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# Economic analysis of cassava production in Cambodia

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**Abstract** The research indicated that the farmers had an average land holding over 7 hectares, with 58% of their land used for planted cassava. For the fresh root cassava, the yield ranged from 8.40 to 37.26 tonnes per hectare, with an average of 24.16 tonnes per hectare. The value-added and net profit represented 83.09% of the total production and 28.82% per hectare. The production cost was 1,058.19 USD per hectare and the break-even point was 43.79 USD per ton, with a return on investment of 1.40 USD. The dried chips cassava showing the value-added and net profit of the total production that accounted at 87.07%, and 33.21% per hectare, respectively. The dried cassava production, it involved a process of peeling and drying the fresh cassava, and the cost of that process was 19.56 USD per ton. The labour revealed mostly hired on cassava production which represented a cost of 21 to 25% of the revenue from the sale of their final products. Furthermore, the farmer's profit was reduced by 24% due to yield variation, although the price fluctuation was not a big issue. In addition, there was a high production cost, a poor investment in the processing of raw materials, and a dependence on the Thai export traders to the Chinese market. Therefore, it was undeniable that the price of cassava is a determinant factor that could represent a significant loss of added value in Cambodia.

**Keywords:** Break-even point, Economic, Value-added, Return on investment, SWOT

## Introduction

Cassava (*Manihot esculenta* Crantz) is the most important upland crop in Cambodia. It is an important source of energy (carbohydrate) when it is served for animal feeding and it can be used also as a feedstock in the processing of bioethanol (CIAT, 2018). For the last 5 years, the cassava production area in Cambodia expanded exponentially from less than 515 thousand hectares in 2014 to a peak of more than 650 thousand hectares in 2018. The production was 13,817,262 tonnes in 2017 (MAFF, 2016-2017). The cassava experiment under Cambodian conditions obtained the highest yield at 36 tonnes per hectare

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(Sopheap *et al.*, 2008). In 2014, the average yield of cassava in Cambodia was 25 tonnes per hectare, which is the second-highest after Laos in Southeast Asia (FAOSTAT, 2017). At the same time, an increase in production came from an expansion of the planting area, as the yield decreased to 22.55 tonnes per hectare in 2017 (AFSIS, 2017). Therefore, over the years, continuous cropping and inappropriate farm management lead to net nutrient removal and the gradual decline of soil fertility (Luar *et al.*, 2018).

In 2007, the cost of production was 464.80 USD per hectare and it increased to 981.25 USD per hectare in 2013 (Hing and Thun, 2009; Ou *et al*., 2016). It continued to increase to 996.76 USD in 2017 (Sopheak, 2017). Within the framework of the Cambodia-China-UNDP Trilateral Cooperation Cassava Project - Phase II, there is a need for the assessment of cassava production in Cambodia. There are serious concerns about the fluctuations of the price (MAFF, 2015). In addition, a study of the cassava value chain, conducted by the project IBC in Tboung Khmum province, found that productivity can be increased through more intense collaboration and better conditions for all value chain players can be achieved (SNV Cambodia, 2015). Nevertheless, there is still a lack of information and research about several factors: the transformation of cassava to dried chips, the value-added, the break-even point, and the return on investment. These are important factors to find out what kind of management could increase cassava production and its profitability.

The aim of the study was to show all the aspects of the economy in the cultivation of cassava in terms of total production cost, net income, net value-added, the net return on investment, and productivity.

## Materials and methods

### *Study area and sampling method*

This study was conducted in Battambang and Pailin province along the Cambodia-Thailand border as shown in Figure 1. Each province has more than 50,000 hectares of cassava cultivation area. In these two provinces, 109 cassava farmers were randomly selected from lists of households provided by the chief of villages surveyed. We adopted a multi-stage survey with a sampling method of at least 10% of the population grows cassava following Taro Yamane formula (created in 1967 & 1973). The first survey was conducted in February and March 2019 in Battambang province and the second one, from June to July 2019 in Pailin province.

