e \quad (1)$$

169

170 The dependent variable (Y) in this research is the amount of WTP that a farmer pays for a year  
171 (two planting seasons). The socio-economic characteristics of rice farmers in tidal lowlands  
172 were used for independent variables (X). (Ahmed et al., 2015; Reflis et al., 2019) presented the  
173 socio-economic characteristics of farmers that influenced WTP. Therefore, age (X<sub>1</sub>), household  
174 size (X<sub>2</sub>), farming experience (X<sub>3</sub>), education (X<sub>4</sub>), frequency of WTP (X<sub>5</sub>), productivity (X<sub>6</sub>),  
175 and distance from land to main channels (X<sub>7</sub>) were used. The equation of multiple regression  
176 created in this study was:

177

$$178 \quad Y_{WTP} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e \quad (2)$$

179

180 where  $Y_{WTP}$  denotes the amount of WTP (rupiah/year).  $\beta_0$  is intercept of model.  $\beta_1 \dots \beta_7$  are  
181 estimated parameters. Then,  $X_1$ ,  $X_2$ ,  $X_3$ ,  $X_4$ ,  $X_5$ ,  $X_6$ , and  $X_7$  represent independent variables  
182 (socio-economic characteristics).  $e$  indicates error term. Hypotheses for the regression analysis  
183 were:

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

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

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

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

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

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

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

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

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

204

## 205 **Statistical Analysis**

206 This study used three statistical analyses. First, the descriptive analysis was performed using  
207 Microsoft Excel 2016. The second and third analyses involved Exploratory Factor Analysis  
208 (EFA) and parametric data analyses (Multiple Linear Regression). The sample data collected

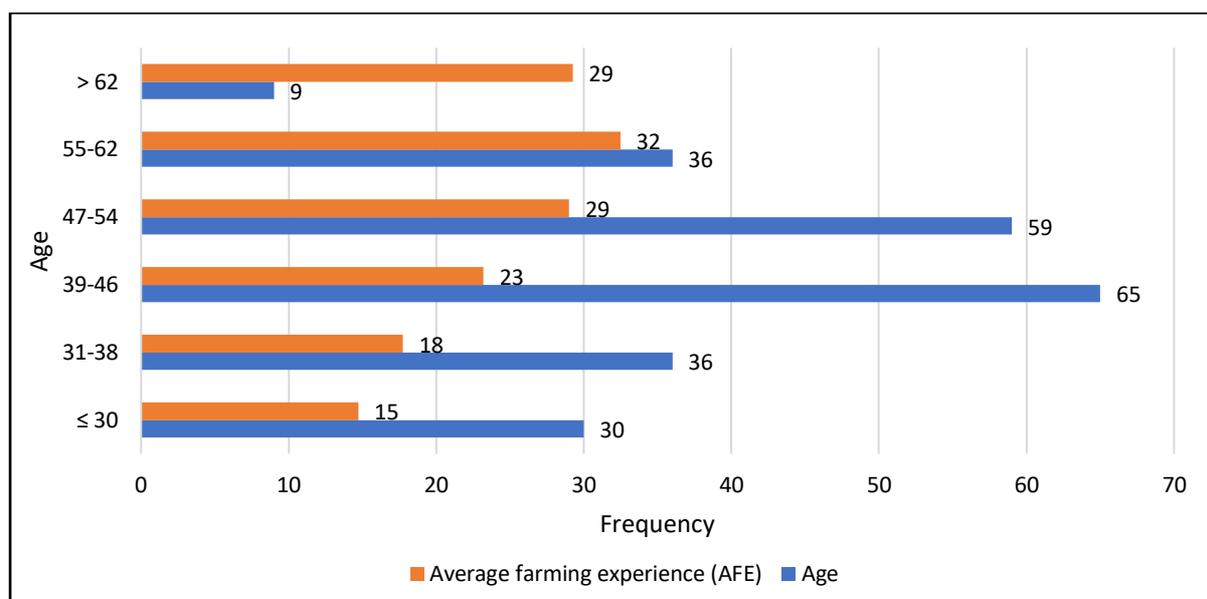
209 were entered and screened using SPSS 23 to analyze factors affecting the WTP of rice farmers  
 210 in water services fees. The significance ( $\alpha$ ) for this study used 5%. The  $p$ -value is expected less  
 211 than 0.05 ( $p < 0.05$ ).

212

## 213 RESULTS AND DISCUSSION

### 214 Socio-economic characteristics of rice farmers

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



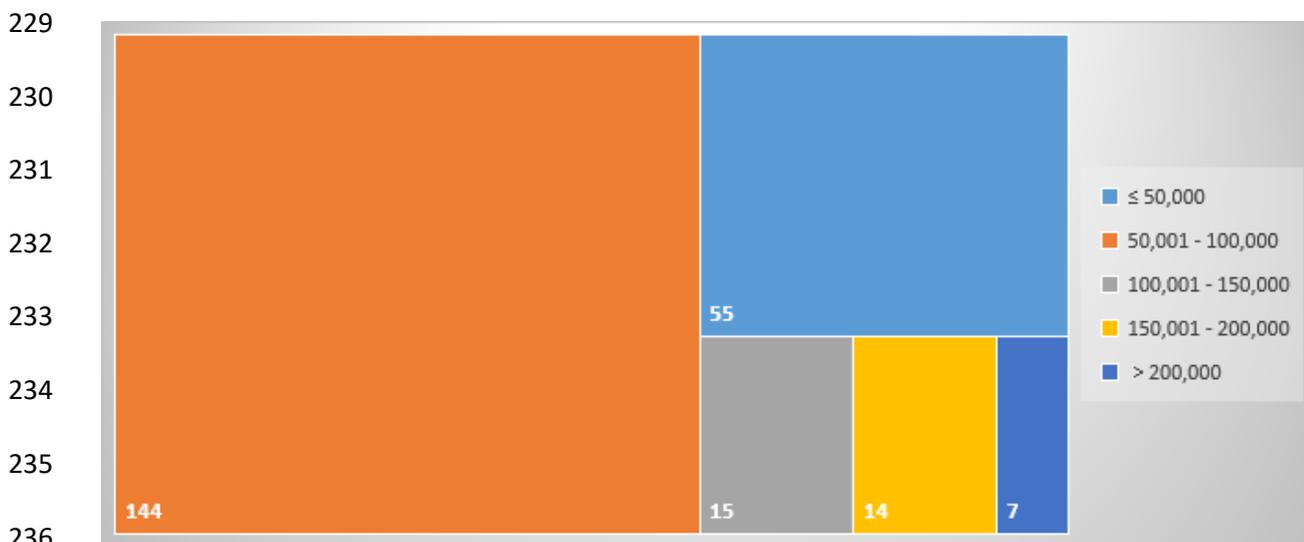
219

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

221

222 Based on Figure 2, there were 30 farmers under the age of 30 with 15 years of average farming  
 223 experience. In age ranges, 31-38 years, 39-46 years, 47-54 years, 55-62 years as many as 36,  
 224 65, 59, and 36 farmers had an average farming experience of 18, 23, 29, and 32 years  
 225 respectively. Meanwhile, there were 9 farmers over 62 years old with an average farming  
 226 experience of 29 years. The relationship between farming experience and farmer's age as

227 illustrated in Figure 2. The higher the age of the farmer, the longer the farmer has experience  
228 in farming.



