Changes in rural household characteristics and their implications on agricultural income in wetland rice ecosystems

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Abstract. Agricultural development has impacted changes in rural economic structure, as reflected by rural economic indicators. The research question is how the direction of the changes is and the implications for rural household agricultural income. This paper aims to analyses household characteristics changes in the rice-based ecosystems and their implication on household agricultural income. The study used micro-panel data of the National Farmers Panel (in 2010 and 2016) from the Indonesian Centre for Agro Socio-Economic and Policy Studies. The survey was conducted in 14 villages of five rice production centers provinces in Java and Outside Java. The number of respondents is 559 households. Data was analyzed statistically descriptive by calculating the average, minimum-maximum numbers, and participation rate. Generalized Linear Models method was employed to determine the factors affecting household agricultural income. The results showed that agricultural land occupation tends to decrease. The number of older workers tends to increase. The increase of workforce older than 65 years is more significant in Java than Outside Java. The workforce level of education remains predominantly in elementary school. Although nominal total income increased significantly, real income increase sluggishly. Household agricultural income is still dominant but declining. The farmland managed, age and level of education of the household member, number of the household member, and cropping intensity affect household agricultural income significantly. To increase the household agricultural income by increasing the production capacity of farmers' households through increasing land occupation, improving human resources skills, and facilitating innovative technology that can increase farming efficiency and productivity.

1. Introduction

Agricultural development enhances the quality of life of farming communities. It is achieved by improving labor and farming productivity and economic infrastructure and developing farming institutions. Agricultural development leads to changes in national and rural economic structure. These changes are reflected in various aspects, including the agricultural assets (especially land), employment, technology, household income and other factors that have important implications for the dynamics of rural economies. These changes have significant consequences for agricultural household incomes and the process of agricultural and rural transformation.

Empirical evidence shows that pressure on agricultural land increases in line with the economic transformation from agricultural to non-agricultural sectors [1–3]. In terms of employment, the new labor force shows increasingly less interest in working in agriculture, leading to the emergence of the phenomenon of the 'aging' farmer [4–8]. With rising levels of educational attainment, working in non-agricultural sectors in urban areas is a choice for rural workers who have migrated to the city for
their education, rather than returning to the village and working on the land [9–11]. The highly educated workforce is increasingly critical of and selective in work areas and chooses those considered more rational.

Changes in household characteristics have a further impact on changes in the rural economic structure, such as alterations in the income structure of rural households and the increasing diversification of household income sources [12–14]. Rural households no longer depend solely on the agricultural sector as a source of income. The changes are shown through the decreasing share of agriculture in the industrial and service sectors in macroeconomic terms and the increasing linkage between the agricultural and non-agricultural sectors [15].

The direction and degree of change in household characteristics and their impact on the rural economy, especially on the role of agriculture in total household income, vary across locations and ecosystems. In this study, ecosystems based on rice commodities were chosen as the focus of research, given that rice has a strategic and essential role in Indonesia's national and rural economies. Among households engaged in land-based farming (crops, horticulture, and plantations) in Indonesia, the percentage of rice-farming households (31%) was the highest [16].

Information on the direction and magnitude of changes in the rural economic indicators discussed above helps improve future policies, especially those related to the rural transformation process and efforts to increase rural household income. Therefore, this study aimed to analyze the changes in or dynamics of agricultural household economic characteristics in rice-based ecosystems and their implications for household incomes sourced from agriculture at two points (2010 and 2016). The discussion will focus on the dynamics of land ownership and tenancy, labor, and rural household income.

2. Materials and methods

2.1. Data, location, and time of research

This study was conducted in five provinces of Indonesia, namely three rice-production centers province within Java (West Java, Central Java, and East Java) and two from outside Java (South Sulawesi and North Sumatra). The study covered 14 districts, namely three districts from West Java province, Indramayu, Subang, and Karawang; four districts from Central Java province, Cilacap, Sragen, Klaten, and Pati; three districts from East Java province, Jember, Lamongan, and Banyuwangi; two districts from North Sumatra province, Asahan/Batubara and Serdang Bedagai; and two districts from South Sulawesi province, Sidrap and Luwu. In addition, one village from each district was selected as a sample village.

