Income and feasibility analysis of rice farming in Sub Watershed Keduang, Wonogiri Regency, Central Java

A Setyarini¹,², E S Rahayu¹, J Sutrisno¹ and S Marwanti¹

¹Doctoral Program of Agriculture Science, Graduate School, Universitas Sebelas Maret, Surakarta, 57126, Central Java, Indonesia
²Agriculture Faculty, Universitas Veteran Bangun Nusantara, Sukoharjo, 57521, Central Java, Indonesia

Corresponding author: agungsetyarini@univetbantara.ac.id

Abstract. Wonogiri Regency has a topography of different areas; some areas are flat, wavy, steep, and very steep, making the condition of natural resources various. The livelihoods of most of the people who live around the Keduang Subwatershed are farmers, who cultivate agriculture in wetland, dry fieldsgardens, and dry land. This study aimed to determine the income and feasibility of lowland rice farming in the Keduang subwatershed Wonogiri. The location and respondents' determination method used in this research was purposive sampling. The number of respondent farmers taken in this study was 90 respondents from 3 districts in the Keduang subwatershed, Sidoharjo, Jatisrono, and Jatipurno districts. Data collection techniques were observation, interviews, and recording. The total cost of farming is IDR 20,773,815/Ha/Year with the average variable cost of IDR 19,807,381/Ha/year and the average fixed cost of IDR 966,200/Ha/year. The average revenue is IDR 29,464,858/Ha/year, and the average income is IDR 8,691,277/Ha/year. R/C ratio of 1.42 indicates that lowland rice farming is profitable and feasible to develop.

1. Introduction

Wonogiri Regency has a topography of different areas; some are flat, wavy, steep, and very steep. Most of the topography is uneven, with an average slope of 30°, making natural resources different. Wonogiri Regency has an artificial reservoir, namely Gajah Mungkur, a source of livelihood for fishing farmers and irrigation for rice fields. Gajah Mungkur reservoir dammed several rivers such as the Keduang, Tirtomoyo, Temon, Solo Hulu, Alang, and several other rivers. The Upper Bengawan Solo River includes six sub-watersheds, namely: Keduang Subwatershed (42,644 Ha), Alang Unggahan Subwatershed (23,728 Ha), Wiroko Subwatershed (20,580 Ha), Upper Solo Subwatershed (19,976 Ha), Wuryantoro Subwatershed (7,333 Ha), Temon Subwatershed (6,753 Ha). Subwatershed Keduang includes twelve sub districts in Wonogiri and one the sub districts in Karanganyar, namely: Bulukerto, Girimarto, Jatipurno, Jatirotro, Jatisrono, Kismantoro, Ngadirjo, Nguntoronadi, Sidoharjo, Purwantoro, Slogohimo, Tirtomoyo (Wonogiri) and Jatiyoso (Karanganyar) [1].

Most of the agricultural land in Wonogiri is not very fertile, rocky, and dry. However, based on identifying the leading sector with the Location Quotient, agriculture was ranked first, followed by the livestock, forestry, and fishery sectors [2].
The livelihoods of most of the people who live around the Keduang Subwatershed are farmers [3], who cultivate agriculture in wetland, dry fields/gardens, and dry land. Cultivated food crop commodities include paddy/rice, corn, soybeans, peanuts, green beans, cassava, and sweet potatoes. In 2016 the agricultural sector contributed 32.8% of the gross income [4], shows that the agricultural sector is still a major proponent of the economy in Wonogiri.

The macro impact of land conversion is the reduced food availability and reduced national food security. In contrast, the micro impact results in farmers who initially worked on food crops to meet food availability for their households were unable to meet their food needs. Another impact of land conversion is the loss of their livelihood, causing farmers to lose their income from farming. In terms of production, it will eliminate agricultural production as much as the converted land area with the conversion of paddy fields. Another disadvantage is the loss of employment opportunities in farming and income opportunities and economic activities related to farming, such as the business of providing agricultural crops, agricultural machinery, rice milling, and tractor rental [5]. From the description above, the research aims to analyze the income and feasibility of rice farming in the Keduang Subwatershed, Wonogiri Regency.

2. Methods

2.1. Research sampling methods
The sampling area was taken by purposive sampling. The selection of research sites is categorized into upstream, middle, and downstream areas. In this research, the area that represents the upstream is determined, Jatisrono Sub District represents namely Jatipurno Sub District, the middle region, and the downstream area is represented by Sidoharjo Sub District. The method of determining respondents was carried out by survey. The number of respondents is 90 farmers.