237 **Figure 3** Willingness to Pay (Rupiah)

238

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

247

### 248 **Exploratory factor analysis (EFA)**

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

252

253 **Table 2** KMO and Bartlett's Test

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

254

255

256 Table 1 shows the results of the Exploratory Factor Analysis (EFA). The value of Bartlett's  
 257 Test of Sphericity was seen from its significance of  $p < 0.05$  or  $0.000 < 0.05$ , which means that  
 258 the correlation between the indicators was acceptable for factor analysis. The KMO test was  
 259 used to demonstrate multicollinearity. The KMO test also helps ensure the fitness of the  
 260 indicators used for factor analysis. Factor analysis will be appropriate if the KMO value is  $>$   
 261 0.60 (Pallant, 2016). Based on Table 1, the KMO value of 0.608 showed that the data do not  
 262 have any significant multicollinearity problems, so the indicators can be used for further  
 263 analysis (Kaiser, 1970; Prasetyo et al., 2019). This analysis reduced 10 variables to 7 variables,  
 264 which will be used in multiple linear analyses.

265

266 **Factors influencing WTP on water services fees**

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

270

$$\begin{aligned}
 271 \quad Y_{\text{WTP}} = & 102108.020 - 1789.067 X_1 - 3325.846 X_2 + 1043.242 X_3 + 4017.617 X_4 \\
 272 \quad & - 10284.346 X_5 + 5027.343 X_6 + 24.498 X_7 + e \qquad \qquad \qquad (3)
 \end{aligned}$$

273

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

280

281 **Table 3** Results of the analysis on factors affecting WTP

Model	Unstandardized Coefficients				Collinearity Statistics	
	B	Std. Error	t	Sig.	Tolerance	VIF
(Constant)	102108.020	23544.043	4.337	0.000		
Age	-1789.067	317.625	-5.633	<b>0.000**</b>	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	<b>0.001**</b>	0.701	1.427
Education (year)	4017.617	901.528	4.456	<b>0.000**</b>	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	<b>0.008**</b>	0.886	1.128
Distance to Main Channel	24.498	7.225	3.391	<b>0.001**</b>	0.941	1.062

a. Dependent Variable : WTP

b. \*Significant at  $\alpha = 15\%$

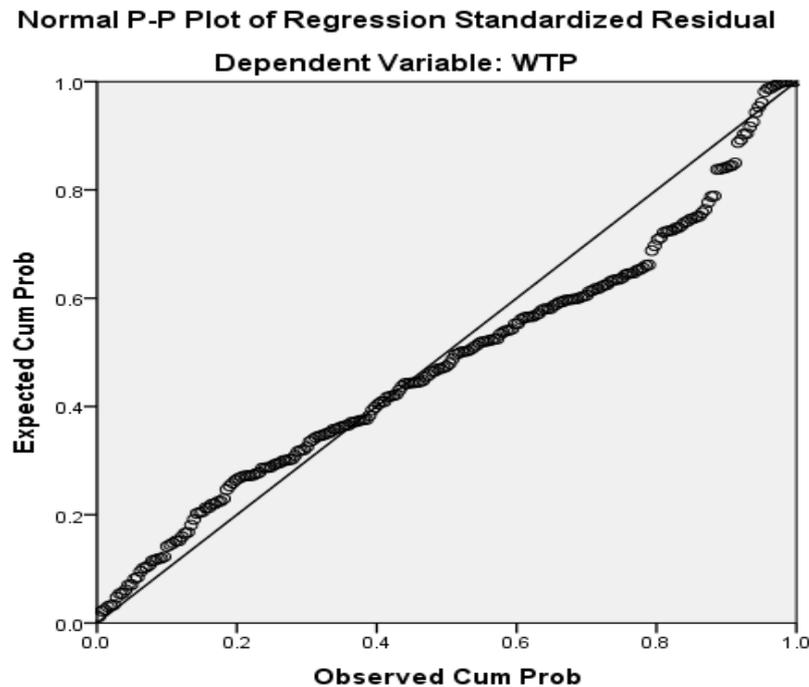
c. \*\*Significant at  $\alpha = 5\%$

282

283 Based on the result from Table 2, B is the estimation parameter, Sig. value is the significance  
284 value of each independent variable, and tolerance & VIF are classical assumptions of

285 multicollinearity. Three classical assumptions in the regression analysis were made with the  
286 following results:

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



289

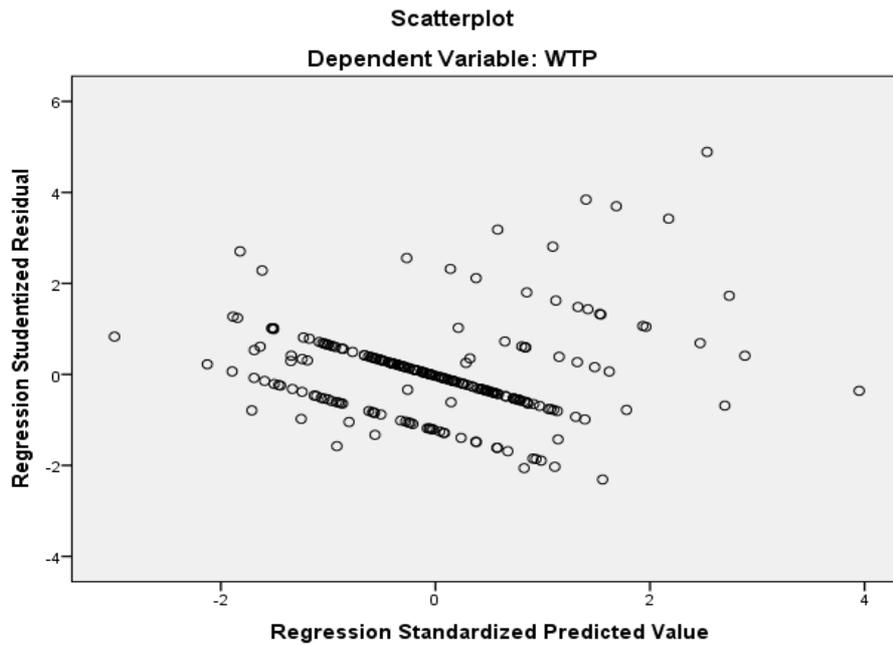
290 **Figure 4** P-P plot for data normality

291

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

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

298



299

300

**Figure 5** Scatterplot for homoscedasticity

301

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

308 The independent variable of age has a significant negative influence on the dependent variable  
 309 (WTP). The estimated parameter value is -1789.067. This means that the higher farmers' age,  
 310 the lower the willingness to pay for water services fees. The WTP value paid will decrease by  
 311 1,789.067 rupiahs for each increase in the farmer's age unit. This contradicts with (Bell et al.,  
 312 2014), research on WTP in irrigation systems in Pakistan. The results of their studies stated  
 313 that the higher the age of the farmer, the higher their willingness to pay. In addition, the age  
 314 variable in the study did not have a significant effect. However, the (Mezgebo and Ewnetu,

315 2015) study were in line with the expected hypothesis in this study. The results showed that  
316 respondents aged over 50 years in Mutale Local Municipality, South Africa, were less willing  
317 to pay higher water services fees.

