Pearl millet (*Pennisetum glaucum*) farming for food security: Gross output, net farm income, and B/C ratio

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Abstract. Pearl millet (*Pennisetum glaucum*) is non-rice food commodity which is not only as a source of carbohydrate but also antioxidants, bioactive compounds, and fiber. Calculating gross output, net farm income and B/C ratio were important for the sustainability of pearl millet farming in which pearl millet is better to be alternative of primary food than rice because it contains any benefit for healthy life availability. This study was conducted in West Sulawesi which was selected by purposive sampling in considering that the area was one of the centers of pearl millet farming in Indonesia. Data were collected by using the structured interview to the farmers as samples who cultivated pearl millet as alternative farming. The result found that both of gross output and net farm income of pearl millet (*Pennisetum glaucum*) in one production period after calculated in IDR was dramatically lower than the regional minimum income of West Sulawesi in a month even though B/C ratio value showed that pearl millet farming was feasible to be cultivated. Pearl millet farming was produced twice or two periods in a year. In justification, pearl millet was not the primary but only alternative farm income when the weather was extremely to produce maize or other plants. This condition showed that pearl millet in West Sulawesi was not the priority of food production to support farmers’ income, it was just alternative farming after maize, cocoa, and local onion.

1. Introduction

Food is a fundamental need by all countries. Food shortages that occur widely in a country will cause economic, social and political vulnerabilities that can destabilize of a country. In Indonesia, food is an important issue which aims to strengthen security at the micro as well as at the macro level. The micro level is aimed at meeting the food needs at the individual and communities level while at the macro level that is increasing the security and ensuring the food availability. Pearl millet which is commonly used as a food source generally has a yellowish color [1].

Pearl millet (*Pennisetum glaucum*) is non-rice food commodity which is not only as a source of carbohydrate but also antioxidants, bioactive compounds, and fiber that is good for healthy life [2]. Pearl millet seeds contain carbohydrates and proteins that are not inferior to rice and pearl millet calcium more superior than maize calcium [3].
People, in general, have not known that pearl millet as a source of food. So far, it is often used as birds feed. Pearl millet seed can be processed into a food source by the people to support food security and anticipate the problem of hunger [4]. Pearl millet ranked sixth as the most important grain and consumed one-third of the world's population. Pearl millet can grow well in high temperatures, limited availability of water, with no application of fertilizers and other inputs of technology, and on degraded land that is difficult to cultivate other such as wheat and rice [5].

Pearl millet can be grown in any region in Indonesia including West Sulawesi. One of potential area for growing pearl millet in West Sulawesi is in Polewali Mandar [6]. Nonetheless, the problems faced in the development of pearl millet farming are low application of technology, limited capital of farming business, the narrowness of business scale, the occurrence of fluctuations in production and prices on crops, the lack of research and knowledge of farmers on pearl millet and the absence of a market for sales of pearl millet. Unfortunately, the problems that have not been able to overcome these causes the productivity of pearl millet is still relatively low. Potential of land for cultivating pearl millet reaches thousands of hectares with production amount of 1.5 tons per hectare [7] whereas pearl millet has 14 chromosome pairs with a yield potential of 3.5 tons per hectare [8].

Also, the price of pearl millet at the level of farmers in Polewali Mandar is still fluctuating and quite more expensive with average 15,000 - 20,000 IDR or USD 1 per kilogram. This also causes displaced by other cheaper food commodity such as rice with only 6,000 IDR per kilogram or wheat 8,000 IDR or equal to 0.5 USD per kilogram. In case purchasing power of the pearl millet is very low, therefore if it is processed into food products, the price will be higher.

2. Methods

This research is designed by the framework for data collection and analysis to answer research questions [9]. Based on the research question, there are two-kind of analysis by using a quantitative approach. Firstly, gross output is used to estimate total revenue from the total volume of marketable price multiplied by average farm gate price of pearl millet in the location of research. Secondly, net farm income results from the total revenue of pearl millet after decreased costs incurred during the farming activities.

