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Cassava root supply chain in Nakhornratchasima Province: Challenges and opportunities for local starch mills

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Abstract

The demand of cassava roots is rapidly growing due to its use in both starch extraction and ethanol production. Not only the demand is high but also the competition for crop's planting areas is also severe. Local starch mills have changed the way they procure cassava. They used to purchase cassava by volume, but now they focus more on the per cent content of extractable starch the cassava contains. Usually, it takes about 4.4 kg of cassava to produce one kg of starch, as long as the cassava contains at least 25% starch. Starch content is at its highest value when cassava is freshly harvested, so procuring the root directly from farmers offers higher starch content than buying from brokers. At the moment, the quality of cassava procured from both farmers and brokers is poor, which makes cassava production inefficient and raises starch production cost. The starch mills realize the importance of procuring quality cassava from its suppliers, since this is a proven strategy towards reducing cost of starch production. Improper planning in cassava procurement causes significant loss in the starch content - at the farmer field while waiting to harvest in anticipatory higher selling price, and at the mill warehouses where it is excessively stocked in the fear of inconsistent supply during off season. This results in loss of potential starch content, dissatisfying return to farmers, and inconsistent supply of raw materials to meet yearlong demand of mills. Proper planning in procurement process would therefore improve production efficiency and decrease production costs; simultaneously will also maintain consistent supply of raw material to the starch mills. To identify the factors influencing production and trading decision of farmers, this study considered the case of a leading starch mill (Corn Product Thailand, Nakornratchasima, Thailand) and its associated farmers and middleman in its procurement process.

Key words: Cassava roots, starch mill, supply chain, starch content, CPT, Nakornratchasima, Thailand.

Introduction

Thai starch industry: Cassava chips are produced from fresh cassava roots by cutting it into small chips and let it dry by sun drying. Cassava chips are used as raw materials of cassava pellets, animal feed and ethanol production. Native starch is produced from cassava roots and directly consumed or used as raw materials of other products. Ethanol is produced from fresh cassava roots or cassava chips for gasohol production.

Trend in cassava production in Thailand: Cassava is one of the main Thai agricultural exports; in recent years, cassava export value has been notably high when compared to other agricultural products export. Cassava planting area is about 1-1.24 million ha, which face severe competition with the other crops such as corn and sugarcane. Thailand has well-established cassava development programs such as variety development, good agricultural practices and soil improvement, which increased cassava yield significantly during 1999-2011. Farm gate prices for cassava roots also showed increasing trend (from 21-30 USD per ton to 57.3 USD per ton in 2011) as its demand for starch production, animal feed and ethanol production have increased (Table 1) ¹.

The demand of cassava in Thailand is still high, which needs more of cassava starch for food, construction of related industry, animal feed and ethanol production. As the demands in many industries are also increasing, cassava root production has to be improved to match high demand. The annual demand of cassava roots is about 34 million ton but the cassava roots yearly production is only 30 million ton (Table 2) ¹.

Cassava is exported from Thailand to more than 120 countries in many kinds of products, which totalled to 6,360 million tons in 2011 (Table 3). Based on the export quantity, chips and starch export proportions are higher than that of other products with about 5,575 million tons ¹.

Materials and Methods

Study area and company profile: Corn Products International, Inc. is one of the world's largest corn refining companies and is a leading supplier of starches and sweeteners. It is also the world's largest producer of dextrose and a leading regional manufacturer of starches, syrups and glucose. The company provides a wide variety of ingredients to customers in more than 60 industries, including the food, beverage, pharmaceuticals, animal feed,

Table 1. Cassava production in Thailand from 1999-2011.

Year	Planting area (Million ha)	Harvesting area (Million ha)	Total production (Million tons)	Average yield (tons/ ha)	Farm gate price (USD/ton)
1999	1.15	1.06	16.507	15.49	30.3
2000	1.18	1.13	19.064	16.85	21
2001	1.10	1.04	18.396	17.53	23
2002	0.99	0.98	16.868	17.06	35
2003	1.02	1.01	19.718	19.29	31
2004	1.08	1.05	21.440	20.27	26.6
2005	1.04	0.98	16.938	17.18	44.3
2006	1.10	1.07	22.584	21.09	43
2007	1.21	1.17	26.916	22.92	39.3
2008	1.24	1.18	25.566	21.6	57.6
2009	1.21	1.05	22.005	20.25	55.7
2010	1.15	0.99	22.070	21.15	56.8
2011	1.21	1.17	26.818	22.93	57.3

Source: Department of Foreign Trade, Ministry of Commerce (2011)

Table 2. Industrial demand of cassava in Thailand.