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

326 (Purba et al., 2021) stated that in tidal lowlands, the agricultural sustainability index was  
327 25.53%. This means that currently, the practice of tidal farming is still unsustainable. Tidal  
328 lowlands farmers in Muara Telang had existed since the 1960s through the transmigration  
329 program. The experience of farmers in agriculture certainly plays an influential role in the  
330 improvement and sustainability of tidal lowland agricultural production. Older farmers  
331 certainly have more extended experience than younger farmers (Bloomfield and Zahari, 1982;  
332 Łukawska-Matuszewska et al., 2018). Farmers with longer experience will consider making  
333 voluntary contributions to the sustainable operation, maintenance, and management of  
334 infrastructure, including channels, water gates, and other supporting irrigation structures.  
335 Water management infrastructure is an important component of tidal management, which is  
336 highly dependent on water conditions (Chapman and Hall, 1996). In Table 2, farming  
337 experience demonstrated a significant positive effect. This means that farmers who have more  
338 farming experience will have a higher willingness to pay water service fees. An increase of  
339 1,043.242 rupiahs will occur in one unit of increased farming experience.

340 Some of the tidal lowland farmers in this study location still think that formal education is not  
341 important. Some farmers did not have formal educational experience. The results showed that  
342 the independent variable of education had a significant positive effect. A total of 4,017.617-  
343 rupiah WTP was seen with longer formal farmer education experience. Research by  
344 (Bakopoulou et al., 2010; Bell et al., 2014) stated that the level of education would increase  
345 the probability of someone being willing to pay voluntarily and even being willing to pay a set  
346 fee with a specific price. Education is widely considered the most important form of human  
347 capital and can significantly influence society in terms of WTP (Kanyoka et al., 2009; Schulze,  
348 2000). Contrary to the results of (Jones et al., 2010) study, the education variable had a negative  
349 effect. That means the higher the education, the lower a person's willingness to pay voluntarily.  
350 However, based on the specific location of the WTP of tidal land farmers, the positive influence  
351 of the education variable became more reasonable. Due to the higher education level, the  
352 awareness to pay the cost of water services fees for the operation, maintenance and  
353 management of infrastructure will certainly provide positive benefits to agricultural production  
354 (Bell et al., 2016).

355 WTP for water management must be carried out continuously, so management will be  
356 sustainable. At least once a year, a fee is charged to maintain water infrastructure. However, if  
357 it is undone WTP, the frequency of contributions will not be scheduled. In the (Kpadé et al.,  
358 2017; Mutaqin and Usami, 2019; Shee et al., 2020), fees for water management were ideally  
359 carried out twice a year or in every cropping season. Therefore, the groups will have savings  
360 in case of sudden damage to the water structure. The results in Table 2 showed that WTP  
361 frequency had no significant effect on alpha 5% on WTP for water. The influence of frequency  
362 was negative. This meant that the higher the frequency of payments, the lower the amount of  
363 WTP that would be paid. For every increase of one unit of WTP frequency, the money paid  
364 would decrease by 10,284.346 rupiahs.

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

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

385

386 **Table 4** The average of farmers' WTP

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

387

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

396 In this research, WTP in water services fees accounted for the operation, maintenance, and  
 397 management of water infrastructures such as canals and water gates. In the research of (Purba  
 398 et al., 2020) in Muara Telang, the use of agricultural inputs was excessive and inefficient,  
 399 affecting rice production in tidal lowlands. Not only was production affected, but it was also  
 400 polluting the soil and water. Excessively chemical soil conditions will block the air aeration  
 401 and water flow in the soil. This results in the growth of plant roots being automatically  
 402 disrupted. The flow of water that is not smooth causes the soil to become moist, and eventually,  
 403 fungus and various germs grow. This problem causes a decrease in productivity (Ikoyi et al.,  
 404 2018; Imanudin and Armanto, 2012; Zhang et al., 2018).

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

419

## 420 **CONCLUSION**

421 This study concludes that WTP for water services fees can be used sustainably. This research  
422 ultimately aimed to obtain significant factors that were used as indicators in determining the  
423 willingness of farmers to pay water service fees voluntarily (WTP). Based on the scientific  
424 hypothesis proposed, the significant factors analyzed were age, farming experience, education,  
425 productivity, and distance from land to main channels, where these factors have a significant  
426 effect on WTP for water services fees. Those factors affect 86.5%, and factors outside the  
427 equation model influence the remaining 13.5%. The estimated value of WTP that can be  
428 applied is 101,298 rupiahs (7 – 8 dollars) per cropping season. The WTP collected in each  
429 cropping season can be used for capital in the operation, maintenance, and management of

430 channels and water gates. In addition, WTP would contribute to overcoming the threats to soil  
431 and water contamination and contribute to the achievement of food safety and quality. This  
432 would ensure that the quality of the water irrigating to the land remains sound and that soil  
433 problems such as pyrite can be resolved with routine land washing. This, in turn, would help  
434 to maintain fertile growing conditions, allowing optimal land productivity. So, when food  
435 production is safe and quality is guaranteed, sustainable food production can be realized. This  
436 study is expected that the results can be used to determine the value of WTP towards  
437 sustainability and improvement of water management in tidal lowlands agriculture and further  
438 research in order to highlight further the essential factor of WTP is productivity, because it  
439 affects farmers' income where farmers will be willing to pay contributions if they have high  
440 incomes.

441

#### 442 **AUTHORS' CONTRIBUTIONS**

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

449

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597

598 **Acknowledgement:**

599 The authors wish to thank the Directorate General of Science and Technology Resources and  
600 the Directorate of Research and Community Service in the Ministry of Research, Technology  
601 and Higher Education of Indonesia through PMDSU (*Pendidikan Magister Menuju Doktor*  
602 *Untuk Sarjana Unggul*) for funding these research grants by letter number  
603 068/SP2H/AMD/LT/DRPM/2020. The authors also would like to express great thanks to the

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

606

607 **Conflict of Interest:**

608 The authors declare no conflict of interest.

609

610 **Ethical Statement:**

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

612

613

**Reviewed and Resubmit Manuscript**  
**(3 Januari 2022)**

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

Dari: Meitry Tafari (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.