The data used in the study came from a database of household survey results from the National Farmer Panel (Patanas) of the Indonesia Center for Agricultural Socio-Economic and Policy Studies. The data were in the form of micro-panel data, commonly referred to as longitudinal data, obtained from a cross-sectional survey from two or more periods. Panel data can provide two types of information: cross-sectional information on differences between subjects; and time-series information that reflects the change in time. With repeated cross-sectional observations, panel data analysis allows investigation of the dynamics [17]. This study used data from two time points (2010 and 2016). The number of sample households was about 40 per village, and the total number of sample households was 599.

2.2. Data analysis

Data were analyzed using descriptive statistical methods and tabulation, including the average (mean), structure, and distribution. To measure inequality of income distribution and land ownership or tenancy, using the Gini index (G). G values vary between 0 (complete equality) and 1 (complete inequality). Income distribution was categorized as severely unequal if G > 0.5, moderately unequal if 0.4 < G < 0.5, and mildly unequal if G < 0.4 [18, 19]. Multiple regression methods were used to determine the factors that affected household income sourced from agriculture.
To estimate the factors that affect the share of agricultural income, using Generalized Linear Models (GLM). The GLM model in this study uses a binomial distribution with a logit link where logit is defined as \[ \logit \left( \frac{\mu}{1-\mu} \right) = x \] [18]. Thus, the GLM model estimated using the Maximum Likelihood Estimator (MLE) can be formulated as follows:

\[ g(\mu) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 \]

where explanation, 
\[ g(\mu) = \text{share of household income from agriculture} \]
\[ x_1 = \text{area of household land managed (ha)} \]
\[ x_2 = \text{age of head of household (years)} \]
\[ x_3 = \text{length of education of the head of household (years)} \]
\[ x_4 = \text{number of household members (person)} \]
\[ x_5 = \text{number of sources of household income} \]
\[ x_6 = \text{the main cropping intensity of household parcels in a year} \]

3. Results and discussion

3.1. Land ownership

The land was the main asset of farmers. The average of own land and managed land (rice fields and non-rice fields) of agricultural households decreased between 2010 and 2016 in almost all locations in Java and outside Java (Figure 1). The percentage decrease in own land in Central Java was the highest due to land fragmentation and land conversion pattern. Managed land also tends to decrease.

The pattern of change was the same for paddy fields. The average paddy land ownership was about 0.63 ha in Java in 2016, while in West Java was much higher at 1.16 ha than in other provinces (Figure 2). According to the 2013 Agricultural Census [16], average land ownership in West Java was about 0.24 ha. It should be noted that for rice production centers that are research locations in the wetland ecosystem, only farmer households that produce rice-based commodities are taken into account. In comparison, the BPS average was for the total land managed by all agricultural households in West Java.

![Figure 1. Total own land and managed land, 2010 and 2016 (hectare)](image1)

![Figure 2. Own land and managed land of paddy fields, 2010 and 2016 (hectare)](image2)

In outside Java, the area of land ownership tended to be greater than land managed. Although the difference was not significant, it indicates that the sample households in the village allocated their land for cultivation by other farmers (both from within the village and outside the village), which generally involved a crop-sharing system of rent pawn or others. Therefore, a land transaction can solve managing all the land owned when there are labour shortages. On the other hand, if farmers have capital, they tend to expand their managed land by renting, mortgaging, or sharing the results. If the demand for land is high, the land value will be higher, as well as for the land rent value.

The distribution of land ownership and land managed was measured through the Gini index. The
results showed land inequality is relatively stable from 2010 to 2016, both within and outside Java (Table 1). However, the distribution of land ownership in North Sumatra Province causes severe disparities, and this occurs due to fragmentation, on the other hand, land consolidation has also occurred.