Industry	Quantity (Million ton/ year)
Food	20-22
Construction	0.26-0.3
Animal feed	1.87-2
Ethanol	0.9-1.2

Source: Department of Foreign Trade, Ministry of Commerce (2011)

Table 3. Export quantity of cassava products.

Product	Quantity (Million ton)	Proportion (%)
Starch	1,888	29.68
Modified starch	739	11.61
Pellets	36	0.56
Chips	3,687	57.97
Others	10	0.15
Total	6,360	100.00

Source: Department of Foreign Trade, Ministry of Commerce (2011)

corrugating, paper and textile sectors.

This study was conducted at Nakornratchasima province, where most of Thailand's cassava is grown. This region is facing unprecedented economic challenges, severe drought and high unemployment rates, and these problems influence the decisions that cassava farmers make. Corn Products (Thailand) Co., Ltd. (CPT) comprises a starch and sweetener facility and employs 400 staff in Bangkok and Nakornratchasima provinces. It also provides marketing and sales support to the Company's Asian market businesses. Corn Products International established its presence in Thailand in 1997. Since then, they are expanding their business in the country to produce value-added products for the food and industrial sectors from tapioca². The main reasons behind selecting CPT for the case study are sizeable production capacity of its starch mill, multinational setup, and its location within the main cassava planting area-which altogether makes CPT an interesting and worth-reporting case study. The average demand for cassava starch in Thailand in 2008 was 1.26-1.47 million tons a year³. Due to just-in-time delivery requirements, planting must occur year-round to keep up with demand. However, stress on the soil between April and October leads to lower yields.

CPT has changed the way it buys cassava. The company used to purchase cassava by volume, but now it is focusing more on the percentage of starch content in cassava. Purchasing by starch content measurement method is popularly adopted by other factories also in the country. It takes about 4.4 kg of cassava to produce one kg of starch, as long as the cassava contains at least

25% starch. If it were possible to increase the percentage of starch content, farmers would not need to increase their yields, since the same amount would still produce as much starch as a larger yield would produce. Sourcing roots with higher than average starch content would therefore improve production efficiency and decrease production costs.

Currently, CPT buys about 70% of its cassava roots from over 1,000 farmers, with the remaining 30% from brokers. Starch content is at its highest value when cassava is freshly harvested, so procuring the root directly from farmers offers CPT higher starch content than buying from brokers, which is an indirect purchasing process that requires middlemen between the farmer and the mill management. Currently, the quality of cassava procured from both farmers and brokers is poor, which makes cassava production inefficient and raises starch production costs. CPT stresses the importance of quality cassava from its suppliers, since this is a necessary strategy to reduce costs of cassava production. Operational constraints of the company are identified as follows:

- The current roots supply does not match the roots needed in each month.
- Extremely low roots supply in May until October during rainy season.
- Surrounding areas of CPT have high roots demand and competition as 5 starch mills are located and one ethanol plant is establishing. Farmers do not have the loyalty to CPT when they sell their roots.

This study strived to determine the current cultivation practices of cassava and its procurement by Corn Products (Thailand). Potential strategies were identified to improve supply and consistency of cassava to CPT in Nakornratchasima province. Being a multinational starch mill having large production capacity, and situated in the main cassava planting area of Thailand, the CPT was considered for the case study.

Methodology: Primary data were collected using farmers' survey based on a questionnaire, which included farmers' current practices and needs. The survey was conducted in Nakornratchasima province, which is having large number of cassava plantations.

Sample consisted of 15 local brokers who supply cassava to CPT, and 100 farmers who directly sell cassava to CPT. In total, questionnaires were distributed to 110 farmers. A total of 100 usable questionnaires were entertained. Response to the questionnaires was checked for completeness and consistency, and subsequently analysed. Five-point Likert scale was employed to measure each construct, ranging from 1 (Strong disagreement) to 5 (Strong agreement).

Results and Discussion

Cassava is a drought-tolerant crop, which needs optimal production management, but tends not to attract pests or diseases. Cassava can grow well even in poor soil conditions but factors including optimum land preparation, appropriate seed selection, stem preparation, and good farming management can improve cassava productions in terms of both quality and quantity. The most favourable environmental factors for cassava production include a sandy or sandy loam soil with pH of 5.5-7.5, at 25-37°C temperature and 1000-1500 mm annual rainfall. The fertilizer ratio and rate are 15-15-15 at 600 kg/ha. Weed management is required both at the pre-planting and post planting stages⁴.

It was revealed that the average farmer's landholding for each family, who sell cassava roots directly to CPT, was limited to between 3-4.5 ha. The Office of Agricultural Economics has reported similar facts and further concluded that as the land holding per family is still so small, yield improvement is a critical point for increasing income⁵.