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Dear Meitry Firdha Tafari,

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.

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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 research 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.

\*\*\*\*\*

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

3  
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15  
16 **ABSTRACT**

17 Operations and maintenance (OM) of water infrastructure cannot be separated from the role  
18 of farmers' water users associations (WUA) or farmer groups. OM needs to be supported not  
19 only skillfully but also financially. This research aimed to assess and identify several factors  
20 affecting self-financing in water management in tidal lowlands agriculture, using the  
21 Willingness To Pay (WTP) approach. The sample size of this research was 245 respondents,  
22 all of which are active members of WUA or farmer groups. Primary data were collected  
23 using direct interviews with structured questionnaires, and secondary data were collected  
24 from some related agencies. The data were analyzed using Exploratory Factor Analysis (EFA)  
25 and Multiple Linear Regression analyses. Regression analysis formally tested the factors and

26 identified the selected significant factors. KMO and Bartlett's Test result was  $0.587 > 0.5$   
27 (alpha), indicating significance. The  $R^2$  (0.86) showed that the independent variables  
28 simultaneously explained the dependent variable ( $Y_{WTP}$ ). From seven independent variables,  
29 five variables significantly affect the willingness to pay for water management. This WTP is  
30 expected to ensure sustainable food production in tidal lowlands since water availability is  
31 crucial in tidal lowland agriculture.

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

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33

## 34 INTRODUCTION

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

47 Tidal lowland is highly dependent on high and low water tides, so it requires a proper plan,  
48 management (especially aspects of water management through water channels), and  
49 utilization of land management and infrastructure technology. This is to allow it to be  
50 distributed appropriately to the rice field (Imanudin et al., 2010). Water management for rice

51 cultivation is needed to maximize productivity (Imanudin et al., 2018). However, the current  
52 problem is the improper application of water management. A land far from the main channel  
53 often experiences water shortages, especially during the dry season. Meanwhile, some lands  
54 experience flooding, due to the drainage system's handling with improper operation of  
55 floodgates in the rainy season (Mercau et al., 2016). Farmers do not implement the micro  
56 water system (quaternary channel or worm channels), even though channels' functions can  
57 regularly distribute and store water for plants in the tertiary channel's middle position. The  
58 primary key to this problem is the appropriate and sustainable water management application  
59 from micro and macro water system levels, supported by suitable infrastructure (Mejjide et  
60 al., 2017). Restoration and maintenance of water infrastructures incur many costs, and this  
61 situation needs the role of farmers. Do farmers have enough capital and able to do self-  
62 financing the water management for their land, or do they need cooperation between other  
63 farmer organizations such as WUA or farmer groups' role? This study will identify whether  
64 farmers are willing to contribute to water services fees for sustainable water management by  
65 applying the Willingness to Pay (WTP) approach.

66 The maximum amount an individual agrees to pay for a good or service without losing its  
67 utility is the definition of WTP (Baghestany and Zibaei, 2010; Cooper, 1993; Kanninen,  
68 1993). WTP reflects the WUA's perceptions toward the existence and importance of water  
69 resources necessary for the active participation of WUA to contribute to WTP (Whittington et  
70 al., 1990). Because there are options for restoring and maintaining water infrastructure  
71 through WUA as a sustainable agriculture scheme, the goal is to increase production. It is  
72 crucial to know whether farmers are willing to pay water management fees, as well as the  
73 factors that affect their willingness to pay (WTP). This study aimed to estimate farmers' OP  
74 self-financing potential to increase water use efficiency and estimate water services' value to  
75 support water service fee applications. To achieve these goals, the study used an exploratory

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

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

95

### 96 **Scientific hypothesis**

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

100

## 101 MATERIALS AND METHOD

### 102 Study area

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

109 These areas are primarily located in basins or close to the mouth of a river (Suprianto et al.,  
110 2010; Suryadi, 1996). The research location is the most productive area for food crops (rice).  
111 Production is supported by an irrigation system using secondary and tertiary blocks, some of  
112 which are equipped with water-management infrastructure. The research location can be seen  
113 in Figure 1.



120 **Figure 1** Tidal lowland canals condition in Muara Telang Sub District

### 121 Samples and data collection

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

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

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

139

#### 140 **Questionnaire preparation**

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

149

150

151 **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 <sup>-1</sup>	The ability or carrying capacity of agricultural land in producing rice crops

153

154 **Data Analysis**

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

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

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

167

$$168 \quad Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_n X_{ni} + e \quad (1)$$

169

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

177

$$178 \quad Y_{WTP} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e \quad (2)$$

179

180 where  $Y_{WTP}$  denotes the amount of WTP (rupiah/year).  $\beta_0$  is intercept of model.  $\beta_1 \dots \beta_7$  are  
181 estimated parameters. Then,  $X_1$ ,  $X_2$ ,  $X_3$ ,  $X_4$ ,  $X_5$ ,  $X_6$ , and  $X_7$  represent independent variables  
182 (socio-economic characteristics).  $e$  indicates error term. Hypotheses for the regression  
183 analysis were:

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

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

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

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

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

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

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

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

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

204

## 205 **Statistical Analysis**

206 This study used three statistical analyses. First, the descriptive analysis was performed using  
207 Microsoft Excel 2016. The second and third analyses involved Exploratory Factor Analysis  
208 (EFA) and parametric data analyses (Multiple Linear Regression). The sample data collected

