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The performance of paddy farming in Aceh province

A Baihaqi^{1,2}, A H Hamid^{1,2}, I Zikri^{1,2}, D Kurniawan^{1,2}, Y D Fazlina³, M Y Wardhana¹, T S Bahri^{1,2*}

¹Agribusiness Department, Agriculture Faculty, Universitas Syiah Kuala

²Pusat Riset Pembangunan Pedesaan dan Pertanian Berkelanjutan Universitas Syiah Kuala

³Soil Science Department, Agriculture Faculty, Universitas Syiah Kuala

*E-mail: tsailbahri@unsyiah.ac.id

Abstract. Aceh Province contributed three percent of Indonesia's paddy production in 2019. This study aims to analyze the farmer's performance and the correlation between income and paddy farmer's performance. The samples were selected using purposive sampling and data were analyzed using descriptive qualitative and Rank Spearman. The results show the average age of farmers is 46 years old, with 20 years experience in average, and the majority are high school graduates. Meanwhile, the average income of the farmers is IDR 15,464,017/ha, with and the average land managed of 0.7 hectares, the average production of 6.5 ton/ha, the average labor use of 32 days. The farmers use the following fertilizers: 125.74 - 216.85 kg/ha urea, 33.71 - 161.61 kg/ha SP-36, 5.62 - 41.99 kg/ha KCl, 19.43 - 70.72 kg/ha ZA, 20.22 - 222.96 kg/ha NPK, 13.69 kg/ha TSP, 7.30 kg/ha NPK Mutiara and 0.82 - 667.57 kg/ha organic fertilizer. In the Central region, female labors strongly dominate the planting, weeding, and harvesting activities. In the north and west region, women are actively planting and harvesting using conventional systems. The Spearman rank analysis shows that the correlations between income and production of 0.930, land tenure of 0.840, the cost of using fertilizer of 0.283, and the cost of using labor of 0.197.

1. Introduction

Paddy farmland is a common main food crop in Indonesia. Paddy is the staple food source for more than half of Indonesia's population and the majority farmers are paddy growers. Furthermore, as population continues to increase, the need for paddy consumption also rises. In 2018, Indonesia's population reached 265,015,300 people and the rice consumption reached 35,512,050 tons [1]. The growth rate of Indonesia's population is on average 1.33% per year, with the requirement of 134 kg per capita [1]. By 2025, Indonesia should be able to produce 78 million tons of paddy for national paddy consumption [2]. In the last few years, national paddy production was low, resulting in around two million tonnes of imported rice in 2001, thus making Indonesia the largest rice importer in the world. Furthermore, efforts to increase paddy production through increasing paddy productivity and increasing farmer's income are always included in government policy plans in the agricultural sector.

The largest paddy production remains concentrated in Java, with a total production of 57.2% in 2018, with the production centers located in East Java Province (18.6%), West Java (16.9%) and Central Java (16.8%). The second-largest amount of paddy production is in Sumatra, with a national contribution of 19.1%, centered in Sumatra Selatan, Sumatra Utara, Lampung, and Aceh Province.

Aceh Province is one of the contributors to paddy production in Indonesia, with a 3% national contribution in 2019. Aceh province is divided into three regions: the northeast coast area bordering the



Strait of Malacca, the southwestern coastal area bordering the Indian Ocean, and the Central region which is dominated by highlands. Among those regions, paddy production in Aceh is dominated by East Coast, with 69% of the contribution to the total province production [3]. The amount of production is presented in Figure 1.

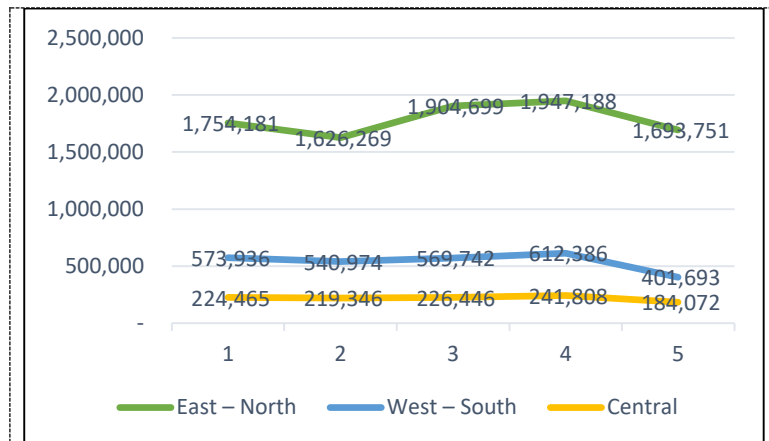


Figure 1. Paddy Production in Aceh Province by Region, 2015 - 2019.