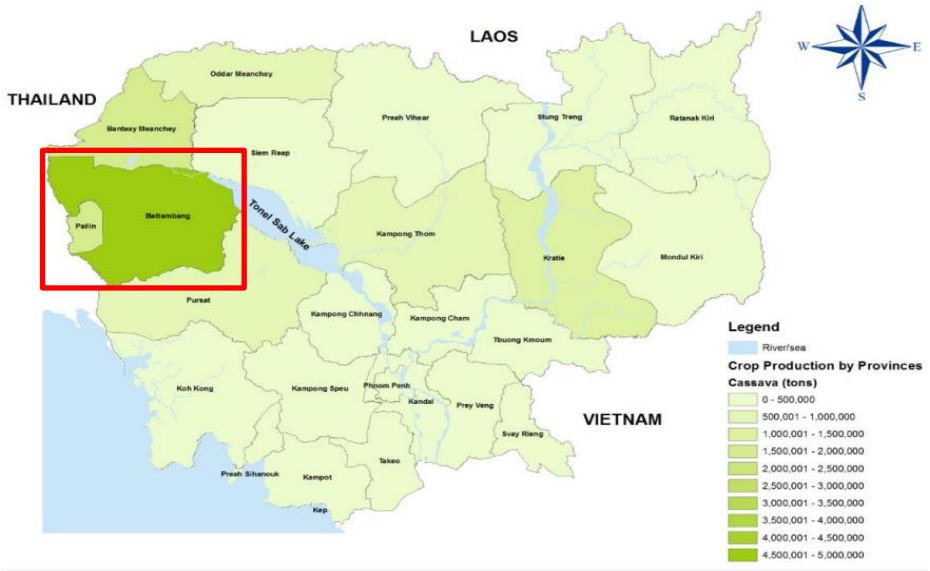


**Figure 1.** Study areas in Battambang and Pailin province
**Source:** Generated by BDLINK, using MAFF's report 2015-2016

### *Data collection*

Data was collected from qualitative and quantitative methods to analyze the roles and actions of cassava farming. Primary data was collected to get information about cassava, the agro-practices, the processing of dried chips, the marketing, and SWOT, using semi-structured interviews and guided questionnaires. Secondary data was collected in the selected areas about rainfalls, soil type, history of cassava production, marketing, processing, and other data relevant to the study.

### *Data analysis*

Data from the questionnaire was analyzed using the SPSS statistical program and Microsoft Excel. Frequencies and means for socio-economic and demographic data were computed as descriptive statistics (Sopheak, 2017; Masamha *et al*., 2018). Budgetary techniques were analyzed by using the total cost, total profit, break-even point (BEP), value-added, and return on investment. SWOT analysis estimated the costs, returns and constraints of cassava production in the study area according to Olukosi (1999) and Hoa *et al*. (2019).

## Results

### *Socio-economic characteristics of cassava farmers*

The results revealed that 87.16% of the respondents were males and head of household, 12.84% were females and widow; the male respondents dominated the farming area (Table 1). The age of the respondents averaged 31 to 50 (54%). The household size ranged from 4 to 6 people (74.31% of respondents). Most of the households had family members working on their own farm and 69.73% of their farm was used for cassava farming, representing 1 to 5 hectares, while 23.85% of the farmers cultivated cassava on a surface of more than 5 hectares.

The results of the survey also showed that the education level of the respondents was very low: 16.51% did not have any education, 41.29% had a primary school education and 28.44% had a secondary school education.

Most of the uneducated farmers (57%) did not know how to apply fertilizers and pesticides. Finally, most of the farmers (63.3%) had more than 5 years of experience in the cultivation of cassava. This group had a basic knowledge for cassava cultivation and they knew how to get a high yield production by using a new variety.

**Table 1.** Socio-economic characteristics of respondents at the study sites

| Items | Category | Frequency | Percentage | Mean |
|---|---|---|---|---|
| Gender | Male | 95 | 87.16 | - |
| | Female | 14 | 12.84 | |
| Age | 19-30 Years | 12 | 11.01 | 44.89 Years |
| | 31- 40 Years | 33 | 30.27 | |
| | 41 – 50 Years | 26 | 23.85 | |
| | 51- 60 Years | 21 | 19.27 | |
| | Above 60 Years | 17 | 15.60 | |
| Household size | 2- 3 persons | 19 | 17.43 | 4.6 Persons |
| | 4- 6 persons | 81 | 74.31 | |
| | 7 person and above | 9 | 8.26 | |
| Land size | 0 – 1 hectare | 7 | 6.42 | 4.33 Hectares |
| | > 1- 5 hectares | 76 | 69.73 | |
| | > 5 – 10 hectares | 19 | 17.43 | |
| | > 10 hectares | 7 | 6.42 | |
| Education | None | 18 | 16.51 | 2.41 Grade Primary school |
| | Primary School | 45 | 41.29 | |
| | Secondary School | 31 | 28.44 | |
| | High School | 12 | 11.01 | |
| | Collect | 3 | 2.75 | |
| Farming experiences | 1-5 Years | 40 | 36.70 | 8 Years |
| | 6- 10 Years | 44 | 40.37 | |
| | 11-15 Years | 19 | 17.43 | |
| | Above 15 Years | 6 | 5.50 | |