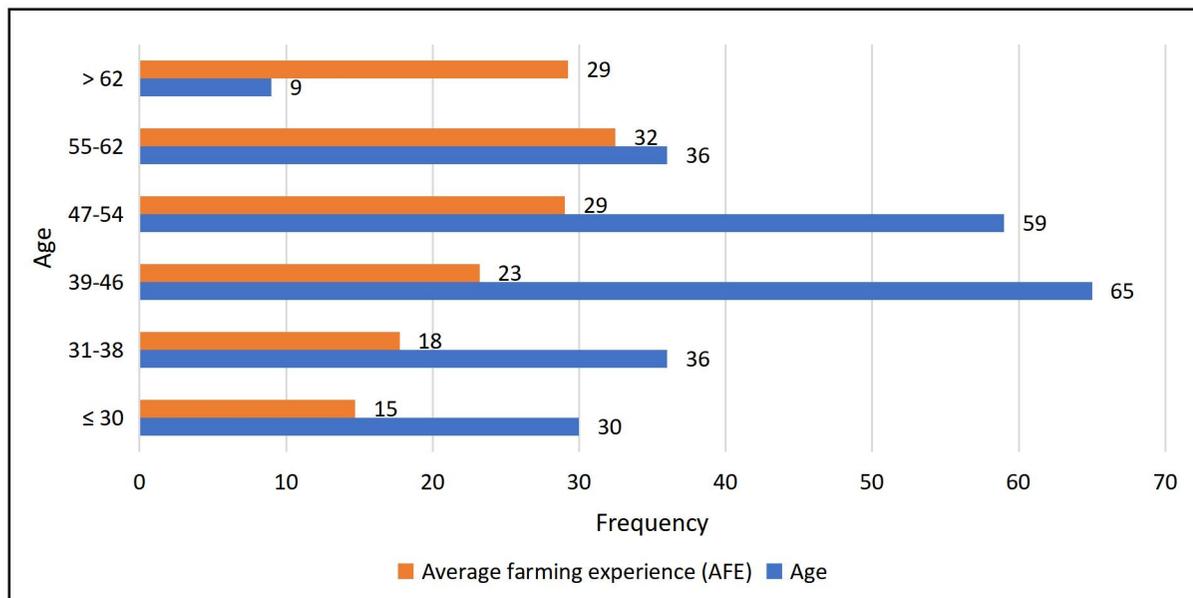
209 were entered and screened using SPSS 23 to analyze factors affecting the WTP of rice  
210 farmers in water services fees. The significance ( $\alpha$ ) for this study used 5%. The  $p$ -value is  
211 expected less than 0.05 ( $p < 0.05$ ).

212

## 213 RESULTS AND DISCUSSION

### 214 Socio-economic characteristics of rice farmers

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



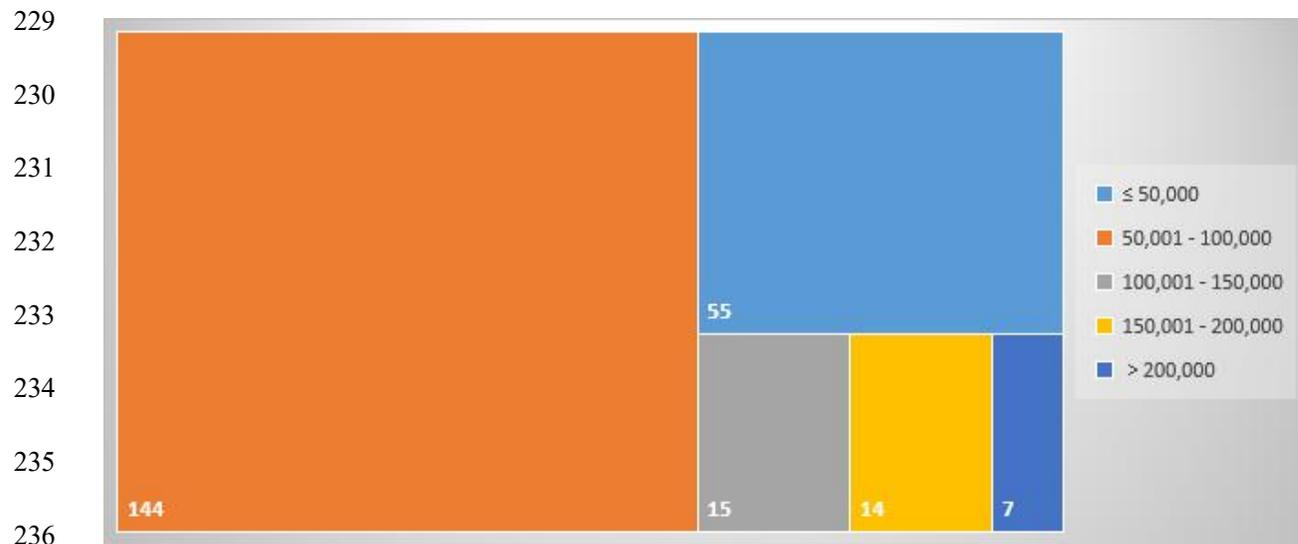
219

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

221

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

227 age as illustrated in Figure 2. The higher the age of the farmer, the longer the farmer has  
228 experience in farming.



237 **Figure 3** Willingness to Pay (Rupiah)

238

239 **Figure 3 showed 235 respondents who were willing to pay water management fees (WTP).**

240 The **number** of fees offered by respondents varied widely. More than half of the respondents,  
241 144 farmers, were willing to pay dues in the range of Rp 50,001 – Rp 100,000. A small  
242 proportion of respondents, 55 farmers, chose to pay a fee of ≤ Rp 50,000. Those who were  
243 willing to pay dues ranging from Rp 100,001 – Rp 150,000; Rp 150,001 – Rp 200,000; and ≥  
244 Rp 200,001 were 15, 14, and 7 respondents respectively. This shows that, on average,  
245 farmers were more likely to pay fees ranging from Rp 50,000 to Rp 100,000. Only 15.32% of  
246 the respondents were willing to pay higher than the average value of willingness to pay  
247 (rupiah).

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248

### 249 **Exploratory factor analysis (EFA)**

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

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253

### 254 **Table 2** KMO and Bartlett's Test

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

256

257 Table 1 shows the results of the Exploratory Factor Analysis (EFA). The value of Bartlett's  
258 Test of Sphericity was seen from its significance of  $p < 0.05$  or  $0.000 < 0.05$ , which means  
259 that the correlation between the indicators was acceptable for factor analysis. The KMO test  
260 was used to demonstrate multicollinearity. The KMO test also helps ensure the fitness of the  
261 indicators used for factor analysis. Factor analysis will be appropriate if the KMO value is  $>$   
262  $0.60$  (Pallant, 2016). Based on Table 1, the KMO value of  $0.608$  showed that the data do not  
263 have any significant multicollinearity problems, so the indicators can be used for further  
264 analysis (Kaiser, 1970; Prasetyo et al., 2019) . This analysis reduced 10 variables to 7  
265 variables, which will be used in multiple linear analyses.