To calculate gross output from the total revenue of pearl millet farming is by multiplying the total production per hectare with the selling price per unit kilogram, which is formulated:

\[ TR = P \times Q \]  

Where:

- \( TR \) = Total Revenue (IDR)
- \( P \) = Price (IDR)
- \( Q \) = Quality (Kilogram)

To analyze net farm income of pearl millet farming is to calculate the difference between gross output in this case total revenue and farming cost that is formulated:

\[ I = TR - TC \]  

Where:

- \( I \) = Income (IDR)
- \( TR \) = Total Revenue (IDR)
- \( TC \) = Total Cost (IDR)

From this formulation, before continuing to calculate net farm income, the first step is calculating total cost (TC) which is resulted from fixed cost and variable cost. Benefit-Cost Ratio is an analytical tool to measure the level of the feasibility of the farming production process [10,11].
To analyze Benefit Cost (B/C) Ratio find out the net benefits that are positive and the net benefits that are negative in a business where interest divided into cost with an assumption:

\[
\text{Benefit-cost Ratio} = \frac{\text{B}}{\text{C}}
\]

Where:
- \( \text{B} \) = Benefit
- \( \text{C} \) = Cost

- B/C Ratio > 1, pearl millet farming is feasible to continue
- B/C Ratio < 1, pearl millet farming is not feasible to continue
- B/C Ratio = 1, pearl millet farming is in Break Even Point (BEP)

3. Results and discussion

3.1. Gross Output

The gross output or total revenue is the prevailing price multiplies the total amount of production of the resulting pearl millet farming at that time. The average value of gross output on the pearl millet farming for two-period production can be seen in the following table 1.

| No | Period/Year | Average of Gross Output (IDR) | USD |
|----|-------------|-------------------------------|-----|
| 1  | I           | 1,800,000                     | 124.22 |
| 2  | II          | 1,650,000                     | 113.86 |
| Total |             | 3,450,000                     | 238.08 |

Source: Primary Data after Processed, 2017.

Based on table 1, the gross output in the first harvest period is higher than the second harvest period. Differences in receipts levels of the period I and II are usually followed by climate change. High degree of rainfall will have a good impact on the growth of pearl millet. Rainfall is a factor determining the yield and quality of plants [12]. The average gross output of pearl millet farming in a year was 3,450,000 IDR or USD 238.08 in 2 times production period which was an average production of 50-60 kilograms.

Pearl millet farming had goals that lead to an income of farmers. Calculating the income from farming cultivation of pearl millet hence need to calculate the total of investment, total cost used in the production process, and total of revenue. The farming system in West Sulawesi was not yet oriented to production and market neither in quantity nor quality. The number of pearl millet productions were largely determined by a series of processes from upstream, in this case, on-farm system and post-harvesting handling in the downstream. Quantity had not been able to provide the maximum welfare for pearl millet farmers because the land used for cultivation was still relatively narrow. The recommendation for pearl millet farming was planting density, inorganic fertilizer application, and short cycle varieties have not been followed by the farmers [13]. The difference in priorities between researchers, who aim to improve yields in average years, and Sahelian farmers, who seek to reduce the frequency of crop failure, could explain the non-adoption of most innovations because the risks of yield losses were not reduced [13].

The average land ownership of farmer was only 0.25 - 0.50 hectare with two production cycles per year. Pearl millet farming is mainly cultivated when the rainfall is low, in which the land was not used to produce maize maximally due to the insufficient water requirement. The pearl millet plant is considered to have a good adaptation of both low rainfall area and dry land as well. The property used for pearl millet farming was still narrow as the main reason for the average yield produced once in the harvest period was also relatively low. Although the investments made, do not suffer losses but the
average profit from the farmed cultivation farm is still relatively small and the lack of investment cost owned by farmers to develop their business.

The technology used to run pearl millet farming with simple production equipment consists of the sprayer to spray disease and grass that interfere with pearl millet plant, other stuff are usually used sickles, drying and a traditional cutting tool that is popularly named “ani-ani” in Indonesia. The production tools used to produce pearl millet were also tools used to produce maize and other cultivated crops.

The facilities of production used in the cultivation of pearl millet were relatively available and easy to obtain. Farm labors used in the cultivation of pearl millet are a family member of farmers themselves or fellow farmers with a system of mutual help each other, so it does not require wages, prepare for food and drink. In agriculture, it was popularly named as subsistence agriculture. His family members assist the whole series of cultivation activities until the drying was done by the farmer itself.