### *Cassava varieties*

In Battambang province, the most popular variety was Rayong 9 while in Pailin province, it was variety 89. More than 43.12% of the farmers in both provinces planted Rayong 9 variety and 17.43% planted the variety 89. Also, 8.26% of the farmers planted an unknown variety, as shown in Figure 2. Among these cassava varieties, Rayong 9, Huay Bong 60, and KU 50 are from Thailand. Kromumyun variety was from Vietnam, while the 89 and KorTorl varieties were from an unknown source, although the owner of the silo mentioned that those come from Thailand.

Rayong 9, KorTorl, Huay Bong 60, and KU 50 have high yield potential and high starch content while variety 89 has a very high yield potential. These varieties were introduced by the local silos and Thai traders because they have high starch content and they are appropriate to make Bio-ethanol and animal food.

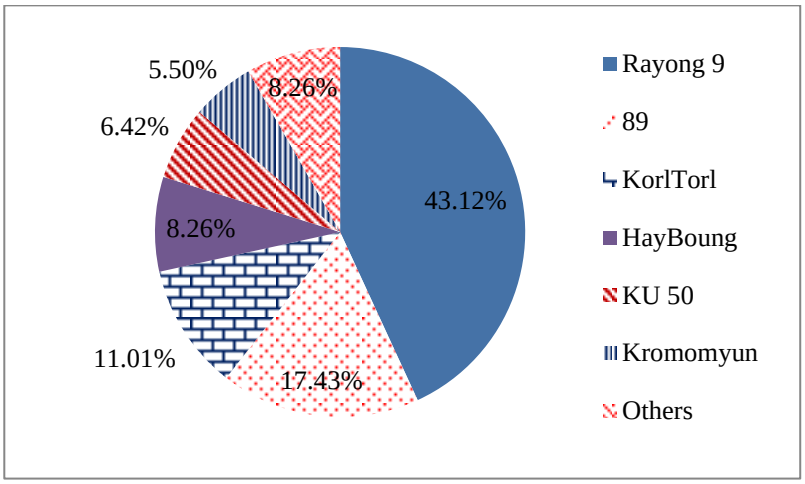


**Figure 2.** Cassava varieties used by cassava farming in both provinces

### *Financial analysis of cassava farmers*

In the study area, out of 109 sampled farmers, 58 produced fresh root cassava, and 51 produced dried chips cassava. At the same time, the silos played a vital role in the cassava value chain and their demand has led to the enhancement of the value of cassava roots, which is transformed into dried chips and provides animal food (CP Company). Some of the dried chips are used locally, and the rest (3.47% in fresh and 67.76% in dried chips) is sold to

Thai traders who in turn, export it to Chinese markets. The yield of fresh root in the study site fluctuated in the range of 8.4 to 37.26 tonnes per hectare. However, in exceptional cases, the yield was as low as 3.6 tonnes per hectare. This is because some cassava farmers suffered from drought. The use of poor quality varieties also contributed to low productivity.

In the production stage, the farmers really need big financial assistance for their cassava production to purchase the agricultural inputs, fuel, and to hire labour. The farmers are faced with a lack of capital and 59% of them take a loan. The analysis was conducted by considering both the cash and imputed cost literally used by the farmers. The cash cost is a cost literally paid by the farmers in cash and as the wages paid for labour and services by fixed capital. The imputed cost is a cost not literally paid in cash but it is capital fixed as the production factors, owned by the farmers such as household labour cost, service cost, etc.