2.2. Analysis methods
There are two kinds of costs in farming: variable costs (VC/Variable Cost) and fixed costs (FC/Fixed Cost). It can be formulated as follows:

\[ TC = VC + FC \] .................................................................(1)

where \( TC \) is the total cost of farming (Rp), \( VC \) is the variable cost (IDR), and \( FC \) is the Fixed costs (IDR)

\[ Revenue = Py \times Y \] .................................................................(2)

where \( Py \) is the Production price (IDR/kg), and \( Y \) is the Total production (kg)

\[ \pi = TR - TC \] ........................................................................(3)

where \( \pi \) is the net income of farming (IDR), \( TR \) is the Total farm revenue (Rp), and \( TC \) is the Total Cost (IDR)

\[ R/C \text{ ratio} = \frac{R}{C} \] ........................................................................(4)

where \( R \) is the Revenue (IDR), and \( C \) is the Cost (IDR). Criteria of \( R/C \) ratio is when \( R/C > 1 \) means efficient farming, when \( R/C = 1 \) means the farm is in BEP condition or break-even point, and \( R/C < 1 \) means farming is not efficient.

3. Results and discussion

3.1. Characteristics of respondent farmers
Farmer characteristics are very important and directly related to rice farming activities. Social factors include farmer’s age, education, experience in paddy farming, and a number of farmer family members, as presented in Table 1.

Based on Table 1, it is known that most of the age of the head of the family of farmer households belong to the productive age group. Age affects the absorption and decisions of farmers in implementing technology or innovation. A person in the productive age generally has maximum
participation, given that human labor has limitations on maximum ability to work [5]. The older the person's physical ability decreases, the more they need the help of workers, both within the family and from outside the family [6]. The farmer's age has a less close correlation and has a positive sign with the level of technology application in lowland rice farming. There are significant differences between the productive to less productive ages on the level of implementation of lowland rice farming technology. Farmers of productive age and unproductive age have the same motivation to improve the application of technology in lowland rice farming [5].

The education of the head of a farmer's household is in a low category because it is equivalent to elementary school, where it affects a person's way of thinking, attitude, mentality and determines a person's tendency to respond to new things. Low education will hinder the diffusion of information and technology. The education level has a close relationship with the application of technology in lowland rice farming. Thus the formal education of farmers affects the level of technology application in lowland rice farming [5]. On the contrary, which states that the level of education does not affect farmers in adopting technology, but gender, marital status, the experience of farmers, and institutional factors influence farmers in adopting technology in Ghana [7].

Table 1. Characteristics of farmer households in the Keduang subwatershed

| Characteristics of respondent farmers | Frequency | Percentage (%) |
|--------------------------------------|-----------|----------------|
| 1. Age                               |           |                |
| < 20                                 | 0         | 0.00           |
| 21-30                                | 1         | 10.00          |
| 31-40                                | 3         | 3.33           |
| 41-50                                | 22        | 24.44          |
| 51-60                                | 33        | 36.67          |
| >60                                  | 31        | 34.44          |
| Total                                | 90        | 100.00         |
| 2. Education                         |           |                |
| Completing/not completing elementary school | 65 | 72.22 |
| Completing/not completing junior high school | 10 | 11.11 |
| Completing/not completing senior high school | 15 | 16.67 |
| Undergraduate                        | 0         | 0.00           |
| Total                                | 90        | 100.00         |
| 3. Farming Experience                |           |                |
| < 10 years                           | 1         | 1.11           |
| 11-20 years                          | 8         | 8.89           |
| 21-30 years                          | 31        | 34.44          |
| > 30 years                           | 50        | 55.56          |
| Total                                | 90        | 100.00         |
| 4. Number of family members          |           |                |
| 1-3                                  | 58        | 64.44          |
| 4-6                                  | 30        | 33.33          |
| >7                                   | 2         | 2.22           |
| Total                                | 90        | 100.00         |

Most of the respondent farmer households have more than 30 years of farming experience. Long farming is a benchmark for the farming experience. It is hoped that the longer a farmer carries out his farming activities, the more experienced he will be in running his farm, the better in managing his farm [8], and the higher the level of application of lowland rice farming technology [5].

The number of members of the respondent's farmer household is mostly between 1-3 members. The household structure category determines the availability of labor [9]. Farmer households in the study area use labor outside the family in running their farm because most of the family members migrated out of town. Family workers and mainly consists of the head of the household and his wife. At the time of land preparation, planting, and harvesting, workers outside the family, while workers in the family carry out plant care and fertilization activities.
Family members are likely to assist in farming activities and be decisive in adopting technology because larger households have more family labor that can be used to practice larger household technologies [5,7]. A larger household size means having a large workforce, increasing income, and allowing diversification off-farm activities to increase income. The availability of considerable household labor reflects the human resources available to households for agronomic activities. Food security is more guaranteed because they can carry out farming activities on time [10,11]. This opinion contradicts research that claims that larger households tend to weaken household incomes because they increase consumption expenditure, thus leaving little or no funds available for further activities outside of agriculture [12].