The amount of paddy production in Aceh Province fluctuates every year. In 2017 to 2018, it increased by 5.16%, while it decreased to -33% in 2019. This condition is influenced by the changes in the planting calendar and land-use, and the lack of water availability. The decline in paddy production is indicated by a decrease in the harvested area of 26,186 hectares (-29.4%). Not only in 2018 and 2019, the indication of decreasing harvested areas also occurred in 2017 by 7,333 hectares (-4.3%). Figure 2 illustrated the paddy harvest area in Aceh Province.

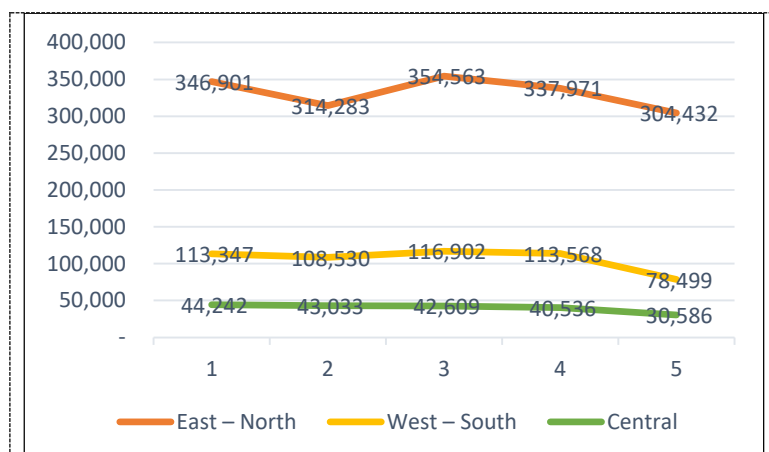


Figure 2. Paddy Harvesting Area Aceh Province by Region, 2015 - 2019.

The area of the paddy harvest in 2019 has decreased due to the lack of rainfall, low irrigation water, failed rice harvests, and the rice planting in October 2019 was harvested in 2020. The differences in paddy cultivation performance in several Aceh locations are because of the differences in the use of varieties, cultivation technology, land area, labor, and input production costs that impacts the income. This study aims to determine the differences in paddy farmers' performance in Aceh Province. The

study locations were the east-north (Aceh Besar, Pidie, North Aceh districts), the South-West (Aceh Barat Daya district), and the Central (Aceh Tengah district) regions.

2. Methods

This research was conducted in three regions in Aceh Province: the north-east (Aceh Besar, Pidie, and Aceh Utara districts), the Central (Aceh Tengah), and the West-South regions (Aceh Barat Daya district). The data used in this study were primary and secondary data. Primary data was obtained from a survey using a questionnaire as the research instrument. The data collection used a purposive sampling method, observing a sample of farmers who had a land area of more than 2000 square meters. Data analysis was performed using descriptive qualitative method by explaining the performance of paddy farmers and calculating the correlation between paddy farmer's income and performance using Spearman Rank analysis.

$$r_s = 1 - \frac{\partial \sum d^2}{n(n^2 - 1)} \quad (1)$$

n = number of respondents

r_s = rank spearman correlation coefficient

d₂ = rank differences

∂ = constant number

Category

1. The correlation coefficient value of 0.00 - 0.25 = very weak relationship
2. The correlation coefficient value of 0.26 - 0.50 = moderate relationship
3. The correlation coefficient value of 0.51 - 0.75 = strong relationship
4. The correlation coefficient value of 0.76 - 0.99 = very strong relationship
5. The correlation coefficient value of 1.00 = perfect relationship

3. Results and discussions

3.1. Respondent characteristics

Age is an important factor in farming. The physical ability of farmers in managing their farms is greatly influenced by their age. According to data from the Indonesian Central Bureau of Statistics, working-age is between 15 - 64 years old [4]. Farmers at a productive age are considered to have good abilities in managing organic paddy farming because of their strong physical abilities. At the age of more than 65 years olds, the physical abilities of farmers are considered to decrease, so that farm management is not optimal. Based on research results, the average age of farmers in the three study areas is 46 years old. It shows that paddy farmers are still productive and considered to have good abilities in managing their farms, especially the paddy fields.