Current practices in cassava plantation: Most of the farmers (about 46%) planted between 1.6 - 4.8 ha, while only 18% of farmers had a planting area in the range of 8.15-11 ha. About 36% of farmers reported planting of 5.0 - 8.0 ha. The average cassava yield in 2007 was 24-25 tons/ha, which increased from 12.0 - 13.0 tons/ha in 1995, because of the introduction of modern technology for cassava planting and new high yielding varieties⁶. The highest cassava yield reported was 25 t/ha, while the lowest yield was 12.5 t/ha. Moreover, about 20%, 28%, 22% and 30% of farmers reported cassava yields in the ranges of 12-15, 16-18, 19-21 and 22-25 t/ha, respectively (Fig. 1). In addition, it was revealed that farmers in the survey areas depend on their own knowledge of cassava production practices such as land preparation, stalk preparation, familiarity with cassava varieties and weed management experience. Their non-scientific practices have been reducing the cassava yields in this area, and have ultimately lowered the national yield average.

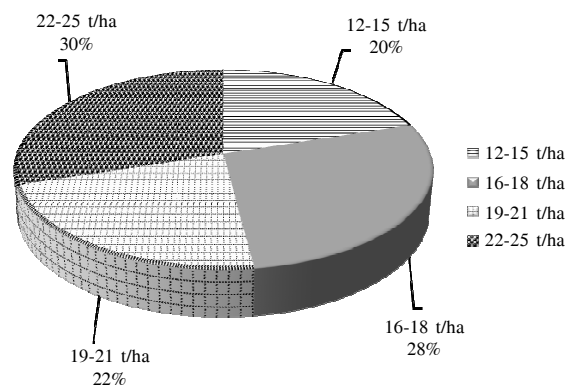


Figure 1. Variation in cassava yields (t/ha).

Most of the farmers (76%) harvested cassava at 8-12 months. About 20% was harvested after 12 months and 4% harvested at 6-8 months. Cassava harvested at different times affects the yield and starch content. Cassava roots harvested later than 1 year after planting provided a higher yield, whereas cassava harvested at 11-12 months after planting produced greater starch content⁷. In general, farmers harvest cassava when prices seem attractive even if they face a labour shortage. It was revealed that about 63.4% of farmers mentioned the market price as a factor, 25.4% of farmers said it was the amount of rain at the time of harvesting, whereas only 11.3% of farmers said the maturity after planting determined when they harvested. Moreover, about 94% of the farmers said they would change their crop based on the market price, whereas only 6% farmers mentioned yield as a crop switching factor. Since cassava can be sold for as much as 2.5 Baht/kg, corn and sugarcane farmers have shifted to cassava⁶.

Farmers' cropping decisions mainly depend on crop price. That means higher crop prices attract more farmers in subsequent seasons. Since cassava returns are currently attractive, more farmers are willing to continue cultivating cassava⁵. About 96%

of farmers confirmed that they would continue growing cassava, whereas only 4% said they might switch to another crop.

Kasetsart-50, Rayong-5, Rayong-90 Huaibong-60 and Rayong-2 were observed as the major cassava varieties being used in the region (Fig. 2). Majority (62%) of the farmers preferred the Kasetsart-50 variety. The Department of Agriculture and the Ministry of Agriculture and Cooperatives (2008) have reported yields of Kasetsart-50 at 27.5 tons/ha; Rayong-2 at 26; Rayong-5 at 27, Rayong-90 at 23.8 and the Huaibong-60 at 37 tons/ha⁵.

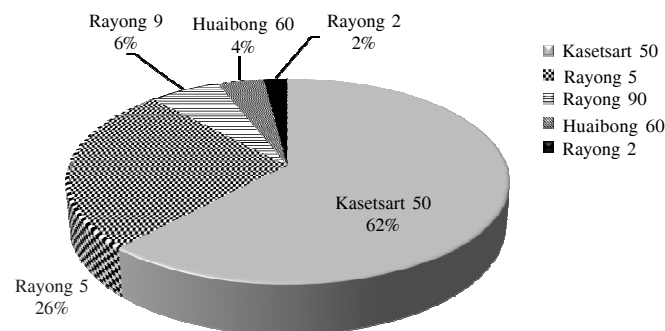


Figure 2. Percentage of farmers using different cassava varieties.