Maintenance of pearl millet (Pennisetum glaucum) planting was done especially from the beginning of farming until at the time of planting mowing had begun to produce. At the time of approaching the harvest period, there were birds that harp ate the seeds of the pearl millet so that the farmers spread the ropes around the land of cultivated cultivars that were considered the cord produces sounds that can repel the birds of plants intruders, in the process of maintaining the pearl millet all the equipment and farming methods run by farmers are still in simple context. Moreover, pearl millet farming is an effort involving women's participation in rural areas. Household women are engaged in harvesting, drying and postharvest processing such as churning out a pearl millet to pick up the seeds by using a simple pestle that can separate between the seeds and stem of pearl millet.

3.2. Net Farm Income
Net farm income is the difference between the sales proceeds of total gross output and farming costs. Before continuing to analyze net farm income, the first step was calculating of pearl millet farming costs that consist of fixed and variable cost. In this case, price had an essential role in decision making for agricultural business. The amount of expenses incurred to produce something greatly determines the cost of goods produced.

| No | Component of Total Cost | Cost (IDR) | Cost (USD) | Percentage (%) |
|----|------------------------|------------|------------|----------------|
| 1  | Fixed Cost             | 470,000    | 32.43      | 41.05          |
| 2  | Variable Cost          | 675,000    | 46.58      | 58.95          |
|    | Total                  | 1,145,000  | 79.01      | 100            |

Source: Primary Data after Calculated, 2017.

Component of fixed costs in pearl millet farming is hand sprayer, water pump, cutting tool, sickle, and drying equipment. Costs that calculated in fixed cost was total is a reserve that will be used to purchase new assets to replace the old assets that were no longer productive.

| No | Variables     | Average of Income (IDR) | Average of Income (USD) |
|----|---------------|-------------------------|-------------------------|
| 1  | Gross Output  | 1,800,000               | 238.08                  |
| 2  | Total Cost    | 1,145,000               | 79.01                   |

Net Farm Income: 655,000

Source: Primary Data after Calculated, 2017.

Pearl millet farming in Western Sulawesi prospects to be developed in the future with the consideration that it can be an alternative food that has rich nutritional content. Pearl millet is a very
potential commodity as a source of any benefit for healthy life [2]. In addition, the pearl millet is resistant to climate and maintenance is relatively easy. As noted by the respondent, Safar (25 years), a pearl millet farmer that “in less rainfall and water availability, pearl millet plant is still able to produce well and not too affected by the season”. It was supported by an opinion [14] that pearl millet has advantages compared to other carbohydrate plants such as can grow on almost all types of soils including soil less fertile, dry soil, easy to cultivate, short harvest age and usefulness diverse.

Moreover, pearl millet has the potential to be developed to strengthen local food security as a source of carbohydrate replacement rice. This plant is spread in any region in Indonesia such as Jember, South Sulawesi, West Sulawesi and Lombok Island as most frequent planting of pearl millet in Indonesia but most of them the production is used for personal consumption [14]. Nonetheless, people generally were not popular with pearl millet as a source of food and also as a processed material to support food security and anticipate the problem of hunger [4].

3.3. B/C Ratio
Climate B/C Ratio. One indicator of business continuity is profit for business actors on investment capital issued, so it can be said that the business is feasible to be continued. B / C ratio analysis is used to determine the extent to which millet farming can benefit farmers. A business based on investment criteria is said to be feasible if the R / C ratio or net R / C ratio > 1. R / C ratio analysis is obtained from the total revenue of the cultivation business (revenue) divided by the total cost of cultivation (cost) that is 1.57. So that, it is considered a farming investment of pearl millet is feasible to be continued in Western Sulawesi.

The feasibility of pearl millet farming in West Sulawesi, marked by the effort has been carried out for years by farmers. Initially, millers were attempted to become subsistence farms which later, realized that the farm had market value or potential to bring benefits to them. Pearl millet seeds have a variety of benefits so that this business is feasible to develop such as making diversified food processing products. Millet seeds are consumed as food in various Asian countries such as the Southeast and North Africa. It was usually processed by cooking and eating like rice, either whole or destroyed. In northern China, millet flour was part of the staple food to make bread and noodle dough. In Russia and Burma, it was used as an ingredient to make vinegar, beer and alcohol. At Sinegal, pearl millet can be processed into porridge, extruder or snack products and substituting yogurt. In Western Sulawesi, pearl millet is consumed by people as porridge and also processed as local product such as snacks as the alternative income of farmers.

