Economic analysis of sweet potato (*Ipomoea batata* L.) farming in Lamongan regency

E Hamidah¹,², E S Rahayu³, J Sutrisno³ and S Marwanti³

¹ Doctoral Program of Agriculture Science, Graduate School of Universitas Sebelas Maret, 57126 Surakarta, Central Java, Indonesia.
² Department of Agriculture, Agriculture Faculty of Universitas Islam Darul Ulum Lamongan, 62253 East Java, Indonesia.
³ Department of Agribusiness, Agriculture Faculty of Universitas Sebelas Maret, 57126 Surakarta, Central Java, Indonesia.

Corresponding author: hamidahemmy@yahoo.co.id

Abstract. Sweet potato has the potential to be developed for diversified food consumption programs as a source of carbohydrates, nutrients, with a small risk of failure, low production costs, various processed products, food providers, industrial raw materials, and animal feed. This research aimed to analyze sweet potato farming economically and socially. The study was carried out quantitatively using a survey method. The research was conducted in Lamongan Regency, East Java, Indonesia. The location was chosen purposively. The sampling method was carried out using census in Kalitengah and Kedungpring Districts, in 6 villages, with 348 respondent farmers. The data analysis employed Revenue Cost (R/C) and descriptive analysis. The results revealed that 80.46% of farmers did not complete elementary school. Farmers with experience in sweet potato farming over 20 years reached 67.53%. Their income from total farm costs was IDR 5,178,296, with an R/C ratio is 1.89. Sweet potato farming is profitable and feasible to develop. The utilization of small sweet potato tubers affected by Cylas Formicarius disease as a fish feed was carried out by 19.54% of the farmers. Meanwhile, 51.72% of the farmers utilized sweet potato stalks and leaves as goat feed.

1. Introduction
Sweet potato as a commodity source of carbohydrates can be developed to meet the community's food needs, thereby making them less dependent on rice. Besides containing vitamins A, C, and minerals, sweet potatoes can be used to substitute staple foods with a source of calories and high nutritional content beneficial for health. Sweet potatoes possess great potential and opportunities to be developed for programs to diversify local-based food consumption, sources of carbohydrates and various nutrients, and produce multiple processed products. They can be farmed as a food provider, an industrial raw material, and an animal feed.

Based on the 2016-2021 strategic plan on the potential for agricultural land resources in Lamongan Regency, the development of superior food agriculture is directed at crop commodities: rice, corn, soybeans, cassava, sweet potatoes, peanuts, green beans, and sorghum. One of the leading food crops developed in the Lamongan Regency is the sweet potato commodity. There are only two districts in working on sweet potato farming, Kalitengah, and Kedungpring. The two communities are the centers
for sweet potato producers within the regency with 2,460 tons and 2,316 tons, respectively, and productivity of 21.97 tons/ha. Undoubtedly, sweet potato production affects farm income.

Income is remuneration for the use of production factors. Farm income is the difference between revenue and all costs. Farm income is divided into income from cash costs and prices incurred by the farmer, while income from total farm costs is income after deducting cash costs and costs are calculated [1]. This study aimed to analyze, economically, and socially, whether sweet potato farming is profitable and feasible to develop.

2. Methods

2.1. Location and time of research
The research was conducted in Lamongan Regency, East Java, determined using the purposive method. The study employed a survey method. The sampling was carried out using census in Kalitengah and Kedungpring Districts, in six sweet potato center villages, with 348 respondent farmers. The respondents referred to all sweet potato farmers working on sweet potato farming in Sugihwaras, Canditunggal, Kuluran, Kediren, Gunungrejo, and Kradenanrejo Villages during the 2019 planting season. The research was conducted from September to November 2019.

2.2. Analysis method
The data analysis employed economic analysis by calculating the amount of Revenue Cost (R/C) ratio and descriptive analysis. The R/C ratio analysis [1] utilized the following equation:

\[ R/C = \frac{PQ \cdot Q}{TFC + TVC} \]

where:
- \( R \) = sweet potato acceptance
- \( C \) = cost of sweet potato farming
- \( PQ \) = price of sweet potatoes
- \( Q \) = sweet potato production
- \( TFC \) = fixed cost
- \( TVC \) = variable cost

The R/C ratio criteria are:
- R/C ratio > 1 means that the business is efficient and profitable.
- R/C ratio = 1 means that the farm is not profitable, not losing.
- R/C ratio < 1 means that it is inefficient or detrimental.