Survey results indicate that 74% of the farmers continued to plant the same varieties for more than 3 years, while 26% of the farmers reported that they had switched to a different variety within 3 years. Farmers tend to switch to a high yield variety if they want to increase their yield. Until high-yield varieties were introduced, farmers selected cassava varieties which responded well to their soil conditions⁷. Farmers also wanted to save money by collecting stems to replant, so they were resistant to switching to a new variety of cassava^{6,8}. In this survey, about 78% of the farmers did not want to try new varieties, while 22% of the farmers showed an inclination towards switching from their current variety. About 68% of the farmers used stems collected from the last season, whereas 22% reported their source from a government organization, whereas 10% responded to whatever varieties the starch mill and brokers would buy.

Fertilizers can improve cassava yields, if used at a recommended ratio and rate. The Department of Agriculture recommended formulations of 15-15-15 and 13-13-21, at a rate of 310-600 kg/ha. Most of the farmers (82%) were found to use the 15-15-15 (N-P-K) fertilizer formulation, whereas the 13-13-21 formulation was used by some farmers (18%). In addition, about 72% of the farmers applied rates of 125-185 kg/ha; 16% applied at 255-310 kg/ha rate and 12% of farmers chose the 190-250 kg/ha option⁴.

Expenditure on fertilizer depends on the fertilizer grade, brand, sources and distributors. A high grade, a good brand name, guaranteed sources and acceptable distributors are the major factors that raise the price⁵. Farmers mentioned prices in the range of 701-800 Baht/bag (68%) and 601-700 Baht/bag (32%), respectively. Farmers accept that fertilizers can improve cassava yields; however, they are mostly motivated by costs since the price of fertilizer cuts into their profit by increasing investment costs. Farmers from the study area responded that they would choose fertilizer if it increased starch content or their yield, which would fetch them greater profit (Fig. 3).

Challenges in cassava production: Farmers mentioned a number of cassava production problems (Fig. 4). Most of the farmers

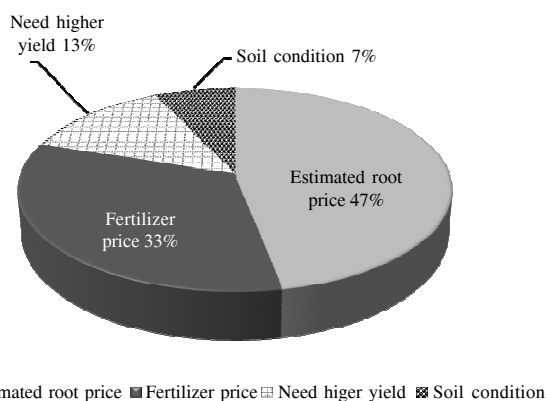


Figure 3. Decision making factors for fertilizer application.

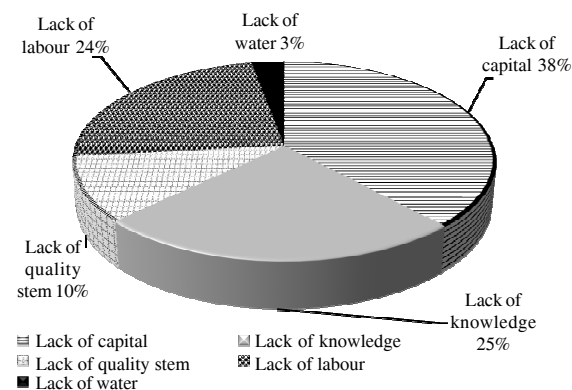


Figure 4. Problems in cassava production.

reported they lacked capital, water and both soil and yield improvement knowledge, whereas some farmers also mentioned the lack of stems for planting as a concern. Since farmers lack a capital investment and mainly rely on loans, they expect financial support, especially from the government.

As increased yield increases income and in turn, improves standard of living, farmers want to increase their yield⁵. In this study, 78% of farmers stated that yield improvement was the highest priority, followed by starch content improvement. Consequently, farmers require assistance on best practices regarding high yield cassava varieties as well as information to improve soil fertility, farm inputs, yields and starch content⁷. The highest sought assistance for best practices was to increase the yield and starch content followed by soil testing, field visits and transportation costs (Fig. 5).

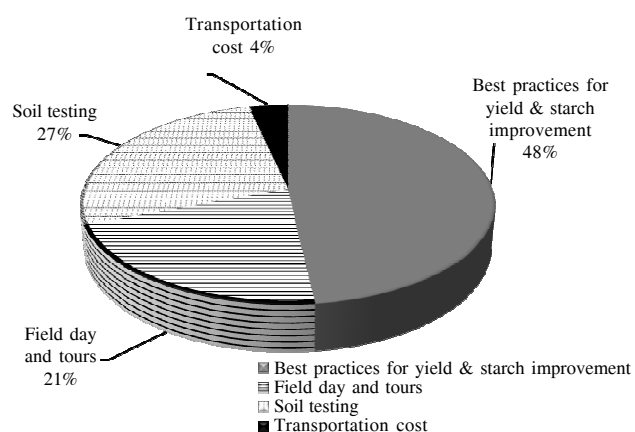


Figure 5. Assistance sought by farmers.