266

267 **Factors influencing WTP on water services fees**

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

271

$$\begin{aligned}
 272 \quad Y_{\text{WTP}} = & 102108.020 - 1789.067 X_1 - 3325.846 X_2 + 1043.242 X_3 + 4017.617 X_4 \\
 273 \quad & - 10284.346 X_5 + 5027.343 X_6 + 24.498 X_7 + e \qquad \qquad \qquad (3)
 \end{aligned}$$

274

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

281

282 **Table 3** Results of the analysis on factors affecting WTP

Model	Unstandardized Coefficients			Sig.	Collinearity Statistics	
	B	Std. Error	t		Tolerance	VIF
(Constant)	102108.020	23544.043	4.337	0.000		
Age	-1789.067	317.625	-5.633	<b>0.000**</b>	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	<b>0.001**</b>	0.701	1.427
Education (year)	4017.617	901.528	4.456	<b>0.000**</b>	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	<b>0.008**</b>	0.886	1.128

Distance to Main Channel	24.498	7.225	3.391	<b>0.001**</b>	0.941	1.062
--------------------------	--------	-------	-------	----------------	-------	-------

a. Dependent Variable : WTP

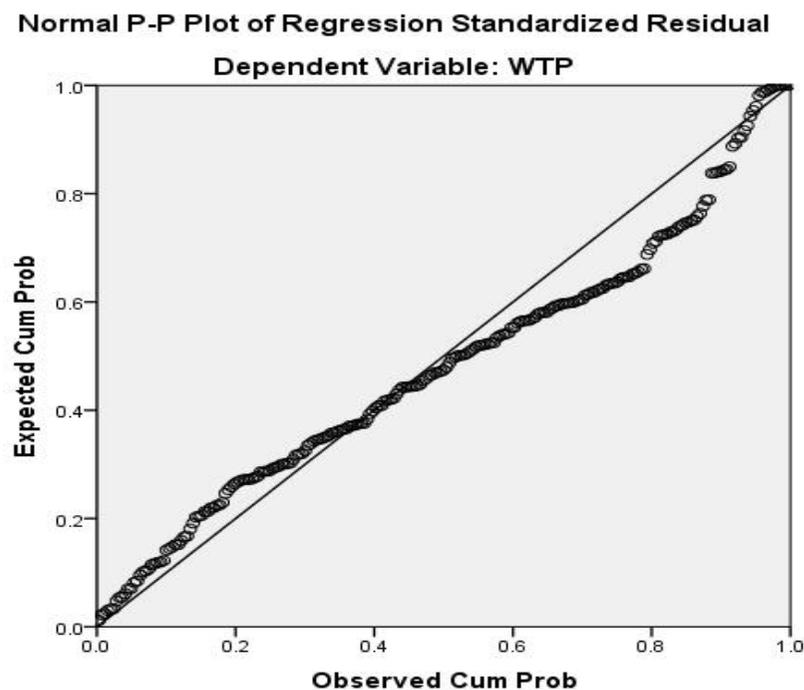
b. \*Significant at  $\alpha = 15\%$

c. \*\*Significant at  $\alpha = 5\%$

283

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

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



290

**Figure 4** P-P plot for data normality

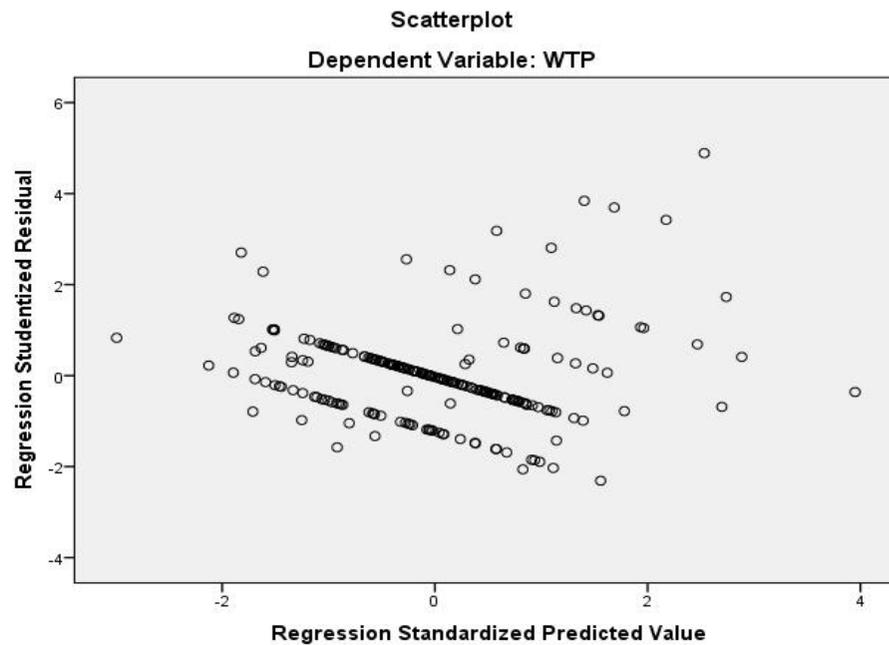
291

292

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

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

299



300

301 **Figure 5** Scatterplot for homoscedasticity

302

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

310 The independent variable of age has a significant negative influence on the dependent  
311 variable (WTP). The estimated parameter value is -1789.067. This means that the higher

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

320 Household size is the number of family members in one household. The results in Table 2  
321 showed that the household size variable had no significant effect. This means that every unit  
322 increase in the number of family members will not greatly affect the amount of WTP. The  
323 estimated parameter value of this variable was -3325.846. This means that the WTP paid will  
324 be reduced by 3,325.846 rupiahs for each additional member of the family. A different  
325 family number normally means an additional child (or children) and therefore that this family  
326 will incur more expenses for non-agricultural activities or primary consumption (Aydogdu,  
327 2016; Tang et al., 2013).

328 (Purba et al., 2021) stated that in tidal lowlands, the agricultural sustainability index was  
329 25.53%. This means that currently, the practice of tidal farming is still unsustainable. Tidal  
330 lowlands farmers in Muara Telang had existed since the 1960s through the transmigration  
331 program. The experience of farmers in agriculture certainly plays an influential role in the  
332 improvement and sustainability of tidal lowland agricultural production. Older farmers  
333 certainly have more extended experience than younger farmers (Bloomfield and Zahari, 1982;  
334 Łukawska-Matuszewska et al., 2018). Farmers with longer experience will consider making  
335 voluntary contributions to the sustainable operation, maintenance, and management of  
336 infrastructure, including channels, water gates, and other supporting irrigation structures.

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

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

357 WTP for water management must be carried out continuously, so management will be  
358 sustainable. At least once a year, a fee is charged to maintain water infrastructure. However,  
359 if it is undone WTP, the frequency of contributions will not be scheduled. In the (Kpadé et al.,  
360 2017; Mutaqin and Usami, 2019; Shee et al., 2020), fees for water management were ideally  
361 carried out twice a year or in every cropping season. Therefore, the groups will have savings

362 in case of sudden damage to the water structure. The results in Table 2 showed that WTP  
363 frequency had no significant effect on alpha 5% on WTP for water. The influence of  
364 frequency was negative. This meant that the higher the frequency of payments, the lower the  
365 amount of WTP that would be paid. For every increase of one unit of WTP frequency, the  
366 money paid would decrease by 10,284.346 rupiahs.