3. Results and discussion

3.1. Characteristics of respondent farmers
Farmers’ characteristics are essential and directly related to sweet potato farming activities. Farming social factors include farmers’ age, education, experience in sweet potato farming, and the number of family members, as presented in Table 1. In terms of farming social factors, the results uncovered that most farmers (43.3%) aged 30-42 years, 70.83% of them were male, 69.16% of them were married, the majority (36.6%) of them had no formal education, and 45% of them owned 0.2–1.0 ha of farming land [2]. The age of the farmers is a factor closely related to their ability in farming activities. There were 80.17% of the respondents' farmers aged over 50 years, while their average age was 56 years. In this study, social factors affecting sweet potato farming consisted of farmers aging 52 years, male gender, 23 years of farming experience, no formal education, and an average land area of 1.05 ha [3]. Age, sex, household size, microclimate conditions, and access to agricultural extension agents affect sweet potato farming [4].

The education level of farmers is influential in changing attitudes, behaviors, and mindsets. Most respondent farmers (80.46%) belonged to the low category, not completing elementary school. Their education level is closely related to the use of technology and the adoption of agricultural innovations.
The higher the education level of farmers, the easier it is to understand and accept innovations. The previous study discovered several social factors influencing sweet potato farming, consisting of the education level of respondent farmers (68%), their gender (69%), and their status, dominated by married (83%) [5]. Another study revealed that education level, land area, and price varied significantly at P<0.01 [6]. Other research stated that education, access to information, and training on fertilizers affected sweet potato farming [7]. Educational status, farm size, and farming experience were found to influence production [8].

Table 1. Characteristics of respondent farmers in Lamongan regency in the 2019 planting period.

| Characteristics of respondent farmers | Frequency | Percentage (%) |
|---------------------------------------|-----------|----------------|
| 1. Age                                |           |                |
| < 20                                  | 0         | 0.00           |
| 21–30                                 | 0         | 0.00           |
| 31–41                                 | 12        | 3.45           |
| 41–50                                 | 57        | 16.38          |
| > 50                                  | 279       | 80.17          |
| Total                                 | 100       | 100.00         |
| 2. Education                          |           |                |
| Completing/not completing elementary school | 280 | 80.46         |
| Completing/not completing junior high school | 45  | 12.93         |
| Completing/not completing senior high school | 23  | 6.61          |
| Under graduate                        | 0         | 0.00           |
| Total                                 | 348       | 100.00         |
| 3. Farming Experience                 |           |                |
| <5 years                              | 0         | 0.00           |
| 5–10 years                            | 0         | 0.00           |
| 11–14 years                           | 23        | 6.61           |
| 15–20 years                           | 90        | 25.86          |
| <20 year                              | 136       | 67.53          |
| Total                                 | 100       | 100.00         |
| 4. Number of Family Members           |           |                |
| 1–3                                   | 136       | 39.08          |
| 4–6                                   | 212       | 60.92          |
| > 7                                   | 0         | 0.00           |
| Total                                 | 348       | 100.00         |

Primary Data Processed, 2020.

Respondent farmers with experience of sweet potato farming over 20 years were 67.53%. They farmed sweet potatoes twice a year. Their expertise in sweet potato farming is also a determining factor in the success of agriculture. The more experienced farmers are in farming sweet potatoes, the more skilled and careful they are in choosing the technology used. Farming experience, education level, household size, and access to credit were also factors influencing sweet potato farming [9].

The number of farmer family members of the respondent ranging from 4-6 people was 60.92%, with an average of 4 people. The number of family members played a role in making farming decisions, behaving, and assisting in farming activities.