Current selling practices and incentive programs: Current selling practices and incentive programs significantly influenced farmers' selling decisions. About 42% of farmers sold cassava to chip brokers, 36% to starch factories and 22% to middlemen. However, about 28% of farmers expressed their willingness to sell to chip brokers in future, 34% were interested in starch factories and 38% were interested in dealing with middlemen. This suggests an increase in the percentage of farmers interested in selling cassava to middlemen, and reflects closer relationships developing with these buyers. This development suggests that starch factories need to build closer relations with farmers to retain their direct customers.

The top two major factors that influenced farmer decisions were price and whether or not buyers would reject their cassava. These priorities were followed by a concern over the waiting time for dumping, and only a very few farmers cited a convenient waiting area or incentive programs as key factors (Fig. 6).

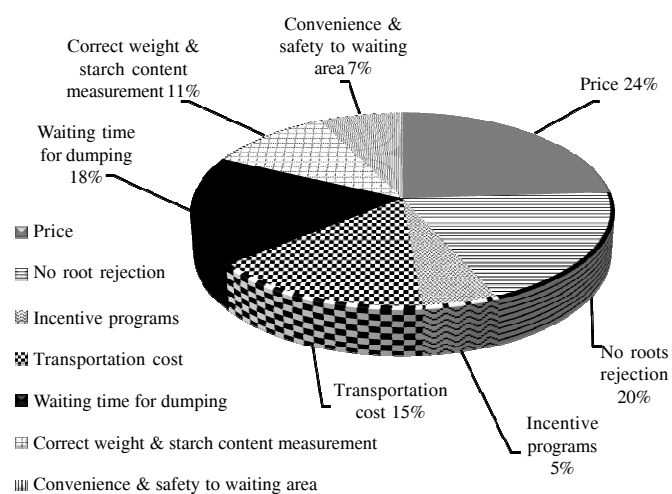


Figure 6. Factors affecting selling decisions of farmers.

Price plays an important role in making selling decisions. A higher price leads to a higher income for farmers. Moreover, when buyers reject their cassava, farmers have to find another factory to approach. Waiting in line for dumping increases the risk of rotten roots, decreases the starch content and ultimately reduces the cassava price the farmer receives. Moreover, transportation costs were reported to be in the range of 100-150 Baht/ton. About 54% of the farmers stated that they spent at least 100 Baht/ton on transportation, while 24% spent as much as 150 Baht/ton (Fig. 7).

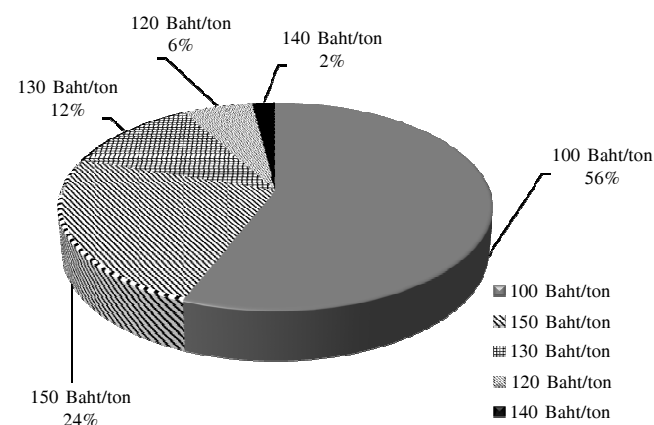


Figure 7. Farmers' spending on respective transportation costs.

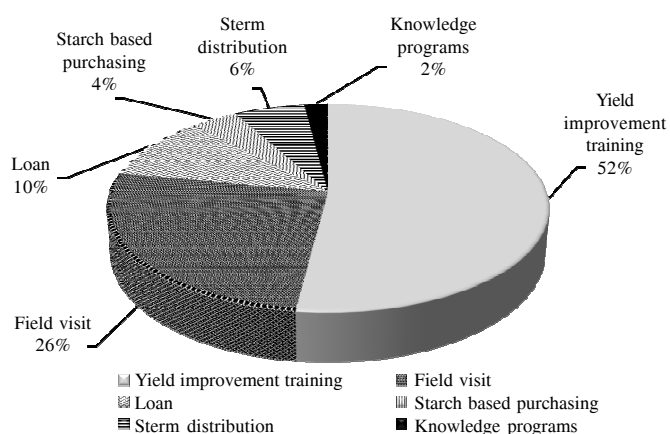


Figure 8. Preference of farmers on incentive programs.