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

380 In (Reflis et al., 2019) research, the key to farmers' participation in paying water services  
381 fees was the distance between the rice fields and the main water source (main channel).  
382 Distance from main channels (as water resources) to fields (meters) has a significant positive  
383 effect. The estimated parameter value is highly substantial. Thus, for each additional  
384 increase in land distance to the main channel by one unit, the WTP paid will increase by  
385 24,498 rupiahs. (Koehler et al., 2015) stated that it would require more expensive service

386 costs if the distance were further. This makes farmers unwilling to participate in paying

387 water fees.

388

389 **Table 4** The average of farmers' WTP

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

390

391 WTP estimation was calculated based on the data distribution of respondents obtained by

392 dividing the total WTP by the number of respondents. The results of the calculation can be

393 seen in **Table 4**. The estimated WTP of Rp. 101,297.87 was applied every cropping season.

394 This value was determined by the willingness and ability of farmers by considering WTP

395 factors that had a significant effect. The results of this WTP estimation can provide

396 consideration for determining policies and sustainable management of water resources,

397 especially for tidal lowland agriculture (Cheung and Jim, 2014; Hizami et al., 2014; Kolahi et

398 al., 2013).

399 In this research, WTP in water services fees accounted for the operation, maintenance, and

400 management of water infrastructures such as canals and water gates. In the research

401 of (Purba et al., 2020) in Muara Telang, the use of agricultural inputs was excessive and

402 inefficient, affecting rice production in tidal lowlands. Not only was production affected, but

403 it was also polluting the soil and water. Excessively chemical soil conditions will block the

404 air aeration and water flow in the soil. This results in the growth of plant roots being

405 automatically disrupted. The flow of water that is not smooth causes the soil to become moist,

406 and eventually, fungus and various germs grow. This problem causes a decrease in

407 productivity (Ikoyi et al., 2018; Imanudin and Armanto, 2012; Zhang et al., 2018).

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408 In tidal lowlands agriculture reclamation, there are often problems with flooding, lack of  
409 water, salinity, and pyrite content, which are dangerous to rice production. In addition to  
410 these problems, inefficient inputs also raise land fertility problems, requiring regular land  
411 washing to remove the remaining chemical content in the land. Land containing pyrite, if  
412 oxidized, will constrain rice growth. In terms of sustainable development, the 2030 agenda is  
413 expected to control water pollution as an international and national priority (Mateo-Sagasta et  
414 al., 2017; Nurita and Ar-Riza, 2014; Purba et al., 2020; Shamshuddin et al., 2004). In tidal  
415 lowlands agriculture, intensive shallow canals were built to wash acidity and toxicity from  
416 the land. Therefore, maintenance of channels and other water infrastructure needs to be  
417 carried out periodically to prevent damage that can cause any problems. In addition, the  
418 operation of the floodgates must also be carried out according to water needs and the  
419 cropping calendar (Ar-Riza and Alkasuma, 2008; Suprianto et al., 2010; Widjaja-Adhi et al.,  
420 1997). This requires a large amount of money. So, WTP can be applied to reduce problems  
421 and support sustainable production.

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## 423 CONCLUSION

424 This study concludes that WTP for water services fees can be used sustainably. This research  
425 ultimately aimed to obtain significant factors that were used as indicators in determining the  
426 willingness of farmers to pay water service fees voluntarily (WTP). Based on the scientific  
427 hypothesis proposed, the significant factors analyzed were age, farming experience,  
428 education, productivity, and distance from land to main channels, where these factors have a  
429 significant effect on WTP for water services fees. Those factors affect 86.5%, and factors  
430 outside the equation model influence the remaining 13.5%. The estimated value of WTP that  
431 can be applied is 101,298 rupiahs (7 – 8 dollars) per cropping season. The WTP collected in  
432 each cropping season can be used for capital in the operation, maintenance, and management

433 of channels and water gates. In addition, WTP would contribute to overcoming the threats to  
434 soil and water contamination and contribute to the achievement of food safety and quality.  
435 This would ensure that the quality of the water irrigating to the land remains sound and that  
436 soil problems such as pyrite can be resolved with routine land washing. This, in turn, would  
437 help to maintain fertile growing conditions, allowing optimal land productivity. So, when  
438 food production is safe and quality is guaranteed, sustainable food production can be realized.  
439 This study is expected that the results can be used to determine the value of WTP towards  
440 sustainability and improvement of water management in tidal lowlands agriculture and  
441 further research in order to highlight further the essential factor of WTP is productivity,  
442 because it affects farmers' income where farmers will be willing to pay contributions if they  
443 have high incomes.

444

#### 445 **AUTHORS' CONTRIBUTIONS**

446 Meitry Firdha Tafari (MFT) wrote the manuscript, developed the theory, and performed the  
447 computations. Muhammad Yazid (MY) was the corresponding author and MY conceived this  
448 research. Muh Bambang Prayitno (MBP) and Muhammad Faizal (MF) provided guide in  
449 collected data. F.X. Suryadi (FXS) corrected the English and typewriting. Khairul Fahmi  
450 Purba (KFB) assisted in data collection. All authors discussed the result and contributed to  
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452

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605

606 **Acknowledgement:**

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

611 068/SP2H/AMD/LT/DRPM/2020. The authors also would like to express great thanks to the  
612 IHE Delft Institute For Water Education, which facilitated the implementation of the PKPI  
613 (sandwich-like) program.

614

615 **Conflict of Interest:**

616 The authors declare no conflict of interest.

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618 **Ethical Statement:**

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

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**Acceptance Letter**  
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Dear Meitry Firdha Tafarini

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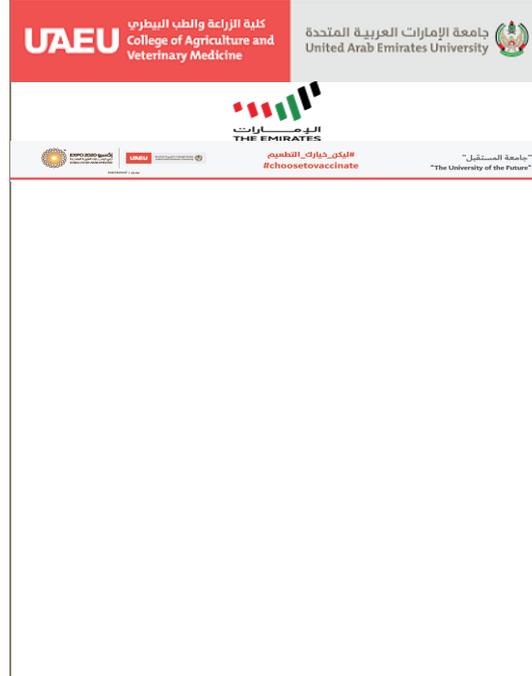
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AQ6: Kindly provide author initial  
AQ6 a has been corrected on page 21, line 456. It had been cited on page 20, line 415  
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Other corrections:

- 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.

