Valuing the canarium trees in Malaita Province of the Solomon Islands

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ABSTRACT

The canarium tree has been a source of food, income and it has cultural significance for the Malaitan communities. The introduction of cocoa as a cash crop and copra processing has resulted in a reduction in canarium nut processing. This study attempts to value the provisioning services lost from the canarium nut as a result of the introduction of the cash crop using the market price and production function approach methods. The cultural ecosystem services value of the canarium tree was difficult to quantify and has been defined qualitatively. The results from this study showed that there has been a shift in the males' priorities from traditional crop processing to cash crops. This shift is due to the fact that canarium nut processing is labor intensive compared to cocoa and copra processing. Due to this shift, the cultural values associated with the canarium nut are being lost and with it the social cohesion and food security associated with the nut. The opportunity still remains for the canarium nut to be processed through the local women by optimizing the available labor. A reduction in labour used for copra processing can instead be used for processing of the canarium nuts and cocoa which would yield higher returns. If the government were to subsidize some of the labor costs associated with canarium production, it might encourage the males of the community to divide their labor between the three enterprises which would improve income diversification and ensure food security for the communities.

Key words: Canarium nut, Ecosystem services, Food security.

INTRODUCTION

Canarium nut has the potential to be commercialized (Carlos and Dawes, 2000), but it is constrained by an inconsistent supply (Pelomo et al., 2003; Sulifoa, 2012). Meanwhile, the Malaitan communities are accruing more revenue through cash crops such as cocoa and copra (Pacific Islands Trade and Invest, 2012, McGregor et al., 2013).

"Every day she cracked some of the nuts with a rock, stopping every now and then to chase the flies off her sores. Every day she ate the sweet, white, oily kernels. The others watched her, wondering what would happen. She'd volunteered because she had nothing to lose. No one had wanted an ugly girl like her for a wife so she had no children and now she was old. There were many trees bearing this type of nut around her village and in the tribal forests in Malaita, but no one ate them because everyone thought they were poisonous. To everyone's amazement the old woman didn't die. In fact after months of eating this nut locally known as *"ngali"* she looked healthier. Her sores were gone and her skin was becoming smoother. The people realized that the nut was edible and so began the nutritional, cultural and economic journey of the canarium nut in Malaita Province."

- Retold by Lilia, Malaita Province to Ramona Sulifoa -

The story depicts how the canarium nut became important to the local communities in Malaita Province, Solomon Islands. The canarium season was important as the local communities would camp and work together for a month to harvest and process the nuts which would be stored for feasts (Pelomo et al*.,* 1993). Each

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gender group was allocated a role so that harvesting and processing the nut was done efficiently. The communities would chant during processing to keep the momentum going (Pelomo et al., 1993). Processing of the nut was part of their survival techniques in addressing food security in the traditional system. The nut was an important food source, and it was used in the bartering system for traditional shell money, which is a significant part of the bride price in the Malaitan culture. With the introduction of the cash economy into the Solomon Islands around 1923 (Tedder, 1966) the communities began selling the canarium nuts in the local village or main markets as a source of revenue.

Communities are replacing the potential economic value of the canarium nut with the more lucrative cash crops, and they are losing an important source of food, and community togetherness associated with the canarium tree. In essence, they are losing the cultural value associated with the tree.

This study investigates the influence of the cash crops on the Malaitan societies and how this has contributed to the loss of the cultural ecosystems and provisioning services provided by the canarium nut. Using the market price and production function approaches for valuing the canarium tree ecosystem services, the results from this study will shed light on policies to aid the communities, especially convincing males to partition their time in the harvesting and processing of the canarium. This will help the local communities in terms of food security, and it will also assist the communities in rethinking their relationship with the canarium to enable the survival of knowledge associated with the tree to be passed onto future generations. It is also important as future valuing work can be done on the canarium tree.

METHODOLOGY

Location of the study and research design

The study was carried out on Big Malaita of the Solomon Islands. The people from this area are mainly Melanesians and rely on semi subsistence agriculture for their livelihood. This Province was selected because it had large areas monocropped with canarium nut, and these communities were active in supplying the majority of the nuts sold during the commercialization trials carried out in the Solomon Islands. Additionally, the nut is important in the diets of the local people as well as in the bartering and commercial systems.

