COMPARING RICE FARMING APPERANCE OF DIFFERENT AGROECOSYSTEM IN SOUTH SUMATRA, INDONESIA

by Dessy Adriani

Bulgarian Journal of Agricultural Science, 24 (No 2) 2018, 189–198
Agricultural Academy

COMPARING RICE FARMING APPERANCE OF DIFFERENT AGROECOSYSTEM IN SOUTH SUMATRA, INDONESIA

IMRON ZAHRI; DESSY ADRIANI*; ELISA WILDAYANA; SABARUDDIN; M. UMAR HARUN
Sriwijaya University, Agriculture Faculty, Kampus Unsri Inderalaya Jl. Palembang Prabumulih KM 32, 30662 Palembang, Indonesia

Abstract

Zahri, I., D. Adriani, E. Wildayana, Sabaruddin and M.U. Harun, 2018. Comparing rice farming apperance of different agroecosystem in South Sumatra, Indonesia. *Bulg. J. Agric. Sci.*, 24 (2): 189–198

Ricefield farming is carried out by farmers on various land typologies, and the most common ricefields are called as technical irrigation, tidal and fresh water swamp land. This study aimed to analyze the existing condition and utilization of land resources owned by farmers, land productivity and farm household income on different land typology. Besides analyzing the relationship between economic and non-economic variables in a rice farming system, this research is also enriched with analysis on different land typology. The results showed that rice fields showing good to less irrigated system are technical irrigation; tidal (its water system influenced by tidal water) and fresh water swamp (strongly determined by rainfall and river water) respectively. The average area of tidal rice fields cultivated by farmers (2.88 ha) is higher than fresh water swamp rice fields (0.88 ha) and technical irrigation (0.56 ha). Most of farmers have increased their owned area by buying new land. The number of *gurem* farmers (cultivated land less than 0.5 ha) in technical irrigation ricefields were more than *gurem* farmers in other ricefields. The better ricefields are technical irrigation, the better cultivation techniques are applied and the higher cropping index was found, the better the productivity level of ricefields was achieved. The productivity of technical irrigation ricefields was not much different from the tidal ricefields, but much higher than Fresh Water Swamp ricefields. Rice farming in tidal areas is more mechanically cultivated, which has caused ability of farmers to cultivate wider land and more efficient rice farming. Income of farmers describing economic efficiency in tidal areas was higher than those of technical irrigation and fresh water swamp farmers. The higher household income was determined, the greater income contribution from on-farm activities was found. The greater income from off-farm activities was earned, and the less number of poor farmers was identified.

Key words: land typology; rice; farm size; productivity; income

Introduction

Rice is the main commodity placed in the economy of Indonesia and several other Asian countries, and increased rice production still needs an effort to meet the food needs of the community (Adriani, 2015; Wildayana, 2017; Haryono, 2014). Rice is generally produced by small-scale farmers. Several studies on small-scale farming have been conducted by Otsuka et al. (2016), Poon et al. (2011) and Wildayana (2015) revealed that agriculture in Asia is dominated by small-scale agriculture, and small-scale farming generally uses labor-intensive production methods. Small-scale agricultural efficiency is lower when compared to large-scale agriculture (Koczberski et al., 2012; Nasir et al., 2015; Demissie and Legesse, 2013). Other facts from Yuya (2014) showed a study in Ethiopia on comparison of technical efficiency of irrigated farmers and rainfed agricultural production founding that there was a positive effect of irrigation on farming technical efficiency, and households participating in irrigation practices, which have improved technical

**Corresponding author:* dessyadriani@fp.unsri.ac.id

efficiency 8.92% compared to households not participating in irrigation practices. Adriani et al. (2017) also showed that the positive impact of the use of technological innovation of farming to increased allocation of working time, to decrease underemployment, income generating and livelihood of rice farmers' households in sub optimal land. Villano et al. (2015) conducted a study to measure the impact of modern rice technology on agricultural productivity in the Philippines, and one conclusion is that the adoption of certified seeds has a significant and positive impact on productivity, efficiency and net income in rice farming in the Philippines. Arifin (2007), that the problem of rice farming in Indonesia is the number of *gurem* farmers (small farmers with less than 0.5 ha of cultivated land), more and more in Java. The results of Munajad's research (2012) of farmers in the technical irrigation area had the largest land (65.7%) less than 0.72 ha and land fragmentation has occurred due to the inheritance system. The potential for expansion of the area by opening new areas in the technical irrigation typology area can not be done. Zahri and Febriansyah (2014) said that the ability of households to work on ricefields of Fresh Water Swamp typology with traditional technology is only about 1.00 ha and the expansion of cultivated area is still possible because there is still a lot of land that is not cultivated (Wildayana et al., 2017). While the area of typology of tidal land with farmers generally comes from transmigrants are still allowing for the expansion of rice farming areas.