3.2. Characteristics of sweet potato farming
The characteristics of sweet potato farming include land area, land ownership status, membership in farmer groups, farming capital, sweet potato varieties, and other respondent farmers' occupations, as described in Table 2. Almost half of the respondent farmers (43.40%) in the Lamongan Regency were
small farmers with a land area of 0.21 to 0.30 ha. The small amount of land owned by the respondent farmers as it was inherited from their parents. In terms of ownership, the land was 100% self-owned. Another farming characteristic was the participation of respondent farmers within farmer groups. A farmer group is a forum for farmers to exchange information regarding sweet potato farming activities. All respondent farmers have participated in farmer groups. The capital used by respondent farmers to finance their farming activities came from two sources, 84.20% personal funds, and 15.80% loans from family and neighbors. A study has disclosed that capital, diversification of production, agricultural resources, and access to credit, influenced sweet potato farming [10]. In line with access to credit, education, access to extension workers, and collective membership also affected sweet potato farming [11]. There were several varieties of sweet potatoes farmed by respondent farmers, consisting of 54.88% white sweet potato (Shi Royataka variety), 30.46% purple sweet potato (Anti 3 variety), 8.91% red sweet potato (Mukidi variety), and 5.75% yellow sweet potato (Sewu variety). Respondent farmers grow many white sweet potatoes (Shi Royataka variety) because of their shorter planting age, high productivity, disease resistance, easier marketing, and ready to buy and send to factories for sauce making by wholesalers for IDR 2000.

Table 2. Characteristics of sweet potato farming in Lamongan Regency in the 2019 planting period.

| Characteristics of respondent farmers | Frequency | Percentage (%) |
|--------------------------------------|-----------|----------------|
| 1. Land area                         |           |                |
| 0.01–0.10                            | 47        | 13.51          |
| 0.11–0.20                            | 139       | 39.94          |
| 0.21–0.30                            | 151       | 43.39          |
| 0.30–0.40                            | 6         | 1.72           |
| 0.40–0.50                            | 5         | 1.44           |
| 2. Land ownership                    |           |                |
| One's own                            | 348       | 100.00         |
| Rent                                 | 0         | 0.00           |
| Total                                | 348       | 100.00         |
| 3. Farmer Group Membership           |           |                |
| Join the Farmer Group                | 348       | 100            |
| Not Joining Farmer Groups            | 0         | 0              |
| Total                                | 348       | 100.00         |
| 4. Farming Capital                   |           |                |
| Owner's equity                       | 293       | 84.20          |
| Borrow to bank                       | 0         | 0.00           |
| Borrow a family                      | 55        | 15.80          |
| Total                                | 348       | 100.00         |
| 5. Sweet Potatoes Variety            |           |                |
| Purple (Antin 3 Varieties)           | 106       | 30.46          |
| Red (Mukidi Varieties)               | 31        | 8.91           |
| White (Shi Royataka Varieties)       | 191       | 54.88          |
| Yellow (Sewu Varieties)              | 20        | 5.75           |
| Total                                | 348       | 100.00         |
| 6. Another job                        |           |                |
| Pond                                 | 68        | 19.54          |
| Livestock                            | 180       | 51.70          |
| Traders                              | 31        | 8.91           |
| Laborers                             | 64        | 19.83          |
| Total                                | 348       | 100.00         |

Primary data processed, 2020
3.3. Analysis of sweet potato farming

The social analysis of sweet potato farming is based on the respondent farmers’ age, formal education, farming experience, and family dependents. Farmers’ education level, farming experience, family members, and credit access are essential factors in sweet potato farming [12]. Older farmers have a better farming ability for having more experienced but are more conservative than young farmers who are more progressive in innovations. Productive age farmers are expected to accept and adopt innovations, particularly regarding sweet potato farming [1].

The respondent farmers aged over 50 years were 80.17%, and the average them aged 56 years, classified as a productive age physically able to manage their farm to yield production. However, their education level was low since 80.46% of them did not complete elementary school. Farmers’ education level is influential in farming, closely related to their role as managers and laborers. The knowledge they possess can help achieve farming success and affect their ability to absorb new knowledge and innovations.

Respondent farmers with experience in sweet potato farming over 20 years were 67.53%. The sweet potato farming skill also affects agriculture success. Farmers’ knowledge and skills were obtained from their experiences, observations, genetic backgrounds, the surrounding environment, and counseling. The more experienced the farmers are, the more rational they are in accepting failure, and the easier it is to solve the problems at hand. Socio-economic factors affecting sweet potato production consisted of household size, education level, farming experience, and agriculture [13]. The family's number of dependents was four people, and two were active in sweet potato farming. Those involved in sweet potato farming were father, son, or son-in-law. The majority (60.92%) of the respondent farmers’ families ranged from 4-6 people, with an average of 4 people, as depicted in Table 2.