The total farmer's revenue was 1,486.58 USD per hectare for the fresh root cassava. The average price of cassava was 61.53 USD per ton and the average yield was 24.16 tonnes per hectare. In the value chain analysis, the cost of intermediate inputs represented 15.47% of the total revenue of the producers. The highest percentage being the cost for herbicides and stem cutting, at 6.3% (93.64 USD) and 5.95% (88.52 USD), respectively of the total revenue. The expenditures for hired labour, hired service by fixed capital and land rental accounted for 494.25 USD or 33.25% of their income and the imputed cost of family labour. The cost of services by farmer's own fixed capital was 312.59 USD or 21.03%. Labour cost itself represented 21.16% of the total revenue. Despite all those costs, cassava remains a favourable crop which contributes to the farmer's income, and with an opportunity of employment for the poor people in rural areas.

The depreciation of the farm equipment such as tractors, trucks, equipment for spraying herbicides, weed cutters, represents an amount of 21.33 USD per period of cassava farming.

The total expenses, not including the imputed cost, were 745.59 USD or 50.16% and the total cost of production was 1,058.19 USD or 71.18% while the net farm income was 773.03 USD per hectare or 52% and the net profit was 428.40 USD or 28.82%, respectively. This table showed that farmers are sharing an imputed cost of 312.59 USD or 21.03% only, while the net value-added represents 83.09% of total revenue.

The return on investment represented 1.40 Riel, meaning that for every 1 KHR or 1 USD invested in Cassava farming, the farmer will get net revenue of 0.40 KHR or 0.40 USD, as shown in table 2.

**Table 2.** Major indicator analysis of fresh cassava per hecatare

| *Items* | *Value* | | *Proportion%* |
|---|---|---|---|
| | **KHR** | ***USD*** | |
| **Total Revenue (A)** | **5,946,331** | **1,486.58** | **100%** |
| **Intermediate Input (B)** | **920,071** | **230.02** | **15.47** |
| Stem cutting | 354,098 | 88.52 | 5.95 |
| Fertilizers | 44,390 | 11.10 | 0.75 |
| Liquid fertilizers | 94,411 | 23.60 | 1.59 |
| Herbicides | 374,579 | 93.64 | 6.30 |
| Pesticides | 10,682 | 2.67 | 0.18 |
| Bags | 5,525 | 1.38 | 0.09 |
| Plastic cable tie | 743 | 0.19 | 0.01 |
| Fuel | 35,643 | 8.91 | 0.60 |
| **Cash cost (C)** | **1,976,984** | **494.25** | **33.25** |
| Transportation | 273,356 | 68.34 | 4.60 |
| Land preparation | 165,470 | 41.37 | 2.78 |
| Harvest by tractors | 21,691 | 5.42 | 0.36 |
| Labor cost | 1,093,444 | 273.36 | 18.39 |
| Interest | 216,245 | 54.06 | 3.64 |
| land rental fee | 206,778 | 51.69 | 3.48 |
| **Imputed cost (D)** | **1,250,359** | **312.59** | **21.03** |
| Transportation | 71,269 | 17.82 | 1.20 |
| Land preparation | 74,446 | 18.61 | 1.25 |
| Harvest by tractors | 2,501 | 0.63 | 0.04 |
| Labor cost | 164,484 | 41.12 | 2.77 |
| Interest | 285,367 | 71.34 | 4.80 |
| land rental fee | 652,292 | 163.07 | 10.97 |
| **Depreciation (E)** | **85,337** | **21.33** | **1.44** |
| **Total expense (F = B+ C+E)** | **2,982,392** | **745.59** | **50.16** |
| **Total cost (G = F +D)** | **4,232,751** | **1,058.19** | **71.18** |
| **Net farm income (H = A-F)** | **2,963,939** | **773.03** | **52.00** |
| **Net profit (I = A-G)** | **1,713,580** | **428.40** | **28.82** |
| **Net value added ( J = A- B -E)** | **4,940,923** | **1,235.23** | **83.09** |
| **Return on investment (J=A/F) 1.40** | | | |

1/: Exchange rate: 1 US$ = 4,000 Cambodia Riel (NBC, 2019)
2/: KHR: Khmer Riel (Currency Cambodia Riel)

In the case of dried chips cassava, the process of drying the fresh root cassava by the farmers and transforming it to dried chips cassava involves a weight loss of 53% to 57%, depending on the degree of moisture and the starch content of each variety. The way to process cassava root into dried chips, by the local workforce, is to slice the roots into chips size and let that dry in the sun for 3 to 5 days. The dried chips cassava production brings a total profit of 1,511.80 USD per hectare.