Ricefield farming is carried out by farmers on various land typologies, and the most common ricefields are called as technical irrigation, tidal and fresh water swamp land. Technical irrigation ricefields are the result of the construction of irrigation networks by the government with the volume of the regulated and measured water entering ricefields. The technical irrigation ricefields are better than the semi technical irrigation and tidal ricefield with draenase networks built by the government with adjustable water volume, but it can not be measured (measurable but unmanageable) and much more better that than Fresh Water Swamp ricefields. The fresh water swamp ricefields are still less developed by the government with water volume can not be regulated and can not be measured, which it is more like a rain-fed ricefield. It's different from land typology of technical irrigation ricefields. Differences of land typologies described the differences in technical engineering on the regulation and measurement of irrigation water, which will lead to the different practice of cultivating for food crops, resulting in different productivity and income (Eshetu and Mekonnen, 2016; Armanto et al., 2013).

South Sumatra Province is located in Western Indonesia and belongs rice producing center in the three land typologies, namely technical irrigation, tidal and fresh water swamp. Tidal area in Indonesia is estimated at 20.11 million ha, tidal swamp area which has potential for agricultural business covering 9.53 million ha and already reclaimed area of 4.17 million ha, mostly located in lowland along the east coast, especially in South Sumatra Province, Riau and Jambi, and few in North Sumatra and Lampung. The reclaimed tidal swamp area for the widest transmigration program in Indonesia is found in South Sumatera Province, which is 0.38 million ha.

Fresh water swamp areas in Indonesia are around 13.26 million ha and have been cultivated areas of 0.73 million ha. Fresh water swamps are located in lowland area which is a basin area separated by river by river embankment, has character generally flood in rainy and dry season in dry season. Fresh water swamp ricefield farming done in the dry season, which starts from April to September. The water requirement for rice farming depends on rainfall. South Sumatera Province has fresh water swamp area that has been planted with the most extensive rice in Indonesia that is 0.27 million ha planted with rice and while not planted with an area of 0.08 million ha. Fresh water swamp includes suboptimal land that has potential as an alternative for the development of the agricultural sector, along with the decline in the ability of potential land in producing food production. Fresh water swamp area is located near to Palembang and its surrounding. The technical irrigation ricefields in Indonesia were recorded in an area of 4.42 million ha, and in the Province of South Sumatra there are around 0.17 million ha.

Therefore this study aimed to analyze the existing condition and utilization of land resources owned by farmers, land productivity and farm household income on different land typology. From this study, it is expected that the results of this study can be used as input for the government in making policies that giving a lot of benefits to the farmers.

Material and Methods

Description of the study areas

This research was conducted in South Sumatera Province specifically in ricefields of technical irrigation, tidal and fresh water swamp. Tidal swamp area is a coastal area of South Sumatra in the north and east of Palembang (capital of South Sumatra Province) and coastal area about 90 km north of Palembang city. Tidal swamps are mostly formed as a result of sedimentation forming several deltas from the mouth of the Musi River and several other major rivers, and the water condition is strongly affected by tides. The technical irrigation ricefields are located in East OKU and Musi Rawas Districts because the districts have the largest areas of technical irrigation ricefields.

The research location was determined by purposive sampling consisting of land typology as follows: tidal swamps of Banyuasin district (this location can only be reached by river transportation only, about 60 km from Palembang with 2 hours of traveling time); Fresh Water Swamp are located in Ogan Ilir district, about 35 km from Palembang (reached by land transport with travel time about 45 minutes); and technical irrigation ricefields are sited in East OKU district and located in the southern city of Palembang (about 300 km traveled by car transport for 5 hours).

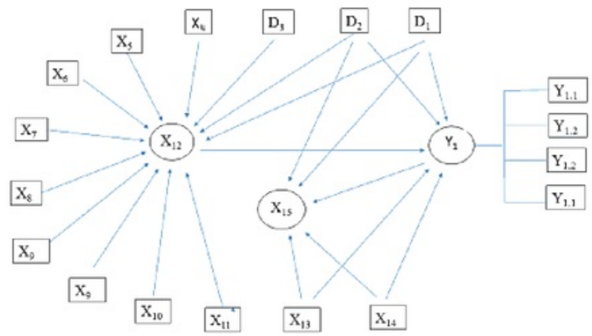
Sampling and sample size determination

This research was conducted by using survey method with primary data collection at three locations of ricefields (namely technical irrigation, tidal and fresh water swamp). In each location was taken two villages, and in each village was randomly selected 50 sampling farmers because the average population of each village in South Sumatra of around 500 households, meaning that each village is on average taken as an average of 10% of the total population. Thus the number of respondents were selected around 300 respondents in six villages and three districts, and sampling techniques used disproportionate stratafied random sampling.

Empirical model specification

In production economics theory, the production process is the conversion of inputs to produce the output and purpose of the agricultural production business is to get the maximum profit. In each land typology, some inputs are used in the agricultural production process, including land, labor, the cost of obtaining the materials and tools used. If the input of production varies among farmers it will produce varied productivity as well. Productivity variation can also be influenced by family demography factor because it can become the determinant factor of farmer's ability to manage their farming, so that in turn will affect the productivity of rice farming. Both indirectly and directly inputs of production and managerial capability of farmers will affect the income of farm households. Farm household income can be used as a "proxy" of welfare.