Revenue is the amount of production multiplied by the price, while income is the difference between revenue and the total cost of farming. The complete components of farm costs are cash costs and calculated costs. Cash costs include purchasing seeds, urea fertilizer, ponska fertilizer, SP-36 fertilizer, ZA fertilizer, pesticides, and outside family labor, while calculated costs consist of depreciation, land and building tax, and family labor. The total cost of farming is obtained from the sum of the total cash costs, and the total charges are calculated, while the cash income is obtained from the deduction of the total cash costs. Income on total farm costs is the result of reduced revenues from the total cost of farming. The total costs of farmers can increase production with a higher allocation of labor [14].

The respondent farmers' average sweet potato production was 4,807 kg, with a medium land area of 0.21 ha. The average income with this land area was IDR 10,993,609 (Table 3), while the respondent farmers in Kalitengah District, amounting 42.53%, sold sweet potatoes for between IDR 2,200 - IDR 2,400. Mediators purchased the harvest, and 4.89% was sold in the surrounding area and the nearest market for IDR 4000. There were 183 respondent farmers in Kedungpring District, and 52.59% of their production was sold to wholesalers to be sent to the sauce-making factory at IDR 2000 for the 2019 planting season.

Farm expenses consisting of cash costs and costs were calculated. Farmers incurred cash costs during sweet potato farming activities. Meanwhile, the estimated charges were incurred by farmers, but not in cash. Cash costs consist of buying seeds, urea fertilizer, ponska fertilizer, SP36 fertilizer or ZA fertilizer, pesticides, and outside family labor. The average total cash costs and the total costs incurred by the respondent farmers was IDR 3,735,294 and IDR 2,080,019, respectively, on a medium land area of 0.21 ha. Costs, including depreciation, land, and building tax, and family laborers, were calculated. The average real price of farming, including the average total cash cost, plus the average total costs, was IDR 5,815,313.

The average income for the total cash costs was IDR 7,258,315, which was the difference between the average income of the respondent farmers of IDR 10,993,609, with an average of total cash expenses IDR 3,735,294. The average income for the total costs of farming was IDR 5,178,296, with a middle land area of 0.21 ha, which was the difference between the average income of respondent
farmers of IDR 10,993,609, with an average expenditure of the total farm costs of IDR 5,815,313 (Table 3).

Table 3. Average revenue, revenue, and the use of production costs per respondent average land

| No | Description                                | Per land area (0.21 ha) |
|----|------------------------------------------|-------------------------|
|    |                                          | Score | Price (IDR) | Amount (IDR) |
| 1. | Revenue                                  | 4,807 kg | 2,287 | 10,993,609 |
| 2. | Cash Cost                                |        |            |              |
|    | a. Seeds                                 |        |            |              |
|    | b. Urea fertilizer                       | 36.60 kg | 2,000 | 73,200      |
|    | c. Ponska fertilizer                     | 69.83 kg | 2,600 | 181,558     |
|    | d. SP36/ZA fertilizer                    | 18.78 kg | 2,000 | 37,560      |
|    | e. Pesticide                             | 2.69 Liter | 116,390 | 313,091    |
|    | f. Labor outside the family (MWD)*       | 24 Person | 125,000 | 3,000,000 |
|    | Total Amount of Cash Costs               |        |            | 3,735,294 |
| 3. | Cost Estimated                           |        |            |              |
|    | a. Depreciation                          |        |            |              |
|    | Hoe (10%/tahun)                          | 9     | 50,000 | 15,000      |
|    | b. Diesel (10%/year)                     | 1     | 5,000,000 | 166,666    |
|    | c. Property taxes                        |        |            | 23,353      |
|    | d. Labour in family                      | 15 Person | 125,000 | 1,875,000 |
|    | Total Cost Estimated                     |        |            | 2,080,019   |
| 4. | Total Amount of Farmer Business Costs    |        |            | 5,815,313   |
|    | a. Revenue from the total cash cost      |        |            | 7,258,315   |
|    | b. Income on the total cost of farming   |        |            | 5,178,296   |
| 5. | a. R/C Income from total cash costs      |        |            | 2.94        |
|    | b. R/C Income on the total cost of farming |        |            | 1.89        |

Primary Data, processed 2020
*MWD= Men’s Work Day

R/C analysis (revenue cost ratio) is the ratio between total revenue (TR) and total expenditure (TC) of a business. The R/C ratio analysis shows the farm income obtained by the farmer for every rupiah spent. The greater the value of the R/C ratio, the greater the farm income received, and the farming activities are profitable and feasible to be developed. The R/C ratio analysis results on the average total cash costs, namely comparing the average income of farmers with the average total cash costs and the average total farm costs, were 2.94 and 1.89. The R/C ratio value of more than 1 indicates that the sweet potato farming activity is profitable and feasible to be developed. Farmers obtained an income of IDR 9,850,000, with the amount of revenue from cash costs of IDR 5,675,000. Payment for the total costs of farming was IDR 4,133,335, the resulting R/C value for cash costs was 1.73, and the R/C value for the full price was 2.1. Hence, sweet potato farming is profitable and feasible to be developed [15].