The value-added and the net profit accounted for 87.07% of the total production and 33.21% per hectare, respectively as shown in Figure 3. As indicated by the left circle graph of Figure 3, the cost of intermediate inputs accounted for 12.05% of the total revenue, while depreciation and value-added accounted for 0.87% and 87.07%, respectively. Peeling and drying fresh cassava cost 195.61 USD per hectare or 19.56 USD per ton, which accounted for 12.94% of the total revenue. And the return on investment represented 1,009.66/1,511.80 = 1.50, providing 17% more profit than the fresh cassava.

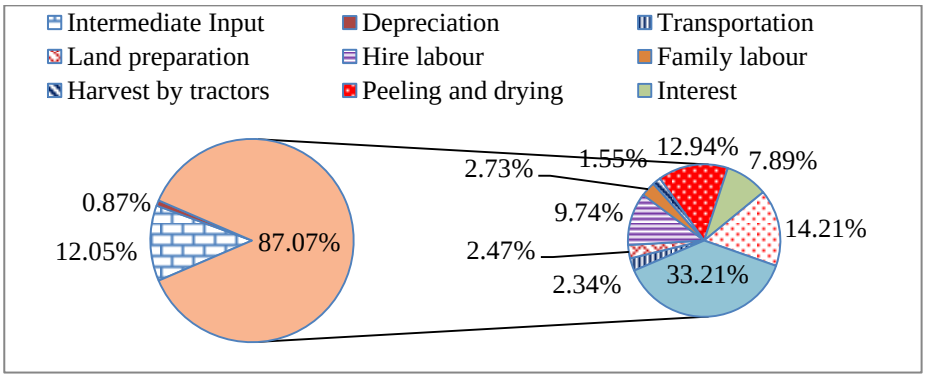


**Figure 3.** The proportion of each cost item to the total revenue

***Break-even point analysis in cassava production***

The break-even analysis is a useful tool to study the relationship between fixed costs, variable costs, and returns. A break-even point tells us when an investment will generate a positive return and can be determined graphically or with simple mathematics. The break-even analysis is divided into 2 types: one type is the price break-even point analysis (sales price varies but the total cost and yield per hectare are fixed). The other type is the yield break-even point analysis (the yield changes due to factors unrelated to variable factors, fertilizers, fuel, labour, etc.). So, the total cost per hectare and the price per ton are fixed.

The analysis shown in figure 4(a) is for fresh cassava production. So if farmers sell fresh cassava roots at a price below 43.79 USD per ton, they will have a loss in their cassava production. But if the farmers sell their fresh root cassava at a price higher than the break-even price with a yield of 24.16 tonnes per hectare, they will gain a profit from their cassava production.

Figure 4(b) shows that the break-even point yield was 17.19 tonnes with a total cost of 1,058.19 USD per hectare. So if the yield is lower than 17.19 tonnes per hectare, the farmers will have a loss in their cassava production. But if the yield is higher, the farmers will gain a profit.

The data analysis indicated that none of the sample farmers sold cassava at a price below the break-even price, while 24.13% of them experienced yield below the break-even yield. So, it is deducted that about 24.13% of the cassava farmers faced a loss in their cassava production.

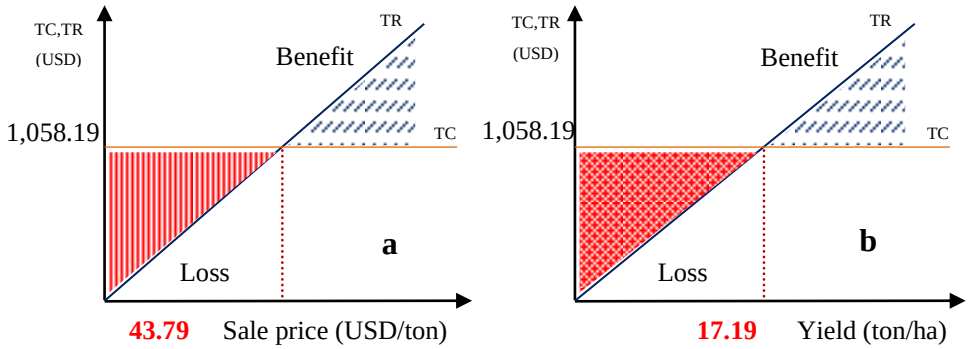


**Figure 4.** The break-even point of fresh cassava production

In the case of cassava dried chips, the break-even point price was 100.96 USD per ton, with a total cost of 1,009.66 USD per hectare. So, if the sales price is lower than the break-even price, it will result in a loss in their cassava production. But, if the sales price is higher than the break-even price with a yield of 10 tonnes per hectare, it will result in benefits for their production as shown in figure 5(a).