From the diagram of the relationship between these variables can be derived model estimator (Figure 1), which is the structural equations and identity equations and states the logical functional relationship of all endogenous variables and exogenous variables. The structural equations compiled are equations for the need for partial regression analysis and regression analysis simultaneously. Simultaneous regression analysis to know behavior of rice farming by farmer household on different land typology was done by using 3 SLS method with endogenous variables and explanatory variable (prediterminant variable).



Explanation: D_1 = Land typology 1 (D_1 = 1 tidal and irrigated, D_1 = 0 Fresh Water Swamp); D_2= Land typology 2 (D_2 = 1 tidal, D_2= 0 Fresh Water Swamp and irrigated). Croping system (D_2 = 1 tidal/tabela, D_2= 0 Fresh Water Swamp and irrigation/conventional); D_3 = Croping system (D_3 = 1 mechanic, and D_3 = 0 conventional); X_4 = Cultivated land; X_5 = Seeds; D_6 = Soil cultivation method (D_6 = 1 tidal and irrigated/mechanic, D_6 = 0 fresh water swamp /manual); X_7 = Urea fertilizer; X_8 = TSP fertilizer; X_9 = KCl fertilizer; X_{10} = NPK fertilizer; X_{11} = Production costs; X_{12} = Land productivity; X_{13} = Age of farmers; X_{14} = Potential of family labor; X_{15} = Education of household members; Y_1 = Income of farmer's households ($Y_{2.1}$ from rice farming, $Y_{2.2}$ from non-rice farming; $Y_{2.3}$ from off-farm, and $Y_{2.4}$ from out-farm)

┈┈┈ = consist of ▭ = exogenous variables

⟶ = influencing ⬭ = endogenous variables

Fig. 1. Relationship between variables in the household economic system of farmers

Data types, sources and collection

The collected data consist of primary and secondary data. Primary data were collected from cross-sectional data for a period of one year (period 2015/2016). Quantitative primary data consist of family demographic characteristic, characteristic of ricefields on three land typologies consisting of land area, cropping pattern, utilization of production input and labor, land productivity, farmer household income and expenditure, and problems encountered collected from 300 respondents. Primary data collection was conducted by using structured questionnaires filled by enumerators of lecturers, students and alumni of Sriwijaya University. Secondary data were related to the aspect studied collected from BPS publication, and other related institutions.

Processing and analysis of data

The recorded information from the questionnaire was transferred into the absorption table of first stage and after that it was transferred to the second stage absorption table using the excel program computer. Data stored in excel program can be called for descriptive data analysis and equations in econometric model with simultaneous equation system approach. In the initial model of simultaneous equations there are four structural equations and two identity equations. Using the approach developed by Koutsoyiannis (2001), the calculation of parameter estimator can be used method of three SLS (three state least squares). Selected variables were included in the model of household economic system, so that there are three endogenous variables and 13 explanatory variables. Identification model was done by using Gujarati approach (1995) based on order condition:

$$(K\text{-}k) \geq (m\text{-}1)$$

where: K = number of determinant variable; k = number of predetermined variables in the equation, and m = number of endogenous variables in the model.

If (K-k) = (m-1) then the equation is correctly identified,

If (K-k) > (m-1), then the equation is identified excessively, and

If (K-k) < (m-1), then the equation is not identified.

In this analysis the value of K = 16, the value k = 13, and the value m = 3. Regression analysis with the simultaneous equation was identified excessively, so the analysis can be implemented. Model estimation was done by calculation of parameter estimator and was done by using computer application program SAS (Statistical Analysis System). Model validation used approaches from Pindiyck and Rubinfield (1991), and the simplest criterion used is the coefficient of determination (R^2).

Results and Discussion

Descriptive Data Analysis

Farmers in the technical irrigation areas are descendants of former transmigrants who were brought to this area around 1937 through the transmigration program of colonization. In the framework of colonization, the government built an irrigation network, so called as ricefields with technical irrigation system. Farmers in the tidal areas were former transmigrant farmers who were imported first in 1969, and subsequently brought in large-scale transmigrants until about 1986. The government built drainage networks to regulate tidal drainage, but water could not be entirely regulated for agricultural needs food crops, so some still depends on the tides. The *Fresh Water Swamp* is flooded areas during the rainy season and dries during the dry season, which is from April to September. Farmers cultivate rice in the dry season. The main problem with *Fresh Water Swamp* is irreversible water, so it cannot be measured and farmers sometimes experience crop failure due to flood or drought conditions.

Household characteristics of rice farmers in three land typologies can be seen in Table 1. The average age of household head, number of family member and potential of farmer labor at three-research location were not much different. The education of farmers' family heads are ranged from non-school/non-primary school to senior high school, whereas the education of farmer's families varied between non-primary school and college graduates. If it is calculated in the educational year, it appears that the level of education of households in the technical irrigation area was better than other areas, namely the average of junior high school, while in the tidal and fresh water swamp level of education between primary school to junior high school.