Most farmers were interested in yield improvement programs followed by field visit programs and then help with loan strategies, starch based purchasing tips, and finally information regarding stem distribution and cassava knowledge (Fig. 8).

At present, farmers share knowledge about cassava production practices with their neighbours, so similar kind of practices were observed in the study area. Optional training programs were also preferred for developing good agricultural practices in terms of cassava planting preparation, cassava management and postharvesting techniques. Farmers still need to improve their yields from 2-4 tons/ha to the optimal yields of about 4-6 tons/ha for the highest yielding areas that provide the best incomes. Moreover, it was observed that farmers, who have more experience in cassava planting practices, are getting higher yields than those who have only been planting cassava for a few years. Due to a lack of capital, farmers cannot take proper care of the cassava and this result in lower yields. Most of the farmers depended either on their experience or consulting with their relatives or neighbours to discover better cassava production practices. Good practices included a good understanding of planting preparations that could improve soil and stalk conditions and information regarding different cassava varieties. They also involved management tips about how to cope with weed and pest control and fertilizer applications. However, the adoption of these good practices was found to be limited by a lack of capital investment, technology transfer and lack of modern cassava production knowledge.

Furthermore, farmers were stressed with many problems. Most of the farmers worried about not being able to sell their complete harvest and long queues. Incorrect starch measurement, late

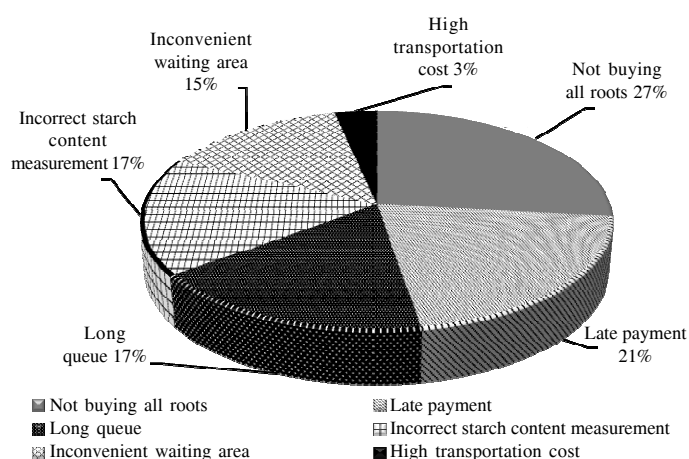


Figure 9. Problems faced by the farmers in selling their produce.

payments and higher transportation costs were also a major concern (Fig. 9).

Generally, buyers make decisions based on the quality of the cassava. Sometimes roots are mixed with soil, premature and rotten. In that case, buyers reject either the complete or partial cassava harvest offered by the seller. When part of their harvest is rejected, the farmer must spend time and money searching for other factories, which reduce their profit margin. Late payments are also a problem since farmers need cash to pay for farming expenditures. It was found that payments were normally done on the same day the cassava was delivered, but sometimes buyers, who pay farmers on time, experience some cash flow problems especially during the peak harvest season. However, this problem can be solved with appropriate advance planning. The late payments, i.e. payments received 7-8 days after delivery, disrupt a farmer's financial planning schedule. Another problem is a long queue that corresponds to more waiting time; and longer the waiting time more the quality of the cassava deteriorates, attracting destructive bacteria. This in turn, reduces the starch content and that means the farmer's income is threatened. Then there is the problem of incorrect (non-calibrated) starch measurement techniques that can indicate a lower starch content, which means that again, the farmer loses fair returns.

The percentage of farmers that either liked or disliked various incentives and their reasons for those opinions are summarized in Table 4. It was revealed that majority of farmers dislike that their cassava is rejected. Moreover, they would like to have either full or partial cash payments and assistance to improve production

Table 4. Percentage of farmers liking or disliking incentives.

Incentives	Liking %	Reasons for Liking	Disliking %	Reasons for Disliking
No roots rejection	96	Farmers get sense of relief and satisfaction	04	Sometimes buyers deduct it from original price
Cash payment	92	Cash payment can help with daily expenditure	08	They have some money to spend and do not have the problem with bank transfer
Extra rewards for volume selling	70	Farmers get more income from volume based selling	30	They want to sell to other buyers
Extra payment for higher starch content	76	Farmers get more income as a sense of high starch content	24	Farmers are not sure that they can improve starch content
Assistance in production improvement	80	Farmers get more income when cassava production increases	20	Farmers do not want to change their current practices and they believe it will cost more money
Price guarantee before planting season start	00	Farmers feared that guaranteed price would be lower than market price	100	Farmers believe market price will be higher than a guarantee priced because of high demand

Source: Authors' field survey (2012).

practices. Partial cash payment can help in a farmer's daily expenditure, whereas assistance in production improvement can improve income.