The sweet potato analysis also contributed to reducing the feed for shrimp and milkfish ponds for the respondent farmers, amounting to 19.54%. The respondent farmers used the sweet potatoes affected by Cylas Formicarius or boleng disease and small sweet potatoes as pond feed by cutting the wet sweet potatoes thinly then drying them. The average land area was 0.21 ha, while the sweet potato affected by the pest disease of Cylas Formicarius, and the small size reached 360 kg. Moreover, sweet potato stalks and leaves were also used as animal feed, 51.72% for goat breeders, carried out by 180 out of 348 respondent farmers.
4. Conclusion
The following conclusions were drawn based on the research results on the economic and social analysis of sweet potato farming in the Lamongan Regency. The respondent farmers aged over 50 years was 80.17%. Most of them (80.46%) had a low education level for not completing elementary school. Farmers with sweet potato farming experience of more than 20 years were amounting to 67.53%. More than half of them (60.92%) possessed dependents family ranging between 4 to 6 people. On average, the number of dependents family was four people, and two were active in sweet potato farming.

The R/C ratio analysis results on the average total cash costs, and the average total farm costs were 2.94 and 1.89, respectively, with a medium land area of 0.21 ha. The R/C ratio value of more than 1 indicates that the sweet potato farming is profitable and feasible to develop. Sweet potato farming economically contributes to reducing feed for panami shrimp and milkfish ponds for 68 respondent farmers (19.54%). Respondent farmers utilized sweet potatoes affected by the pest disease of Cylas Formicarius and small sweet potatoes as pond feed. The yield of sweet potatoes affected by disease and small size reached 360 kg from an average land area of 0.21 ha. Furthermore, 51.72% of farmers also utilized the sweet potato stalks and leaves for goat feed.

References
[1] Soekartawi 2003 Analisa Usahatani (Jakarta: Universitas Indonesia)
[2] Ahmad I M, Makama S A, Kiresur V R and Amina B S 2014 IOSR Journal of Agriculture and Veterinary Science 7 1–6
[3] Adewumi M O and Adebayo F A 2008 Journal of Rural Development 31 105–120
[4] Zawedde B, Harris C, Alajo A, Hancock J and Grumet R 2014 Economic Botany 68 337–349
[5] Amengor E N, Yeboah H, Fordjour E, Acheampong P P, Adu J O, Frimpong N B, Adofo K and Sagoe R 2016 American-Eurasian Journal of Scientific Research 11 13–20
[6] Mnasas J J, Msuya E E and Mlambiti M 2012 Research on Humanities and Social Sciences 2 86–103
[7] Jepkemboi C, Kebeney S J and Kitilit J 2016. RUFORUM Working Document Series 14 695–705
[8] Yusuf A and Wuyah Y T 2015 American Journal of Economics, Finance, and Management 1 171–178
[9] Ohajianya D O, Otitolaiye J O, Saliu O J, Ibitoye S J, Ibekwe U C, Anaeto F C, Ukwuteno O S and Audu S I 2014 Asian Journal of Agricultural Extension, Economics & Sociology 3 108–117
[10] Olagunju F I 2007 J. Soc. Sci. 14 175–178
[11] Gbibi M T 2011Research Journal Agriculture and Biological Sciences 7 163–168
[12] Hummel M, Talsma E F, Honing A V D, Chibwana A, Gama, Vugt D V, Brouwer I D and Spillane C 2018 PLOS ONE 10 1–19
[13] Ume S I, Onunka B N, Nwaneri T C and Okoro G O 2016 Global Journal of Advance Research 3 872–883
[14] Wall A, Saha S R M, Khaled M and Khan M A 2007 J.Bangladesh Agril. Univ. 5 159–167
[15] Masyitoh S, Novita I, Derina A and Widara 2017 Journal AgribiSains 2 1–9