The land area occupied by farmers in the three research sites can be seen in Table 2. The land area of farmers in the tidal area is 2.88 ha, much larger than the 0.88 ha of fresh water swamp and 0.56 ha of the technical irrigation farmers. The average cultivated land was around 1.76 ha larger than most farmers of ricefields in Indonesia. Based on data from BPS in 2013, the average rice cultivation area per household in Indonesia was 0.69 ha, and the average of rice field ownership in Java as the national rice barn was less than 0.30 ha. Farmers in the typology area of tidal land as ex-transmigrant farmers initially gained the division of two ha of land for rice and 0.25 ha for home and yard. But now the farmer's land area in the tidal area was on average 2.88 ha which consists of more than 1 land of famine. The original area of 2.0 ha has been changed to an average of 1.95 ha, meaning there has been a kind of land cleavage. The addition and subtraction of land area is generally carried out by purchasing and selling land and opening other areas, as well

Table 1
Descriptive statistics on sample characteristics of households

Variable	Unit	Technical irrigation	Tidal	Fresh Water Swamp
Age of farmers	Year	47.3	48.54	47.4
Family size	People	4.1	3.55	3.7
Potential labor	HOK	753	667	712
Education	Year	37.1	22.86	24.96
Origin of farmers				
Local	%	16	5	100
Migrations	%	84	95	0

Source: Result of field survey (2017) and statistical analyses (2017)

Table 2
Area of land crop farming

Variable	Unit	Technical irrigation	Tidal	Fresh Water Swamp
Farm size	Ha	2.88	0.88	0.56
Land 1	Ha	1.95	0.77	0.51
Land 2	Ha	0.93	0.11	0.05
Gurem farmers	%	8	48	61

Source: Result of field survey (2017) and statistical analyses (2017)

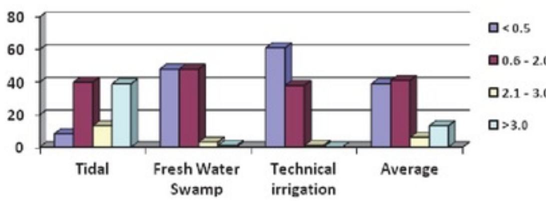


Fig. 2. Percentage of farmers based on land size

as the inheritance system. Smallholder farmers in the technical irrigation area are 61%, 48% on land and 8% in tidal land. Percentage of farmers based on land size can be seen in Figure 2.

Figure 1 showed that the largest percentage of tidal farmers has a land area between 0.6-2.0 ha/farmer, and fresh water swamp and technical irrigation farmers showed the same level percentage (0.5 ha/farmer). The average size of the cultivated area with the highest percentage was the area of between 0.6-2.00 ha/farmer, except the ownership of technical irrigation land.

Different cropping patterns have different cropping patterns as shown in Figure 3. Farmers of technical irrigation and tidal areas have been able to conduct rice farming and other cultivation activities at two growing seasons (cropping index of 200), but in the technical irrigation areas are already planted in three planting activities (such as by fish). Rice in the fresh water swamp area is cultivated only once a year in the dry season in the months of March to September. The timing of rice farming in fresh water swamp area is a form of local wisdom that is farmed according to natural rhythm. In addition to adjusting the planting time with water levels in the area of ricefields, local wisdom is also done with a floating nursery system because the land is still inundated; selecting seeds that resist puddles and fertilize the conditions of the flooded land.

The characteristics of farming system in three-land typology can be seen in Table 3. The table shows the variation of planting, soil processing, and fertilizing and harvest methods. There is a tendency that difference in land typology causing differences in farming practices that are carried out with land characteristics with better irrigation/drainage using better cultivation practices as well. Types of rice varieties used are generally superior varieties, but for nurseries, planting and harvesting are done in different ways. In the technical irrigation areas, farmers conduct nurseries, land treatment using tractors and harvesting done with slashing system, threshed and dried. Farmers in tidal areas no longer do nursery rice, but by planting the seeds directly (tabela), soil processing and harvesting is done mechanically, that is by using agricultural machinery, while farmers in the Fresh Water Swamp area, nursery and include a floating nursery, land processing is not done and harvesting is done with slash system.

The existence of different cultivation practices will lead to the use of different labor and with relatively little use. The uses of family labor for one season of rice farming in the technical irrigation technical areas, the tidal area and in the Fresh Water Swamp area were on average 19.6; 16; 40.41 day work (HOK) respectively. The little labor use for rice farming in tidal areas was because using tractors did land preparation, rice planting is done without nursery and with the tabela system, and rice harvest is done by using the combined harvester machine. Farmers in the technical irrigation areas used a lot of family labor and also use wage labor, such as for planting and harvesting. The existence of mechanization in rice farming causes the ability of farmers to work on wider land and there is a reduction of manpower.