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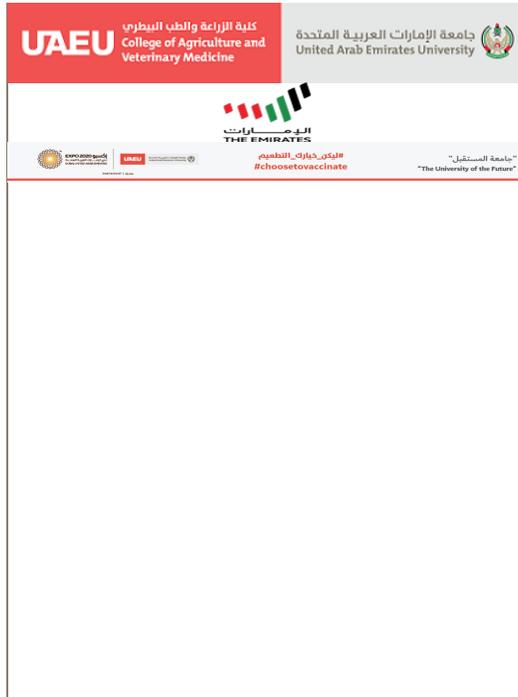
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# **Final Manuscript**

RESEARCH ARTICLE

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

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## 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; Tafari 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

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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:

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

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:

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

where  $Y_{WTP}$  denotes the amount of WTP (rupiah/year).  $\beta_0$  is intercept of model.  $\beta_1 \dots \beta_7$  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 ( $\alpha$ ) 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  $\leq$  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  $\geq$  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.

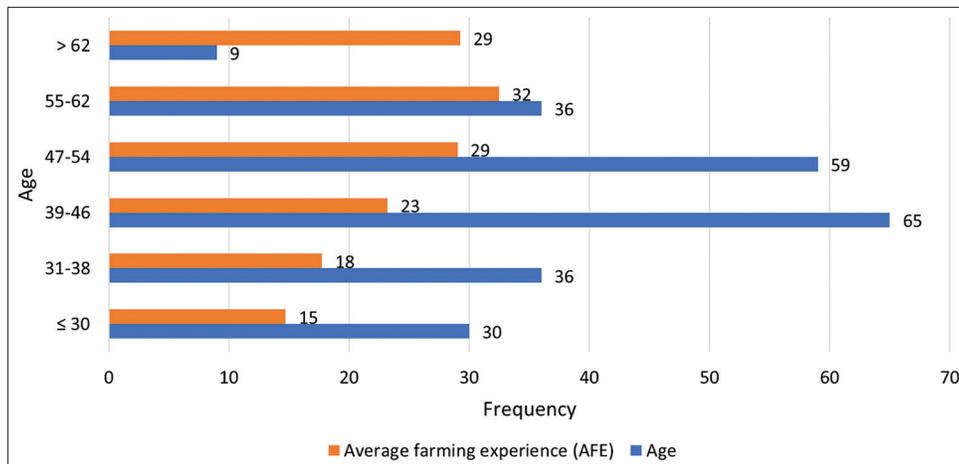


Fig 2. Age of farmers & average farming experience (AFE).

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:

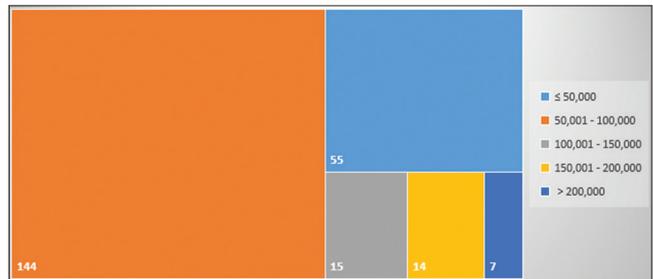
1. Data normality showed in Fig. 4: P-P plot. The points in Fig. 4 approach the straight diagonal line without any length to the right or left of the line.
2. Multicollinearity can be checked through tolerance value and VIF showed in Table 2. In Table 2, tolerance values are higher than 0.1 and VIF values 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 <sup>-1</sup>	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  $< \alpha (0.05)$ . 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

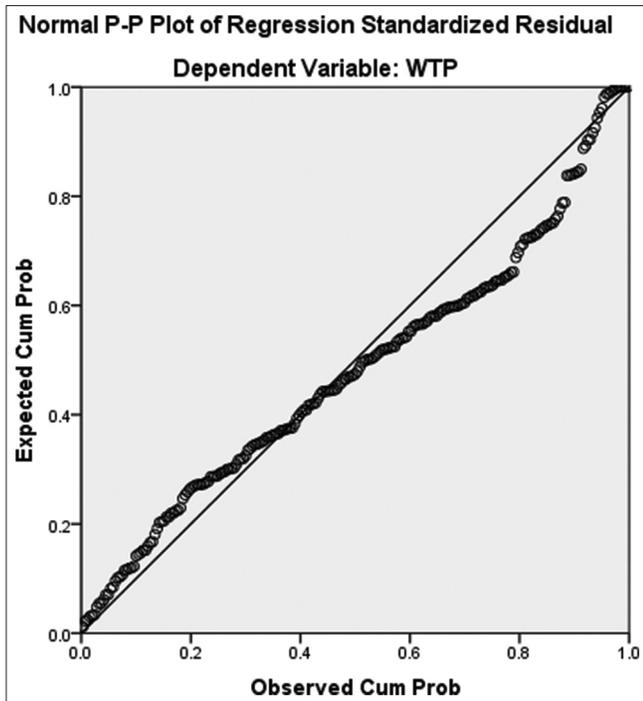


Fig 4. P-P plot for data normality.

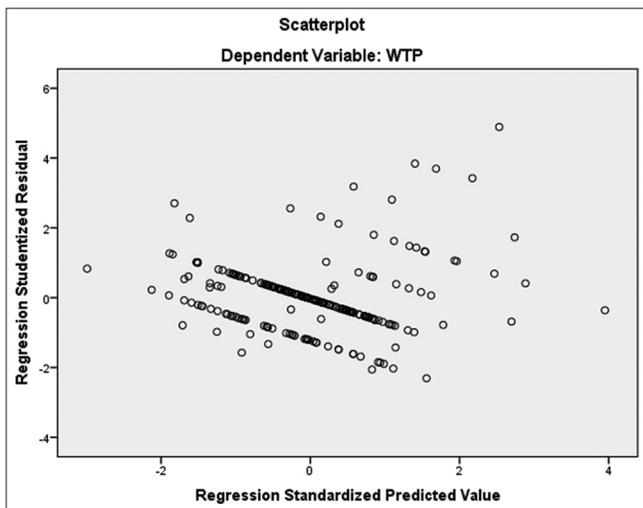


Fig 5. Scatterplot for homoscedasticity.

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	Statistic
WTP	235	10000	375000	23805000	101297.87	3286.023
Valid N (listwise)	235					2537517730.496

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. FX. 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.

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