Method of data collection

This study used the stratified sampling method. From the 20 wards in Malaita accessible by road, eight wards (Baegu/Fataleka, Foondo/Gwaiau, Keaimela/Radefasu, Malu'u, Mandalua/Folot, Sububenu/Buruaniasi, Waneagu/Silaviasina, Fauabu were randomly selected. A total of 100 households were interviewed from these wards using a structured questionnaire. The study also involved direct observations on the collection, consumption and marketing of the canarium nuts.

Secondary data on cocoa and copra production was collected from Dan Vadnjal and Moses Pelomo's (2014) cocoa chain analysis and David Young and Moses Pelomo's (2014) copra chain analysis.

Data analysis

Several approaches were used to analyze the data collected to enable economic and quantitative comparisons to be made with the cash crops as well as the canarium trees. The geographical information as well as statistical differences in the information collected were analyzed using the Genstat Statistical Software. The market prices as well as the production function approach were used to determine and make comparisons in the profits earned between the three enterprises and to identify an optimum division of labor between the three enterprises.

Market price approach

The market price approach is one method which can be used to value ecosystem services. It is mainly used for those services in which a market price can be obtained as the goods are sold in the market (TEEB, 2010). The main challenges with this method is that imperfect market structures may distort the market price influencing the final value for the ecosystem service in question.

Profits and costs associated with the production of each enterprise (cash crops and canarium nuts) was determined using the market price approach method. The survey carried out identified the market prices that people were willing to pay for the canarium nut. The main costs of production include labor and capital associated with the enterprises, because land is owned by tribes and clans, the communities do not have to pay for its use (Bunt, 1996). Profit takes into account the labor and capital costs associated with the enterprises.

Since the research only collected data related to canarium nut marketing, the information related to cocoa and copra processing and sales was determined through literature review. The findings from the analysis carried out by Dan Vadnjal and Moses Pelomo (2014) for a cocoa chain analysis and the analysis by David Young and Moses Pelomo (2014) on the coconut chain analysis in the Solomon Islands were used to provide estimates for marketing costs for both copra and cocoa production in Malaita.

This analysis uses the authors' shadow price of S$30.00 per labor person for labor costs associated with the production of the cash crops as well as labor costs associated with the canarium nut. This is to ensure that there is consistency in terms of determining the end costs for all products to allow for comparisons to be made. Directly determining the casual labor costs associated with labor services in the villages is difficult as labor can be exchanged for goods, a situation similar throughout the Solomon Islands.

The calculations used by Dan Vadnjal and Moses Pelomo (2014) and David Young and Moses Pelomo (2014) indicate that labor costs for cocoa production were calculated based on 150 person days, whereas for copra production, the labor costs have been calculated based on 37 person days. Similarly for processing the canarium nuts, the labor costs have been calculated based on discussions with communities In contrast to past practice, almost exclusively women now harvest the canarium nuts; these estimations allowed for comparisons to be made between the three enterprises.

Production function based approach

The production function approach is one valuation method which can be used to measure ecosystem services (TEEB, 2010). It is mainly used for valuing provisioning and regulating ecosystem services (UNEP, 2010) and in some cases, it has been used for valuing cultural services such as recreation values (TEEB, 2010). Production function looks at the input – output relationships between the ecosystem being valued and the output which in most cases is the marketed product (UNEP, 2010; TEEB 2010). The method is heavily dependent on market data being available in order to make the estimations. Furthermore, it is important that the correct function is derived for the purposes of the study.

Generally, the input – output relationship can be mathematically written as:

$$Y = \boldsymbol{f}(X_1, X_2 \ldots . X_n)$$

Where Y is the output being determined and X_1, $X_2 \ldots . X_n$ are the inputs.

For the purposes of this study, the production function was only used to look at the relationship between the factors of production such as Land, Labour and Capital associated with the profits for the three crops compared. Since market data were available for the factors of production for canarium, cocoa and copra, the study used the production function to identify the best option for maximizing profits taking into account that labour is a scarce resource. It is important to note that capital is minimum at the village level as cocoa and coconut seeds are saved. In some cases, the seeds are given to the communities for free by the government through their outreach programmes. No fertilizers are used in the production of any of the crops compared.