The productivity of ricefields with better irrigation/drainage systems leads to higher productivity. The highest productivity

Ricefields	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Technical irrigation	Rice farming MT 1*/					Rice farming MT 2				Rice farming MT 1		
Tidal	Rice farming MT 1				Rice farming/corn/fallow					Rice farming MT 1		
Fresh Water Swamp	Fallow				Rice farming						Fallow	

Explanation: MT 1 (cropping season 1); MT 2 (cropping season 2)
Source: Result of field survey (2017) and statistical analyses (2017)

Fig. 3. Rice farming system calendar on three land typologies

Table 3
Characteristics of food crop farming

Variable	Unit	Technical irrigation	Tidal	Fresh Water Swamp
Planting methods				
Conventional	%	100	0	100
Tabela	%	0	100	0
Soil cultivation				
Manual	%	0	0	100
Mechanic	%	100	100	0
Fertilizer uses				
Not recommended	%	50	70	100
Recommended	%	50	30	0
How to harvest				
Manual	%	100	50	100
Mechanic	%	0	50	0
Ricefield cost	Rp Million/ha	5.90	5.12	1.44
Productivity	Kw/ha/MT	40.14	39.09	13.72

Source: Result of field survey (2017) and statistical analyses (2017)

per planting season (MT) was reached by technical irrigation farmers averaging 40.14 quintals /Ha, the average tidal area was 39.09 kw/ha, and the lowest in the area with average productivity of 13.72 quintals per ha. Based on data from Indonesian Central Bureau of Statistics in 2015, rice field productivity in Indonesia amounted to 55.08 quintals per hectare and in the province of South Sumatra amounted to 49.98 quintals per ha. So the rice productivity in three study locations is still lower than the productivity of Indonesian rice and the rice productivity in South Sumatera Province. But if farming in irrigated and tidal ricefields is done on two growing seasons, the productivity of ricefields is higher than rice productivity of Indonesia and productivity of swamp rice in South Sumatra Province. The income and expenditure structure of households in the three research locations can be seen in Table 4.

Total household income varied and the highest average income was found in the tidal areas, followed by technical irrigation and *Fresh Water Swamp* areas. The largest source of income in these three locations come from on-farm activities, and the largest revenue source from out-farm was for *Fresh Water Swamp* farmers. This suggests that in areas with better irrigation/drainage systems, revenue generated from on-farm ac-

Table 4
Structure of household income and expenditure of farmers

Variable	Unit	Technical irrigation	Tidal	Fresh Water Swamp
Total income of households	Rp Mill/year	54.14	61.69	25.96
Sources				
On farm	%	74.0	97.2	59.0
Off farm	%	7.0	1.8	7.4
Out farm	%	9.0	1.0	33.6
Total income in US$	US $	4 164.85	4 745.54	1 996.69
Number of family members	People	4.14	3.55	3.73
Education of family members	Year	15.71	22.86	16.26
Income/capita/year	US $	1 006.00	1 336.77	535.31
The poor	%	27	9	57
Household expenditure	Rp Mill/year	26.61	27.92	18.34
Food consumption	%	43.0	35.42	41.4
Non-food consumption	%	38.4	39.59	49.1
Investment	%	6.1	21.97	6.2
Savings	%	12.5	3.19	3.3

Source: Result of field survey (2017) and statistical analyses (2017)

tivities was greater. On-farm activities consisted of rice, maize, chili, livestock and fishery; while off-farm activities come from labor, and out-farm activities consist of trading, carpentry, home industry, transport services and others. Farmers who do farming besides rice reached around 39% and worked as farm labor reaching around 33%. Various alternatives that have been done by farmers in fresh water swamp area to diversify the business, such as horizontal diversification in the form of adding branches of business, such as *lele* fish farming, development of Pegagan duck, swamp buffalo, floating farming, etc., and vertical diversification such as technological improvements post-harvest and marketing improvement of local products.

If it is seen by the household expenditure of farmers in three areas of land typology, the average amount of expenditure was smaller than household income, meaning that there is a surplus of household income of food crop farmers. The use of such income surplus cannot be captured in this study, but it was estimated that such surplus was used by some farmers for investment activities, such as buying arable land.

Impact of land typology differences: Simultaneous Regression Analysis

Simultaneous regression analysis to know farming behavior by farmer households on different land typology using SLS 3 method was done through various stages to get the best estimator model. Result of analysis of estimation of farmer household farming system model in three typology of land can be seen in Table 5.