3.2. Cost, income and efficiency of rice farming

3.2.1. Farm cost. Farming costs are calculated based on the amount of money spent by farmers to finance their farming activities, including variable costs and fixed costs. The variable cost includes the purchase of seed, fertilizer, labor costs, rental equipment, and transportation costs. Fixed costs include taxes and depreciation costs of the purchase of agricultural equipment.

Land area is the amount of land that is managed in farming to produce production. Based on research data, the average area of land cultivated by farmers in the research area is 2,454 m². Table 2 shows that the average variable cost is IDR 19,807.381/Ha/year, with the largest cost structure being the cost of labor outside the family starting from land cultivation, planting, and harvesting with an average cost IDR 9,039,620/Ha/year. Labor costs can be saved after the regulation of water regulation from upstream to downstream in a subwatershed [13]. This has not been implemented in the Keduang subwatershed, Wonogiri Regency, because most irrigation canals are technically simple, semi-technical, and rain-fed. Based on the results of the estimation of the Cobb Douglas function, it was found that labor and land area are production factors that have a large positive influence on production [14]. The labor cost of conventional paddy farming is higher than agroecological paddy farming because conventional farming requires tillage and soil leveling every planting season. In contrast, agroecological farming only tills the soil at the beginning of the growing season [15].

The highest variable cost after labor costs is the cost of purchasing fertilizer. The highest fertilizer cost is for purchasing urea fertilizer. Besides chemical fertilizer, some farmers also use compost derived from straw for the rest of the harvest. The use of straw returned to paddy fields will reduce the cost of purchasing nitrogen fertilizers and reduce greenhouse gas emissions [16]. Farmers in the study area often use chemical fertilizers above the recommended dose, so the cost of purchasing fertilizers is high. The cost of buying fertilizer is IDR 5,411,612/Ha/year. The fertilizers used include Urea, Phonska, and SP-36 fertilizers.

The equipment rental fee is IDR 3,172,743/Ha/year. The equipment rental includes the rental of tractors for land cultivation and the rental of rice thresher machines. Besides that, farmers also rent water pump diesel engines. Equipment rental and fuel costs for farmers in Bachok, Kelantan, Malaysia are higher than conventional farming because conventional farming carries out tillage and soil leveling for 3 planting seasons [15].

The average cost of seeds is IDR 1,014,752/Ha/year. The seeds used by farmers are Ciherang, Mekongga, Pepe, and Sunggal. The average pesticide cost is IDR 750,374/Ha/year. Farmers do not use pesticides much because pests and plant diseases do not attack rice plants much. The pesticides used are Furadan, Score, Regent, and Roundup. Transportation costs are the smallest costs because they are only used to bring crops from the fields to the farmers’ homes.

The average fixed cost is the cost of depreciation of the equipment and the cost of land tax. The largest average cost structure is depreciation cost of around IDR 873,196/Ha/year.
Table 2. Analysis of rice farming income in the Keduang Subwatershed Wonogiri Regency in 2020

| No | Description             | Per Land Area (2,454 m$^2$) (IDR) | Hektar (IDR) | Percentage (%) |
|----|-------------------------|-----------------------------------|--------------|----------------|
| 1  | Revenue                 | 7,230,640                         | 29,464,858   | 100.00         |
|    | a. Product (kg) : 1520  |                                   |              |                |
|    | b. Price (IDR) : 4757   |                                   |              |                |
| 2  | Cost                    |                                   |              |                |
|    | A. Average Variable Cost|                                   |              |                |
|    | a. Seeds                | 249,009                           | 1,014,752    | 5.12           |
|    | b. Fertilizer           | 1,327,949                         | 5,411,612    | 27.32          |
|    | c. Pesticide            | 184,133                           | 750,374      | 3.79           |
|    | d. Labor outside the family | 2,218,222                     | 9,039,620    | 45.64          |
|    | e. Tractor machine, etc | 778,556                           | 3,172,743    | 16.02          |
|    | f. Transportation       | 102,642                           | 418,281      | 2.11           |
|    | Sub Total (A)           | 4,860,511                         | 19,807,381   | 100.00         |
| 3  | Average Total Cost (A + B) |                                   |              |                |
|    | a. Land tax             | 22,822                            | 93,004       | 9.63           |
|    | b. Depreciation         | 214,272                           | 873,196      | 90.37          |
|    | Sub Total (B)           | 237,095                           | 966,200      | 100.00         |
| 4  | Average Income (1-3)    | 5,097,606                         | 20,773,581   | 70.50          |
|    | 2,133,034               | 8,691,277                        |              | 29.50          |

3.2.2. Rice farming income. Rice farming income is calculated by subtracting income from rice farming costs. Based on table 3, it is known that the average revenue is IDR 29,464,858/Ha/year, with an average farming cost of IDR 20,773,581/Ha/Year, so that the income is IDR 8,691,277/Ha/year.