Table 1. The Gini index of land ownership and land managed in 2010 and 2016

| Region         | Land ownership | Land managed |
|----------------|----------------|--------------|
|                | 2010 | 2016 | Change | 2010 | 2016 | Change |
| Java           | 0.47 | 0.45 | -0.02  | 0.49 | 0.50 | 0.01   |
| Outside Java   | 0.48 | 0.53 | 0.05   | 0.47 | 0.43 | -0.04  |

3.2. Household employment

The household working members were grouped by age (Figure 3). The 45–64 age group was the largest and showed a 50% increase in 2016, while the younger group under 35 years tended to decline. This result supports the phenomenon of the 'aging farmer'. The agricultural workforce grew to be older in Java than outside Java and showed an increasing trend. The results of this study are consistent with those of the 2013 Agricultural Census that showed that the proportion of farmers over the age of 40–54 years was the largest at 41%, the second largest group was over 55 years of age (27%) classified as older farmers, while the group less than 35 years old made up only 11% of the farmers [19]. Various studies at the micro-level also provide the same evidence of this phenomenon [8,20]. The phenomenon of aging farmers and a younger generation reluctant to work in agriculture is found not only in Indonesia [10] but also in other developing countries and developed countries, for example, Europe and Canada [7,21,22], North America [4–6], Australia [7], and Japan [23,24].

Figure 3. Number employment by age group, 2010-2016

The quality of agricultural, human resources continues to be a concern. The sector's workforce is dominated (48–67 %) by elementary school education. Nevertheless, between 2010 and 2016, the workforce percentage with higher education and senior high school qualifications has increased.

Table 2. Number employment by education, 2010-2016

| Education          | Java 2010 | Java 2016 | Change  | Outside Java 2010 | Outside Java 2016 | Change |
|--------------------|-----------|-----------|---------|-------------------|--------------------|--------|
| Primary school (%) | 57.32     | 53.25     | -4.07   | 55.14             | 39.45              | -15.69 |
| Secondary school (%)| 19.51     | 18.68     | -0.83   | 19.8              | 19.14              | -0.66  |
| High school (%)    | 17.42     | 20.53     | 3.11    | 20.05             | 30.47              | 10.42  |
| College (%)        | 5.75      | 7.55      | 1.8     | 5.01              | 10.94              | 5.93   |

3.3. Household income

The total household income increased in the period between 2010 and 2016. The average household
income outside Java was relatively higher than in Java (Table 3); in contrast, the increase in income was higher in Java. The increase of nominal income in Java was also in line with the rise in real income equivalent to rice, but for locations outside Java, the real income of households declined (-7.12%). The difference trend between nominal and real income suggests that the increase in household revenue was lower than the increase in food prices.

The share of agricultural income declined between 2010 and 2016 in all provinces. The most significant decline was in North Sumatra. Agriculture contributed the largest share to the household income in villages was in West Java (71%), while the smallest percentage was in Central Java (41%).

**Table 3.** Agricultural household income, 2010 and 2016

| Province       | Income (IDR 000) | Rice-equivalent income (kg) | Agricultural share (%) |
|----------------|------------------|----------------------------|------------------------|
|                | 2010             | 2016 | Δ (%) | 2010 | 2016 | Δ (%) | 2010 | 2016 | Δ (%) |
| Java Outside   | 26173            | 49273 | 88.26 | 4659 | 5664 | 21.56 | 61.12 | 51.35 | -9.77 |
| Java           | 34584            | 52802 | 52.68 | 6483 | 6015 | -7.21 | 65.94 | 51.09 | -14.85 |

Note: Δ = change between 2010 and 2016

The share of agriculture income showed a faster decline in Java and was offset by a rapid increase in the non-agricultural income share. Communities in villages located in districts with easier access to the metropolitan city of Jakarta or other major cities had had more opportunities to diversify their non-agricultural income.

The incomes of rural households have changed from being single-source (agriculture) to becoming more diverse. Rural households with only one source (agriculture) of income are about 22%, while the rest of the households have two to four or even more sources of income [25]. The purpose of income diversification in the short term is to secure the household income and improve the standard of living [26]. In the long run, diverse sources of income are aimed at creating more jobs, improving the economy of the agricultural sector and rural communities, and developing service activities through the link between agriculture and rural areas and non-agricultural sectors [13]. Households in wetland paddy ecosystems have a greater diversity of income sources than households in other ecosystems [14]. The more significant variation of income sources is influenced by the ease of accessibility of economic growth centers.