Table 5
Estimation of parameters of the behavior equation of farmer household farming

No	Variable	Alleged Parameter Value	t-calculated	Prob>t
1	Land productivity (X_{12})			
	Intercept	12.7886	3.121	0.002
	D_1 = Land typology 1	22.4865	7.414	0.000
	D_2 = Land typology 2	0.7959	0.201	0.841
	D_3 = Harvest method	10.6795	3.242	0.001
	X_4 = land size	-0.8758	-1.028	0.305
	X_7 = Urea fertilizer	1.6974	1.903	0.058
	X_8 = TSP fertilizer	-1.2722	-1.237	0.217
	X_9 = KCL fertilizer	4.3895	0.733	0.464
	X_{10} = NPK fertilizer	-2.0923	-2.657	0.008
	X_{13} = Age of farmers	0.0463	0.648	0.517
	X_{14} = Labor potency	-0.0063	-1.564	0.119
	X_{15} = Education	0.1370	1.913	0.057
	F-calculated = 19.005; DW = 1.643			
2	Income of households (Y_1)			
	Intercept	-9.7161	-0.762	0.447
	X_4 = land size	3.6341	2.256	0.025
	X_{12} = Land productivity	1.1163	5.238	0.000
	X_{13} = Age of farmers	0.3922	1.876	0.062
	X_{14} = Labor potency	-0.0511	-4.46	0.000
	X_{15} = Education	1.2968	7.144	0.000
	F-calculated = 9.909; DW = 1.877			
3	Education (X_{15})			
	Intercept	3.718447	1.006	0.315
	Y_1 = Income	0.2084	3.923	0.000
	D_1 = Land typology 1	3.5071	1.505	0.134
	D_2 = Land typology 2	-11.3038	-6.260	0.000
	X_{13} = Age of farmers	-0.2062	-3.243	0.001
	X_{14} = Labor potency	0.0367	12.909	0.000
	F-calculated = 45.895; DW= 1.963			
	R^2 system = 41.34 %			

Source: Result of field survey (2017) and statistical analyses (2017)

In Table 5 it can be seen that the behavioral equation gives a role to the model of household farming model which is described by the coefficient of determination (R^2) of 41.34%, while partially structural equation with endogen X12 variable (land productivity), Y1 (household income of farmer), and X15 (family education) yielded coefficient of determination (R^2) respectively 42.5%, 14.68% and 44.35%. The value of the coefficient of determination is thus moderate to small, meaning that there are other variables with greater influence not included in the farm household farming model. If we can see the result of partial regression analysis, we can explain the response of the endogenous variable to the explanatory variable variation.

Land productivity of farming (X_{12})

Response variable X12 (land productivity) to variations of explanatory variables is described by the value of coefficient of determination (R^2) of 42.57. The variables that have a positive influence on land productivity are D1 (land typology) and D3 (way of harvest), while X7 (Urea fertilizer) and X15 (education level) have significant effect on land productivity. There are 4 explanatory variables X4 (land area), X8 (NPK fertilizer), X10 (harvest) and X14 (labor potential) have negative relation with X12 variable (land productivity), but seen from the parameter of each estimator the explanatory variables do not show any significant effect.

Household income of farmers (Y_1)

Response variable Y1 (farmer household income) to the explanatory variable is described by the value of determination coefficient (R^2) of 14.68%, meaning only 14.68% variation explanatory variables affect variations of variables Y1. If seen from the sign and the number of other estimator parameters, namely the variables X4, X12 and X15 have a positive effect is very significant, while the X13 variable (farmer age) has a significant positive effect on Y1. The existence of a very significant negative effect of labor potential on household income can be attributed to the low participation of the working age population in the household in working on productive economic activities, especially the still large number of household members who are still attending education, some are temporarily unemployed, or mothers households who do not work in their husbands' jobs.

Education level of household members (X_{15})

Response variable X15 (farmer household education) to the explanatory variables is described by the value of coefficient of determination (R^2) of 44.35%, meaning 44.35% variations explanatory variables affect variations X15 variables. Judging from the parameter of estimator, there is one variable with negative sign that is X13 variable (age of head of household), and seen from parameter of estimator, the influence is very significant. If seen from the sign and magnitude of other estimator parameters, i.e. variables Y1 and X14 have a positive effect is very significant, while the variable D1 (typology of land) has no effect on X15. But if D2 (a typology that distinguishes between typology of tides and not tides), then the typology of land affects education, that is the education of farmers in tidal areas is higher compared with farmers in the area of Fresh Water Swamp and technical irrigation.

Discussion

From the results of this study can be seen that the area of farmers' land in the tidal area was around 2.88 ha, much wider than the fresh water swamp land (0.88 ha) and 0.56 ha of technical irrigation land. Better land typologies will lead to improve cultivation techniques in the form of fertilizer and harvesting, and thus lead to better farm productivity and income. Farmers' income is positively influenced by land area, land productivity, farmer age and education, while labor potential negatively affects income. Between education and income have a reciprocal effect; higher education will lead to higher household incomes, whereas if household income is high, then there is an opportunity to improve the education of household members. From the analysis it can be seen also that farmers who participate in the land with better irrigation/drainage systems have better technical and economic efficiency.