Broker's purchasing concerns: It was observed that brokers maintained their own farmer groups, who could provide cassava directly to them. Some brokers provided financial support to farmers as well. About 66.7% of the brokers maintained their permanent suppliers, who were either farmers or root collectors. Moreover, about 86.7% of brokers mentioned farmers as their source for direct purchasing, whereas 13.3% of brokers were buying from root collectors. In addition, about 73.3% of brokers reported 50-100% of their purchase was within their area, whereas other brokers bought cassava depending on availability.

Generally, brokers rely on the starch mill price to set their purchasing price since they sell cassava to starch mills. The majority of brokers (73.3%) set their price according to the starch mill price, whereas others (26.7%) relied on the guaranteed price set by the government. Furthermore, it was observed that all the brokers provided transportation services to both farmers and starch mills. Consequently, they maintained their own trucks and arranged transportation by themselves. No broker reported any transportation problem, but since brokers are independent and can choose the starch mills that offer the best prices, they wouldn't be worried about transportation costs.

Broker's selling concerns: About 80% of the brokers sold cassava to starch mills, while 20% of them sold to chip brokers. This is because starch mills have maintained their confidence in terms of precise starch content measurement and on time payments. About 46.4% of the brokers sold cassava to starch mills because of cash payment, whereas 39.3% chose starch mills because of high demand and 14.3% stated it was due to a good price. Since starch mills produce starch every day and have a continuous demand for cassava, brokers envisage a very low possibility that their cassava will be rejected from starch mills. Consequently, only 46.7% of brokers stayed with the same customer, and the remaining 53.3% chose the starch mills or chip brokers that offered the highest price.

Various factors were identified as playing a significant role in brokers' selling decisions (Fig. 10). The buying price was the major factor in selecting a customer, followed by the possibility of rejection, and then the waiting time for dumping and starch content

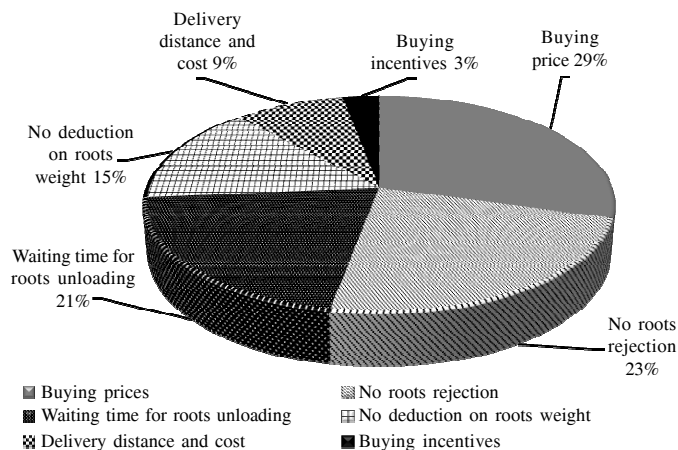


Figure 10. Percentage of brokers reporting respective factors for selling to starch mills or chip brokers.

measurement techniques. As mentioned earlier, this is obvious because these are all factors that either directly or indirectly affect a broker's income.

Moreover, starch mills and chip brokers received special incentives to avoid cassava rejection, possible weight deductions, and to encourage a high starch content, cash payment, volume selling and a consistent supply. A higher number of brokers reported incentives especially to avoid crop rejection, and others received incentives to prevent weight deductions and encourage high starch contents and cash payments. Only a few reported incentives for sales by volume or to ensure a consistent supply (Fig. 11).

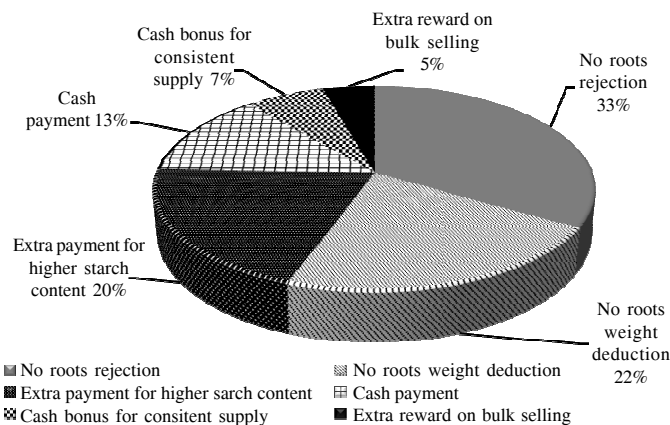


Figure 11. Percentage of brokers receiving different incentives from starch mills or chip brokers.