To create a balance in pearl millet farming, so as not to suffer losses, millet farm is important to set a minimum amount of production in one year by calculating the value of the break-even point of production so as not to lose and profit. As according to [15,16,17] the break-even point value is revenue equal to cost. Break-even point analysis can also be used to determine the minimum amount of production and sales so that the company still does not lose and does not profit [16,18]. Then, break event point is a process where the value of a parameter such as the component of fixed costs, product selling prices, or MARR (Minimum Attractive Rate of Return) is varied and the value at which the financial performance of the investment reaches the point return (from profit to loss, or vice versa) is a break-even point [17].

4. Conclusion
Conclusion that can be drawn that pearl millet (Pennisetum glaucum) farming in Western Sulawesi has the potential alternative food security to be developed where the production costs were not too high so that the farmer earns a profit from the sale of pearl millet and the business deserved to be continued based on the R / C ratio obtained greater than one.

References
[1] McDonough, C.M., Rooney, L.W., 2000. The Millets. Di dalam: Kulp, K., Ponte, Jr., J.G. (Eds.), Handbook of Cereal Science and Technology. (Marcel Dekker, Inc., New York)
177–201
[2] Rooney L. W., Serna S. 2000. *Handbook of Cereal Science and Technology* (New York: Marcel Dekker) 67-68
[3] Widyaningsih dan Mutholib, A. 1999. *(Pakan Burung.* Penerbit Swadaya, Jakarta) 678-679
[4] Marlin. 2009. *Sumber Pangan Tanaman Minor.* http://daengnawan.blogspot.com/ 2009/07/ sumber-pangan-tanaman-minor.html. [13 Juni 2015]. Maxwell L. Brown, 1974 dalam Soekartawi, 2002.
[5] Bhuja, P. 2009. *Identifikasi dan Karakterisasi Tampilan Agronomis Jewawut Lokal Nusa Tenggara Timur: Upaya Merevitalisasi Keragaman Ketersediaan Pangan Nasional.* http://www.goole.co.id. [13 Juni 2015]
[6] Ministry Agriculture of Indonesia. 2016. Indonesia
[7] Agriculture and Livestock Service of Polewali Mandar. 2015.
[8] Dukes, J.A. 1978. *The Quest of Tolerant Germplasm.* di dalam: *Crops Tolerance to Suboptimal Land Conditions.* Jung, G. A. (ed.). Spec 32 Pub. Madison 4-5
[9] Bryman, A., Bell, E., Mills,A.J., and Yue, A.R. 2011. *Business Research Methods.* First Canadian Edition, (Oxford University Press, Toronto) 89-90
[10] Soekartawi. 2006. *Farming Science* (UI Press; Jakarta) 67-70
[11] Yunita, I. 2017. *Analysis of Feasibility “Dodol” Business at Paloh, Peusangan District Bireuen Regency.* Journal S.Pertanian 1826-836
[12] Sholeh, M. *Curah Hujan dan Waktu Tanam Tembakau Temanggung.* (Balai Penelitian Tembakau dan Tanaman Serat, Malang) 678-679
[13] Rouw, A. 2004. *Improving Yields and Reducing Risks in Pearl Millet Farming in the African Sahel.* Science Direct: Agricultural Systems 81 73-93
[14] Suherman, O., Zairin, M., dan Awaluddin. 2005. *Keberadaan dan Pemanfaatan Plasma Nutfah Jewawut di Kawasan Lahan Kering Pulau Lombok.* Laporan Tahunan pusat Penelitian Serealia Balai Penelitian Tanaman Serealia Maros, Sulawesi Selatan.
[15] Yamit, Z. 2007. *Manajemen Operasi dan Produksi.* (Edisi kedua. (Cetakan ketiga, ekonisa, Yogyakarta) 567-568
[16] Pattiwiri, A.W. 2006. *Teknologi Penggilingan Padi,* (Gramedia Pustaka Jakarta) 23-25
[17] Salengke, 2012. *Engineering Economic. Techniques for Project and Business Feasibility Analysis,* Identitas Hasanuddin University, Makassar 56-57
[18] Sukiman 2017, *Development Strategy of Factory Rice Processing Complex (RPC) Anabanua, Wajo Regency.* School of Post Graduate, Hasanuddin University pp 78-80