The distribution of household income in 2010–2016 was highly unequal (Table 4). Only villages in West Java province showed a decrease in inequality, although it was still classified as severely unequal.

**Table 4.** The gini index of household income in 2010 and 2016

| Province         | Year | Change |
|------------------|------|--------|
|                  | 2010 | 2016   |       |
| Java             | 0.55 | 0.58   | 0.03  |
| Outside Java     | 0.54 | 0.58   | 0.04  |

3.4. *Factor affecting household agricultural income*

Based on generalized linear models estimation results, agricultural income (represented by the share of household agricultural income to total household income) is positively and significantly influenced by the variable household land managed and cropping intensity (Table 5). This result means that if managed land and cropping intensity increase, the share of agriculture also increases. In contrast, the variables of household head education and the number of household income sources are negatively and significantly affected household agricultural income. This result means that agricultural income will be
reduced if there is an increase in head household level. The same results are for a number of household sources of income.

**Table 5.** The results of the generalized linear estimation model of factors affecting household agricultural income, 2010 and 2016.

| Income proportion                      | 2010         | Coefficient | P>|z| | 2016         | Coefficient | P>|z| |
|---------------------------------------|--------------|-------------|------|--------------|-------------|------|
| Household land managed                | 1.229989     | 0.0000      | 0.593779 | 0.0000       |
| Head of household age                 | -0.00643     | 0.4610      | -0.01634 | 0.0310       |
| Head of household education           | -0.11598     | 0.0000      | -0.12142 | 0.0000       |
| Number of households member           | -0.08154     | 0.1540      | -0.10439 | 0.0300       |
| Number of household sources of income | -0.25937     | 0.0000      | -0.18855 | 0.0000       |
| Cropping intensity                    | 1.312923     | 0.0000      | 0.594121 | 0.0000       |
| Constanta                             | -1.0189      | 0.0550      | 1.848888 | 0.0000       |

**4. Conclusion**

The average household land ownership area declined from 2010 to 2016, especially in villages in Java. However, the distribution (Gini index) of own land and managed land showed relatively stability at a moderate level. The 45–64-year age group dominated the agricultural workforce structure, and this group tended to increase in the same period. The older farmer group was more dominant in Java than outside Java and showed an increasing trend. Most of the workforce was educated to the elementary school level, but the percentage of workers with a college education increased. Availability and access to agricultural and non-agricultural employment opportunities, agricultural modernization, agricultural wage levels, and human resource development policies have important roles that affect labour and employment opportunities in rural areas.

The primary source of household income was no longer the only agricultural sector. The share of agricultural income declined in all provinces. The distribution of household income in 2010–2016 indicated increasingly severe inequality. Agricultural and non-agricultural employment opportunities influence the income dynamics in the region and the price of paddy and other agricultural commodities, and technological and institutional innovations that lead to increased farming efficiency. The agricultural income is significantly influenced by the household land managed and cropping intensity, household head education, and the number of household income sources.

Land policy should be pursued through many approaches simultaneously to improve productivity, efficiency, competitiveness, and farmer wellbeing. Land conversion, polarization, and fragmentation, in the agricultural sector, especially for wetlands, should be prevented. The land market should be promoted through market information. In the medium term, the availability of and access to land resources of farming households should be pursued by establishing agrarian reform programs. In this context, a regulation that restricts larger farm size should be reviewed, especially to increase farm household land tenure at a reasonable level.

The rural development efforts should focus on improving human resources and rural workforce skills to increase employment opportunities. Agro-technology in rural areas should be pursued to attract younger workers into the agricultural sector. Agricultural infrastructure to facilitate the flow of farm products to the markets should be developed to increase the agricultural and non-agricultural rural household income. Development of small and medium scales of agricultural-based industry in the rural region should be pursued. Economic connectivity between villages, cities, and regions rural also should be emphasized to increase agricultural product development and added value.

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