Figure 5(b) shows that the break-even point yield was 6.67 tonnes per hectare. So if the yield is lower than 6.67 tonnes per hectare, the farmers will have a loss in their cassava production. But if the yield is higher than the yield break-even yield, the farmers will gain a profit from their cassava production.

The data analysis indicated that none of the sample farmers experienced a yield lower than the break-even point yield nor sales price lower than the break-even price in dried chips cassava production.

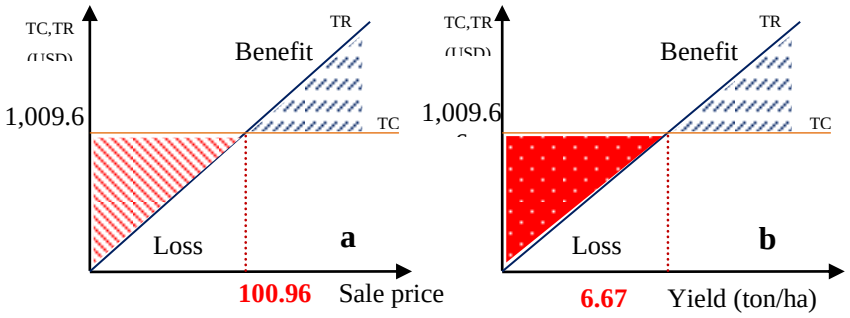


**Figure 5.** The break-even point of dried chip cassava production

***SWOT analysis on cassava farmers***

Identifying the cassava production internal Strengths and Weaknesses, and examining the external Opportunities and Threats that all stakeholders face. The main findings from this study are summarized in the SWOT analysis that follows in Table 3.

**Table 3.** SWOT analysis on cassava farmers

| **STRENGTHS** | **WEAKNESS** |
|---|---|
| - Cassava is a major crop in the study area; Average land holding is over 7 hectares, 58% of the land is used in cassava farming and crop rotation every season<br>- Harvesting periods can be delayed.<br>- Less intensive labour than other crops<br>- High yield of fresh root cassava (24.16 tonnes per hectare) | - Education level of farmers is low, resulting in poor knowledge of new techniques to improve productivity<br>- Cassava needs a longer growing period.<br>- Farmers do not know which variety is suitable for their specific agro-ecological conditions<br>- Labour not readily available in study areas during planting and harvesting seasons<br>- 59 % of farmers take a loan and 24 % of them had faced a loss from their cassava production due to large yield fluctuation<br>- Large yield fluctuation in a range of 8.4 to 37.26 fresh root tonnes per hectare |
| **OPPORTUNITIES** | **THREATS** |
| - Increased cassava production is attracting more investors to the cassava business<br>- Cassava is adaptive to a wide range of soils and can survive a moderate drought | - Climate Change (increase in pest, disease, and drought)<br>- Limited research and development and transfer of new techniques to farmers<br>- Market depends on Thai traders only<br>- Soil nutrient depletion and a yield decline over time |

## Discussion

The World Bank in 1992 reported that with basic education, the farmers could increase their productivity by 7% to 8% in low-income countries (Gasperini, 2000). Likewise, the major finding in the study concerned the educational level increases, cassava output increases with secondary school education having the highest returns on agricultural productivity (Oduro *et al*., 2014). In contrast, a large part of the cassava farmers in our sample had a low level of education (41.29% of them, and had a primary school diploma as their highest education). A major effect of the education on agriculture was the cognitive effect whereby a farmer acquiring basic literacy and mathematic can read instructions on fertilizers, pesticides, and herbicides and can calculate inputs to enhance productivity (Appleton and Balihuta, 1996). Therefore, the farmers with no education found that their ideas on cassava production based on myths instead of facts, like thinking that cassava did not need fertilizers or pesticides (CIAT, 2018).