Futhremore, the farming experience of farmers usually influence their thinking and actions. Farmers who have long farming experience are usually better to design farming plans and allocate agricultural resources. They have been obtained the information, including counseling from the government or stakeholders, and repeated the farmland activities. More experience can support higher production. Based on the results of the study in three regions, the average paddy farming experiences in the South-West, the East-North, and the Central regions are in average 22 years, 20 years, and 19 years, respectively. This affects the farmers' level of ability, skill, knowledge which in turn affects the production.

Education is a crucial factor for improving the quality of human resources and enhancing one's intellectual and insight. Education level of farmers help them adopt new knowledge from the training provided by field extension agents. The educational level of farmers in this study are varied, ranging from elementary to high school.

The educational level of farmers with a bachelor degree in Aceh Tengah and East-North is 30 % and 6%, respectively. This finding shows that educational level of paddy farmers in Aceh increases every year. The expected achievement of schooling duration in Aceh in 2019 continues to increase, in 2010 the expected achievement of schooling duration is 12.90 years and it reached up 14.30 years in 2019 [3]. The higher the education, the more capable the farmers in developing agriculture. The application of technology, cultivation techniques, harvest, and postharvest will be more advanced. The level of education, in general, will also affect the mindset. With education, people will have broader insights, easily develop new ideas, adopt technology, and have a dynamic nature in accepting innovation, especially in facing more modern changes [5].

3.2 Paddy farming performance region on Aceh Province

The paddy farming characteristics in this research were grouped into: land tenure, use of fertilizers, labor, productivity, production costs, income, farm profits, consumption, and sales chain. The results of paddy farming performance in three regions are presented in Table 1.

Table 1. Paddy farming performance in three regions.

Variable	Unit	Region		
		East-North	West-South	Central
Land Tenure	Hectare/Farmer	0.62	0.91	0.56
Fertilization	IDR	1,748,303	1,157,667	594,375
Labor	MD ^a /hectare	30.92	20.31	44.7
Production	Tonne/Hectare	6.55	6.74	6.06
Productivity	Tonne/Hectare	10.5	7.3	10.9
Production Costs	IDR	19,039,597	13,102,874	17,901,910
Income	IDR	23,103,379	33,831,583	30,694,339
Farm Profits	IDR	13,264,128	20,728,710	12,399,213
Household Consumption	%	18	10	100
Amount of Paddy Sold	%	82	90	0
Sales				
a. Collector	%	40	83	0
b. Paddy Mill	%	60	17	0

^a Man days

3.2.1. Land tenure. The status is divided into three parts: owner-operator, the tenant (cash tenant), and shared tenant. Theoretically, different land tenure status will determine different levels of farming diversity, including various levels of land productivity, income, and expenditure. Differences in land tenure status will also determine farmers' access to capital, which in turn will affect the production. Besides, the level of income and efficiency in farming will also be varied.

Besides, the land area cultivated by farmers determines the size of the production. In this study, farmers' land area ranges from one to two hectares, according to their respective farmland status. Based on Table 2, the highest agricultural land is in the West-South area with an average area of 0.91 hectares, followed by the East-North and the Central regions with an average of 0.62 and 0.56 hectares, respectively. According to a sample in the West-South region, the capital ownership influenced them to use other people's land. Farmers generally use their capital for paddy cultivation during one growing season. They are not financed by landowners or other financial institutions. In the West-South region, it was found that the land rental system were given to tenant farmers with the highest bid. In the Central and East-North regions, they are accustomed to dividing around 33 percent for landowners and 67 percent for farmers with maximum or minimum paddy harvesting.

3.2.2. Fertilizer is one of the essential production factors in agricultural cultivation. Its the key to soil fertility because it contains one or more elements to replace the elements that have been used up by the plants. The terms macro and micro are known in fertilizer. Fertilizing means adding nutrients to the soil (root fertilizer) and plants (foliar fertilizer). Fertilization is one of the efforts to obtain fertile soil conditions. Lately, the amount of fertilizers tends to be more diverse with different brands. Farmers in the East-North, West-South, and Central regions of Aceh Province use the combination of Urea, SP-36, KCl, ZA, NPK, and organic fertilizers.