If farmer's household income was equal to US $ with exchange rate of Rp 13,000 per US $ 1, the farmer's household income in the technical irrigation area was US $ 4,164.88, the farmers in the tidal areas were US $ 4,745.54, and the farmers in the area are US $ 1,996.67 per year. If the poverty line values by the World Bank are used to classify the poor living with less than USD $ 1.25 per person per day, then the poor can be estimated in the technical irrigation area of 27%, the tidal area by 9%, and in the Fresh Water Swamp area of 57%. This shows that the livelihood of some food crop farmers was still colored by poverty, and in areas with better irrigation/drainage systems, the number of poorer farmers was less. According to Adriani (2015), there has been a disguised unemployment at the farm household level, and farmers through social rationality over cover unemployment disguised by the diversification of work structures (new occupations), and the reduction of outside labor in farming activities by maximizing the economic potential of households. This rationality has an economic impact on the reduction of unemployment by 69% and an increase in income of 267% at the micro level.

The area of crop cultivation in Indonesia was 23.1 million ha, while it can still produce food for the community, but increased food production through agricultural intensification and area expansion still needs to be done to meet the food needs of the community in the future as the population grows. Area expansion is still very potential to be done in tidal swamp and Fresh Water Swamp area. The potential for increased rice production through area expansion and productivity increases is on typology of tidal and Fresh Water Swamp land. Expansion of agricultural areas requires the development of infrastructure for irrigation/drainage water management so as to improve the index of cultivation and better cultivation practices. Implementation of better cultivation techniques and productivity to date has proven that the drainage network infrastructure development in the tidal swamp area that has been done by the government has been in the right position, although here and there still needs improvements. Increasing rice production and productivity in tidal areas requires better post-harvest handling and marketing systems.

The unachievable success was the development of infrastructure in the swamp area, causing farmers' ability to cultivate less than 1 ha of land and poor agricultural cultivation practices, resulting in low swamp productivity. Therefore it is necessary to continuous efforts to make the design of site-specific infrastructure development, so that there can be an expansion of swamp ricefields, increased cultivation index and good cultivation techniques, which in turn can increase food production from the fresh water swamp area. To develop the fresh water swamp area, we could have lesson learned from Telang's Independent Integrated City. D Adriani et al. (2018) conducted that Telang's Independent Integrated City Program in tidal land proved to have a great chance of success due to various technological innovations that are available. Farmer's income has been able to cover their decend living needs, so the household are welfare. Judging by local and migrants farmers, the income of migrant farmers is higher than local farmers. From the income structure side, migrant farmers rely more on the livelihoods of the on-farm sector, while local farmers rely more on the livelihoods of the off-farm sector.

Conclusions

- Differences in land typology with better irrigation networks resulted in different land area of different ricefields; tidal ricefields was higher (2.88 ha) than fresh water swamp area (0.88 ha) and technical irrigation ricefields (0.56 ha). There has been fragmentation and splitting of ricefields in technical irrigation and tidal areas, and the number of smallholders (less than 0.5 ha) in the technical irrigation areas was 61%, 48% of the Fresh Water Swamp areas and 8% of tidal areas respectively. Most of the farmers increase the land area acquired by buying land.
- In the better typology of ricefields lead to better agricultural cultivation practices, namely in the case of soil cultivation, how to plant, the intensity of cropping and harvesting. In tidal areas that are more mechanical than irrigated and fresh water swamp areas and the development of mechanization in tidal areas showed more efficient features compared to technical irrigation and Fresh Water Swamp areas. In the fresh water swamp areas have developed local wisdom in terms of doing rice farming in the dry season and farming in accordance with the rhythm of nature.
- The difference of land typology causes the productivity of tidal ricefields and technical irrigation ricefields were not much different, but the rice productivity was much lower. Factors that have positive effect on swamp productivity are land typology, cultivation practice and education level. There is an increasingly widespread trend of cultivated land so the productivity of rice will be lower.
- The level of education of household members of farmers in tidal areas is higher than that of farmers in fresh water swamp and tidal areas. Factors that positively affect the education of household members are income and labor potential, while the age of the head of household negatively affects the level of education. Between household income and the education of household members has a reciprocal relationship.
- Differences in typology of ricefields leads to differences in household income of farmers, higher tidal farmer income compared with technical irrigation farmers and farmers in fresh water swamp. There is a positive relationship between total household income and revenues derived from on-farm activities and there is negative income relationship originating from out-farm activities.
- In areas with higher farmer incomes tends to lead to lower proportion of spending on food consumption, the proportion for non-food consumption that tends to be the same, the proportion of spending on larger investments, and the proportion of spending on larger savings.

Policy implications

○ Improved drainage/irrigation system for typology area of Fresh Water Swamp and tidal with the aim that irrigation water for rice farming can be arranged and measured. With abundant water resources in the rainy season and drought in the dry season it is necessary to continuously strive for site-specific development designs for water regulation and can be used by smallholders for small-scale agriculture.

○ Required efforts to develop agricultural mechanization for agricultural cultivation techniques, so that farmers have the ability to work on a wider land in the area of swamps and tidal Fresh Water Swamp.

○ Business diversification efforts are needed to exploit the potential of excessive labor, especially for farmers who have a narrow land. After production can be improved then it is necessary development and improvement of processing and marketing results.

References

Adriani, D., 2015. Rasionalitas Sosial Ekonomi dalam Penyelesaian Pengangguran Terselubung Petani Padi Sawah Tadah Hujan. *MASYARAKAT*: *Jurnal Sosiologi*, **20** (1): 43-58.