Brokers also extended some benefits to farmers (Fig. 12). Most brokers mentioned their incentives in terms of harvesting services and transportation services. Normally, brokers maintain their own harvesting team. Farmers inform when their fields require harvesting and then the brokers send their teams, consisting of labourers and trucks to harvest the fields. Some brokers reported offering incentives to avoid rejection and weight deductions. Other brokers, who didn't provide transportation services, offered reduction in transportation fees.

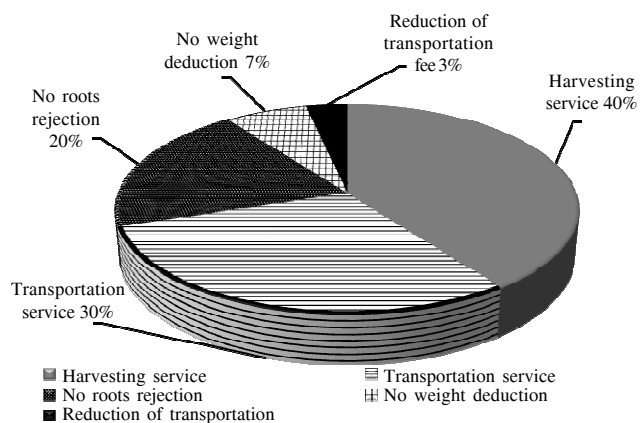


Figure 12. Percentage of brokers providing different incentives to farmers.

Both farmers and brokers faced many challenges in selling cassava. The majority of brokers mentioned their worst problems were not being able to sell everything they bought, as well as faulty starch measurement techniques that affected the price they received. Other troubles were long queues/traffic jams, inconvenient waiting areas, late payments and higher transportation costs (Fig. 13).

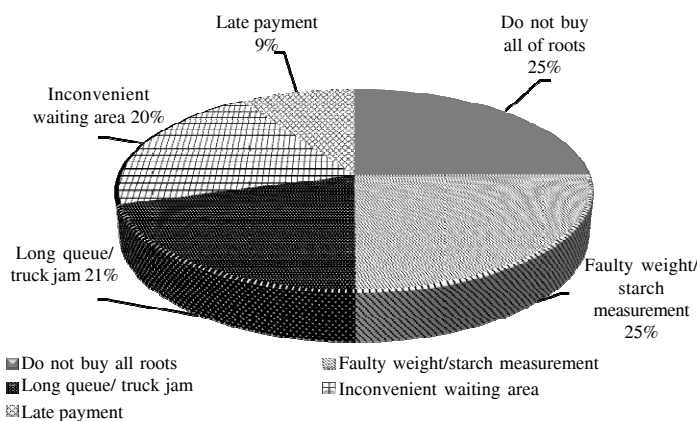


Figure 13. Percentage of brokers facing respective problems.

Conclusions

The survey revealed that extensive experience with cassava planting management facilitated higher productivity. Moreover, farmers, who sell their roots to starch mill, reported a lack of capital, skills and experience as problems in adopting proper cassava management practices. However, cassava farmers have shown an interest to learn and accept modern cassava management practices. Consequently, starch mills may consider setting up technology transfer programs to improve cassava yields and starch content. Furthermore, the starch mill could create farmer training programs and offer farmers' visits to high yield cassava farms or plantations, since this would allow farmers to observe, compare and analyse field conditions. Consequently, farmers could be better planners by adopting profit maximizing farm management practices.

The issues related to the farmers' selling decisions can be addressed by introducing appropriate strategies at starch factories. Starch factories can attract more farmers by providing comparatively higher purchasing prices. A pricing strategy for purchasing cassava depends on two systems; starch content based buying and cassava with a range of high-low starch content. Generally, factories in the vicinity of high starch content cassava production areas buy cassava based on starch content. During the low supply season, not enough cassava can be harvested. In that case, starch mills tend to accept cassava with lower starch content simply because demand is still high. This mixed harvest includes high-yield cassava, which is preferred by brokers and farmers because they can produce more, even though the starch content may be less. However, the price gap between the two procurement methods (starch-based and mixed-roots based compensation) should be tactfully handled and implemented by starch mills, otherwise farmers will tend to focus only on the high-yield varieties without considering quality.

Generally farmers transport their cassava roots to starch mills as soon as possible to avoid losing any starch content, but small farmers have to wait 2-3 days after harvesting because they can't afford to pay for daily transportation. It would not be economic since their land holding per family is only 0.1-3.2 ha (Authors' field survey, 2012). As small holder farmers lack the labour required to harvest efficiently, they must rely on family members to help out with harvesting, and collecting the cassava to be transported to the starch mills.

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