The results of the study show that the average use of fertilizers by farmers in the East-North, West-South, and Central Aceh regions for one planting season of lowland paddy ranges from 125.74 - 216.85 kg/hectare urea, 33.71 - 161, 61 kg/hectare SP-36, 5.62 - 41.99 kg/Hectare KCl, 19.43 - 70.72 kg/hectare ZA, 20.22 - 222.96 kg/hectare NPK, 13.69 kg/hectare TSP, 7.30 kg/hectare NPK Mutiara and 0.82 - 667.57 kg/hectare of organic fertilizer. According to the study conducted by [6] [7], the averages use of fertilizers in the East-North, West-South, and Central regions of Aceh ranges from 72.84 - 94.71 kg/hectare of Urea, 36 - 77.20 kg/hectare of SP-36, 26.45 - 44 kg/hectare of KCl, 14.16 - 19.43 kg/hectare of ZA, 77.45 - 84.85 kg/hectare of NPK and 8.62 - 35, 44 kg/hectare of organic fertilizer.

3.2.3. Human labor in agricultural farming generally uses men, women, and children. In the study location, men and women workers manage the rice fields. Labor is needed in almost all production processes, including several types of works: (a) plant preparation, (b) procurement of agricultural production facilities (seeds, fertilizers, treatment of pests/diseases used before planting), (c) planting/nursery, (d) maintenance (weeding, fertilizing, maintenance, water management, and maintenance of water structures), (e) harvesting and transportation of produce, (f) selling [8]

The use of labor is divided into two categories: Inside Family (IF) and Outside Family (OF). The results of the study show that the use of labor in the family for the East-North and West-South areas reached 14.3 and 16.8 working days (MD), while it reached 29.7 working days (MD) in the Central region. Meanwhile, for workers outside the family, the working hours are 16.6, 3.6 and 15.1 in the East-North, West-South and Central regions, respectively. These results indicate that the West-South region uses more labor within the family than outside the family.

The contribution of female laborers in agricultural development is quite large. They work in several aspects of production, post-harvest, food distribution, and consumption. Besides playing a role in farming activities to increase family income, they also participate in decision-making processes, such as the expenditure of paddy farming inputs and households [9]. The use of labor in paddy farming in the Central region is dominated by women, specifically for planting, weeding, and harvesting activities, with an average of 12 working days (MD). In the West-North region, women actively plant and harvest using the conventional system on average 5-7 working days (MD).

3.2.4. Production costs are the sacrifice of economic resources measured in units of money to obtain goods or services. The sacrifice is to pay for rice farming to obtain the input of goods or services that are expected to provide benefits now and in the future [10]. Production costs relate to the input costs for the production of goods or the provision of services [11]. Based on Table 1, the production costs in the East-North, West-South, and Central regions are IDR 19,039,597, IDR 13,102,874, and IDR 17,901,910, respectively.

The effect size of the production cost depends on the labor and fertilizer use. The high cost of labor is incurred due to the use of labor outside the family. The average wage for workers in the East-North region is IDR 100,000, while it is IDR 90,000 in the Central and the West-South regions. Based on the use of labor, labor activities from outside families are higher in the East-North, Central, and West-South, regions by 9 MD, 8 MD, and 5 MD, accordingly. Using labor outside the family affects production costs. Besides, 85 percent of farmers do not get subsidized fertilizer when they need it, so the costs incurred is even higher, affecting production costs.

3.2.5. Income is one indicator to measure farmer welfare. Thus, the increasing income of farmers reflects their economic progress. The income of the household head is the income received by all households in the economy from payments for the use of production factors that they have and from other sources [12]. This study shows that the income received by farmers in the West-South region is greater when compared to the North-East and Central regions. This condition is influenced by the minimal use of labor and the use of fertilizers in this area. These areas use more family labor, and a combination of fertilizers, thereby reducing production costs. The net income of farmers in the West-South region is IDR 20,728,710 Hectares/farmer. The results of other studies have explained that differences in agroecosystems affect the income structure of farmers [13]. The off-farm sector plays a more prominent role in areas with wetland agroecosystems (irrigation and rainfed). On the other hand, in dryland agriculture, the agricultural sector plays a greater role in contributing to the total income of farmers. Trading activities are an important source of income from the off-farm sector in areas with irrigated wetland agroecosystems, although the types of activities in this sector are more diverse.