Adriani, D., E. Wildayana, Yulius, A. Idham and H. M. Mustofa, 2017. Technological innovation and business diversification: Sustainability livelihoods improvement scenario of rice farmer household in sub-optimal land. *RJOAS*, **9** (69), September 2017: 77-88. DOI https://doi.org/10.18551/rjoas.2017-09.10

Adriani, D., I. Zahri, E. Wildayana, Maryadi, M. Hamzah and Yulius, 2018. Farmer's welfare in Telang's Integrated Independent City: Lesson Learned from Migrant dnd Local Farmers in Tidal Land, South Sumatera. DOI:10.1088/1755-1315/122/1/012013. *IOP Conf. Ser.: Earth Environ. Sci.,* **122:** 012013

Armanto, M.E., M.A. Adzemi, E. Wildayana and M.S. Imanudin, 2013. Land evaluation for paddy cultivation in the reclaimed tidal lowland in Delta Saleh, South Sumatra, Indonesia. *Journal of Sustainability Science and Management*, **8** (1): 32-42.

Demissie, A. and B. Legesse, 2013. Determinants of income diversification among rural households: The case of smallholder farmers in fedis district, Eastern Hararghe Zone, Ethiopia. *Journal of Development and Agricultural Economics*, **5** (3): 120-128.

Eshetu, F. and E. Mekonnen, 2016. Determinants of off farm income diversification and its effect on rural household poverty in Gamo Gofa Zone, Southern Ethiopia. *Journal of Development and Agricultural Economics*, **8** (10): 215-227.

Haryono, 2014. The Ministry of Agricultural Policy in Developing Inclusive Agricultural Development System for Promoting Farmers Land Sub Optimal. A National Seminar Suboptimal Land. Palembang.

Koczberski, G., G.N. Curry and V. Bue, 2012. Oil palm, food security and adaptation among smallholder households in Papua New Guinea. *Asia Pacific Viewpoint*, **53** (3): 288-299.

Koutsoyiannis, A., 2001. Theory of Econometrics, 2nd ed., *Publishing of Macmillan Education Ltd.*, New York, USA.

Munajad, 2012. Economic improvement strategy farmer households post-occurrence of land fragmentation in rice production Center East OKU District. Graduate Program *Sriwijaya University*, Palembang

Nasir, I. Zahri, A. Mulyana and Yunita, 2015. Business patterns and farmer household income in various typology land swamp. *Jurnal Manajemen & Agribisnis*, **12** (3) November 2015.

Otsuka, K., Y. Liu, and F. Yamauchi. 2016. The Future of Small Farms in Asia. Development Policy Review, *Wiley Online Library*, pp. 441-661.

Pindyck, R.S. and D.L. Rubiensfield, 1991. Econometric Models and Economic Forecasts. 3rd ed. *Mc Graw-Hill Inc*, New York.

Poon, K. and A. Weersink, 2011. Parameters affecting variability in farm and off-farm income. *Agricultural Finance Review*, **71** (3): 379-397.

Villano, R., B.B. Ureta, D. Solís and E. Fleming. 2014. Modern Rice Technologies and Productivity in the Philippines: Disentangling Technology from Managerial Gaps.

Wildayana, E. 2015. Formulating rice fields conversion control to oil palm plantations in tidal wetlands of South Sumatra, Indonesia. *Journal of Wetlands Environmental Managements*, **3** (2): 72-78.

Wildayana, E., 2017. Challenging Constraints of Livelihoods for Farmers on the South Sumatra Peatlands, Indonesia. *Bulgarian Journal of Agricultural Science*, **23** (6); 894-905. http://www.agrojournal.org

Wildayana, E., M.E. Armanto, I. Zahri and M.Y. Hasan. 2017. Novel innovation of subsidized fertilizers based on soil variability and farmer's perception. *Jurnal Ekonomi Pembangunan*, **18** (1): 50-63.

Yuya, B.A., 2014. Comparative analysis of technical efficiency of smallholder irrigated and rain-fed farm production: The case of Girawa District, Oromia, Ethiopia. *Journal of Agricultural Economics, Extension and Rural Development*, **2** (5): 054-062.

Zahri, I. dan A. Febriansyah, 2014. Diversification and its effect on rice farmer household income fresh water swamp. *Jurnal Agrise,* XIV(2), Mei 2014.

Received November, 11, 2017; accepted for printing March, 26, 2018

COMPARING RICE FARMING APPERANCE OF DIFFERENT AGROECOSYSTEM IN SOUTH SUMATRA, INDONESIA

ORIGINALITY REPORT

1%	%	1%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	D Adriani, I Zahri, E Wildayana, Maryadi, M Hamzah, Yulius. "Farmer’s welfare in Telang’s integrated independent city: lesson learned from migrant and local farmers in tidal land, South Sumatera", IOP Conference Series: Earth and Environmental Science, 2018 Publication	1%

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		