Farming income in the research area is relatively small. After all, most farmers can only cultivate their farming for 2 growing seasons in one year because most of the irrigation channels in the research area are simple, semi-technical, and rainfed irrigation. This is in contrast to the income of farmers in the Sukamarga Village, Central Ranau Sub District, Ogan Komering Ilir Regency where farmers have an income of IDR 13,652,686/Ha/year [17].

A study in Thailand compared rice production in rainfed rice fields in the rainy season, irrigated rice fields in the rainy season, and irrigated rice fields in the dry season. The highest production was in irrigated rice fields in the rainy season and the lowest in irrigated rice fields in the dry season. The lowest net income is farmers in the irrigation system in the dry season compared to the other two systems because it requires energy, labor, and water management [18]. Good irrigation arrangements and adjustment of planting time will reduce the negative impact of climate change that affects rice production in China [19].

3.2.3. Farming efficiency. Table 3 shows the revenue (R) of IDR 29,464,858/Ha/Year and cost (C) of IDR 20,773,581/Ha/Year, so that the R/C ratio of rice farming in the Keduang subwatershed, Wonogiri Regency is 1.42. The Return Cost Ratio (R/C ratio) value of 1.42 indicates that the R/C ratio >1, that farming is profitable and feasible to develop.

Table 3. Average Income and Efficiency of Rice Farming in the Keduang Subwatershed Wonogiri Regency

| Description                          | Per Land Area (2,454 m$^2$) (IDR) | Hectare (IDR) |
|--------------------------------------|-----------------------------------|---------------|
| Revenue                              | 7,230,640                         | 29,464,858    |
| Total cost of farming                | 5,097,606                         | 20,773,581    |
| Income on the total cost of farming  | 2,133,034                         | 8,691,277     |
| R/C income on the total cost of farming | 1.42                             | 1.42          |
4. Conclusion
Following are the conclusions from the research on income analysis and the feasibility of rice farming in the Keduang Subwatershed, Wonogiri Regency. The average total cost of farming is IDR 20,773,581/Ha/Year, with the revenue of IDR 29,464,858/Ha/Year, so that the income is IDR 8,691,277/Ha/Year. Farming efficiency (R/C ratio) of 1.42 indicates that farming is profitable and feasible to develop.

Acknowledgments
The authors would like to thank the technical and financial assistance also the support from BUDI DN LPDP Kementerian Keuangan Republik Indonesia

References
[1] Lastiantoro Y and Cahyono A 2016 J. Analisis Keb. Kehutanan 13 203–212
[2] Cahyono S and Wijaya W 2014 J. Pen. Sos. dan Ekonomi Kehutanan 11 32–43
[3] Rhoyani I, Rahayu E and Ani S 2016 Agrista 4 31–43
[4] Badan Pusat Statistik Wonogiri 2017 Kabupaten Wonogiri Dalam Angka 2016 (Wonogiri: BPS Statistic of Wonogiri Regency)
[5] Purnamasari N, Hamzah A and Gafaruddin A 2018 Jurnal Agribisnis Dan Ilmu Sosial Ekonomi Pertanian 3 30–33
[6] Suratiyah 2020 Ilmu Usahatani (Jakarta : Penebar Swadaya)
[7] Ehiakpor S, Danso Abbeam G, Gilbert D, and Ayambila S 2019 Technology in Society 59 1–8
[8] Ernante J, Wiendiyati, Pudjiastuti S, Bernadina L and Levis L 2019 Buletin Excellentia 8 186–195
[9] Niragira S, Ndimubandi J and Orshoven J 2018 In Encyclopedia of Food Security and Sustain. 1
[10] Asravor R 2018 J.of International Development 30 1318–1338
[11] Mango N, Zamasiya B, Makate C, Nyikahadzoi K and Siziba S 2014 Development Southern Africa 31 625–640
[12] Danso A G, Dagunga G and Ehiakpor D S 2020 Heliyon 6 1–11
[13] Liu M, Yang L, Min Q and Bai Y 2018 Agricultural Water Management 204 192–197
[14] Rondhi M and Hariyanto A 2018 Journal of Agribusiness and Rural Development 4 101–110
[15] Er A, Ahmad H and Manaf A 2021 Int. J. of Env. Sci. and Development 12 181–187
[16] Liu B, Wu Q, Wang F and Zhang 2019 Energy 171 393–402
[17] Hernanda E, Indriani Y and Kalsum U 2017 JIIA 5 304–311
[18] Thanawong K, Perret S and Basset-Mens C 2014 Journal of Cleaner Production 73 204–217
[19] Ding Y, Wang W, Zhuang Q and Luo Y 2020 Agricultural Water Management 228