The farmers who had acquired enough farming experience were able to effectively use new farming techniques and much responsive to sustainable conservation practices to make a meaningful and real impact on agricultural production (Ejike and Osuji, 2013; Osuji *et al.*, 2014). Furthermore, experienced farmers who belong to farmer's associations and who relatively had access to markets, who sold cassava to processors, and who planted cassava as sole crop; those farmers have achieved higher levels of technical efficiency in cassava production in Uganda (Abass *et al.*, 2017). Our results indicated that the farmers with enough experience (8 years), who had basic knowledge of cassava farming, accepted to use new varieties with very high yield potential. There is a demand on the market for the varieties of cassava used in animal feeding and bio-ethanol, which are mainly the varieties 89 and Rayong 9.

The farmers used different cassava varieties, but they did not know which varieties were suitable for their specific agro-ecological condition. At present, no cassava breeding program has been either established or carried out in Cambodia besides some testing of some varieties from cassava breeding centers of Thailand, Vietnam, and China (MAFF, 2015). It is undeniable that the cassava farmers had difficulty to find and accept a healthy and high-quality planting material. Research findings also revealed that most of the farmers used stem cutting from a previous crop to plant a new crop. It was very convenient, but unfortunately, this technique provided an easy way for disease-causing pathogens, particularly viruses, to pass directly from one plant generation to another. The varieties was not only need to respond to the requirements of the farmers but also resistance to diseases which concerned economic importance as one of the main reasons for production losses in cassava (Martin *et al.*, 2013).

Moreover, the farmers mostly used little fertilizer or no fertilizer at all. The lack of fertilizer application, poor technologies, and management contributed to a large yield variation, with an average of 24.16 tonnes per hectare. The fertilizer recommendation based on the 4R nutrient stewardship concept to apply the right source of plant nutrients at the right rate and time in the right place which become the key to success. The farmers who followed those recommendation would reap the full benefits of their investment in fertilizer (IPNI, 2012).

Around 24% of the fresh root cassava farmers achieved a yield which was lower than the break-even yield but none of them sold their fresh root cassava below the break-even price. So, it can be deducted that about 24% of the fresh root cassava farmers faced a loss in their cassava yield production, partly due to the price fluctuation. This was not a big concern because both groups of farmers, fresh roots and dried chips, sold their cassava higher than the break-even price which it was not consistent with MAFF (2015); SNV Cambodia (2015) explained as a serious concern about the fluctuations of the price on the market due to lack of market information access, market uncertainly and lack of government support on the value chain in their location. In the case of dried chips cassava, none of the farmers had experienced a yield or a sales price below the yield and price break-even point. Hence, the farmers who produced fresh root cassava had a larger deficit than the ones who produced dried chips cassava. However, there is also a lack of a developed processing industry - only 28.77% of cassava is processed locally and the rest is sent to Thai traders who export the cassava to the Chinese market. Therefore, there is a significant loss of potential value-added and not sustainable market to Cambodia.

For the fresh root cassava, the value-added and the net profit accounted for 83.09% and 28.82% of total revenue, respectively. For the dried chips cassava, they respectively accounted for 87.07% and 33.21%. The study showed that 58 out of 109 farmers produce fresh root cassava even though dried chip cassava brings a larger income and profit. This indicated that they had some difficulties in producing dried chips due to the lack of labour and they are faced with irregular rainfall. The farmers who sold cassava as dried chips got a net profit of approximately 17% more than the farmers who sold cassava as fresh root. One reason for that difference was due to the transportation cost of dried chips cassava which is lighter than fresh root cassava. Furthermore, processing cassava into dried chips at the farm level was an opportunity for employment for poor people in growing problem in the region. Hence, both income and profits of the producers were higher for dried chips cassava than fresh cassava, and dried chips attractted a higher price than fresh cassava which is related to the findings of Hoa *et al*. (2019).

Moreover, the large yield variation, the high cost of production, and the volatility in supply and demand in the cassava have been the biggest problems in Cambodia. It is important to promote an income generation for the farmers

through the adoption of field-specific technologies, good management of practices, and a 4R nutrient concept. Other scholars had emphasized the importance of the farmer's participation in the profitable stages of the cassava value chain by strengthening coordination, growing new cassava varieties, and applying novel processing technologies (Sewando, 2012). In addition, the research finding had not clearly analyzed causal factors that affectted yield variation and the value-added of all stakeholders for local traders and Thai traders. Thus, it was highly recommended to do further research to find out the causal factors which impact to yield variation and improve the volume of cassava produced in Cambodia. The value-added of all stakeholders' reform may be needed to give a boost to the cassava value chain for everyone involved in its production.

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