The level of income received is generated from paddy and other income. By region, 87 percent of farmers' income in the West-South region is from rice farming, while the remaining 13 percent is from other sources. In the East-North region, 80 percent is from agricultural land and 20 percent from other sources. On the other hand, in Central Aceh, the income from the rice fields is not cashed, but 100 percent is consumed by the household. This means that household consumption costs for rice purchases covered by the rice production stored in warehouses.

3.2.6. Consumption and sales paddy is a portion of paddy for own consumption and sale to traders. The farmers sell their paddy for covering their needs which are grouped into two broad categories: food, and non-food. Thus, at a certain income level, households will allocate their income to meet these two needs. Naturally, the amount of food a person needs will reach a saturation point while non-food needs, including food quality, are not limited in the same way [14]. Thus, the amount of income will be represented by the total expenditure spent on food in a household, which can then be used as an indicator of household welfare. Or in other words, the higher the portion of expenditure on food, the less prosperous the household concerned. Conversely, the smaller the percentage of food expenditure, the more prosperous the household is [15].

Based on the study, farmers who save the most paddy harvested for consumption are in the Central region (Aceh Tengah district). They store 100 percent of their paddy harvested and used for household consumption only. Their consumption is around 1,942 kg of paddy per year per household. Especially for the Central region, the main income received by farmers comes from coffee plantations. Meanwhile, in the East-North and West-South regions, 82 percent and 90 percent of the paddy harvested is sold to buy household needs.

3.2.7. There are three differences in the supply chain for paddy sales in the study area. A very different supply and sales is located in the Central region, where the farmers do not sell their rice after harvesting. Meanwhile, in the East-North region, 40% of the sales are conducted by paddy collectors and 60% goes to paddy mills. In the West-South region, 83% of sales goes to collectors and only 17% to rice mills. This study reveals that this circumstance is influenced by the performance of the rice milling industry services in the East-North region, with a greater capacity of rice milling capacity than the West-South. For the West-South region, collectors also come from East Aceh and North Aceh Districts, especially during the main harvest season.

3.2.8. The increase in paddy production is closely related to an increase in paddy productivity per unit area. Increased production requires intensification support, such as increasing the harvest index, varieties improvement, quality and labeled seeds, pests control, nutrients, and crop management. Based on Table 1, the highest production is in the East-North region, the largest producer in Aceh Province, with sufficient land area and technological support compared to the West-South and Central regions. The average production of Aceh Province during the harvest season reached 5.5 tonnes/hectare in 2019,

with a productivity level of 55.01 quintals/hectare. This figure is less than the average production in the research locations, reaching 6.55 tonne/hectare and the productivity up to 64.09 quintals/hectare. Rank Spearman's analysis was conducted to examine the correlation between income and paddy farming performance. the results of the analysis are displayed in Table 1 (the significance level of 0.05).

Table 2. Spearman's rank test results.

	Land Tenure (X1)	Fertilization Cost (X2)	Labor Costs (X3)	Production (X4)	Production Costs (X5)
Income (Y)	0.840	0.283	0.197	0.930	0.672

The Rank Spearman's analysis showed that the correlation coefficient between the income and production is 0.938, and the land tenure is 0.840, both indicating a very strong correlation. The income and production costs also show a strong positive correlation (0.672). In contrast, the correlation coefficient between income and the fertilizer cost is 0.283, indicating a moderate correlation, and the correlation between income and labor costs is 0.197, showing a very weak correlation.

4. Conclusions and recommendations

The differences in the performance of paddy farming in the three research regions include land tenure, land ownership, fertilizer use, labor use, productivity, production costs, income, profits, consumption, and the paddy sales chain. The average of farm income, production cost, land ownership, fertilizer cost, and cost of using labor in the study area is IDR 10,474,760, -, IDR 11,6002,559, -, 0.68 hectare, IDR 1,440,396, -, and IDR 1,846,489.39, -, respectively.

The correlation between income and performance of paddy farming are varied. The correlations between income and production as well as income and land-tenure are very strong (0.930 and 0.840). The correlation between income and production costs is also strong (0.672). In contrast, the correlation between income and cost of fertilizer as well as income and labor usage are moderate (0.283) and weak (0.197).

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