For the purposes of this study, (Y) will be our profits and the inputs (X) into the function will be land, labour and capital. Furthermore, since labour will be one of the units in the function which is one of the scarce resources, it is important to note that labour will be a function of the processing methods, as well as the distances travelled to harvesting site and marketing of the three individual crops. This can be expressed as:

Labour = $\boldsymbol{f}$ (Harvesting, Processing stages, Distance travelled). Solver in excel was used to identify the maximum profit output taking into account labour as being a scarce resource. The cultural ecosystem services provided by the canarium nut cannot be directly valued in this study using the production function. However, the hope is that through the use of this method, an idea of how to share the scarce labour available between the three crops studied for profit maximization can be recommended and that in the end, the cultural values associated with the canarium nut are conserved.

The cultural ecosystem services provided by the canarium nut cannot be given a monetary value, and has been defined qualitatively. It is anticipated that the study, will shed an idea of how to share the scarce labour available between the three crops for profit maximization which will in turn bring to light the cultural values associated with the canarium nut.

ciated with the canarium nut.

RESULTS

Geographical representation of respondents

The geographical representation of the communities surveyed can be found in Tables 1, 2, 3 and 4.

Canarium nut and the provisioning ecosystem services

Provisioning services are those products derived from our ecosystem such as food, genetic resources and energy (MA, 2005; TEEB, 2005). The canarium nut is a source of food for the local communities. Yen, (1996) notes that the oil is high in minerals as well as some vitamins and it is a good source of protein (Evans, 1999b). The canarium is not only mixed with starch crops such as taro, but it is also mixed with slippery cabbage (*Abelmoschus manihot*) (Chaplin, 1988).

Canarium nut and the cultural ecosystem services

The cultural values of the canarium to the communities, can be identified through the values associated with knowledge systems, educational, as well as social relations and cultural heritage values. It is important to note that in least developed countries such as the Solomon Islands, the cultural services of the canarium are closely linked with the provisioning services which are needed to support the overall wellbeing of the communities (Goto, 1996).

In defining these values, it was important to look at how they processed and stored the nuts using the traditional way. These traditional processing methods required knowledge and skills in order to ensure that it is carried out successfully. Furthermore, the link between the canarium nut and its use in the bartering system was identified. The bartering of the nuts with shell money was important as shell money is part of the traditional economy of the communities.

Canarium nut harvesting

The canarium season varied between edible species, but generally the season for the main edible species *Canarium indicum* preferred by the Malaitans occurs around May to October with the peak harvesting time occurring around July or August (Sulifoa, 2012). Around this time, the communities would camp at the harvest sites for one month and work together to harvest and process the canarium nut. It is not clear when this communal practice and more research to identify this change could be looked into as currently no research addresses the changes in the practices.

Four methods were used by the communities for harvesting the canarium nut. The most popular method was by climbing the tree and using a hooked bamboo to twist off the canarium bunches (86 percent). The second method was by picking up the ripened fruits which had fallen to the ground (46 percent). The least popular methods were by climbing the trees and cutting the branches with a bush knife (26 percent), snapping the branches off (five percent), throwing the nuts with rocks (one percent) and climbing by using a rope (one percent).

Significant differences existed between the number of nuts harvested using the two common methods (using the bamboo and picking the nuts off the ground). Harvesting the nuts using the bamboo with a median of 15,040 nuts with mesocarp (485.16 kg) was significantly ($P = 0.002$) better than using the hand picking method which gave a median amount of 5,302 nuts with mesocarp (171.03 kg).

Canarium nut processing

Five main methods were still used by the communities for processing the canarium nut.

Method one: This is the most commonly used one for processing the canarium nuts. The mesocarp, shell and testa are removed. The kernels are placed in bamboos and the top of the bamboo is closed with canarium leaves. The bamboo is placed over a hot fire to remove the oil and the juices from the canarium nuts. The bamboos are then placed over the fireplace to be further dried. This method had a mean shelf life of five months.

Method two: The mesocarp is left to decompose in baskets for several days before being cleaned and the nuts in shell (NIS) are washed and dried in the sun for about a week. The nuts are then cracked, the testa removed and the kernels roasted over hot stones. The kernels are then left to cool down before being packed in either plastic buckets or in plastic bags.

Method three: The canarium nut is cracked, the mesocarp, shell and testa are removed and the kernels are eaten immediately. Around 25 percent of the respondents used this method during the canarium season.

Method four: The nuts are left in baskets to decompose, once the NIS have been cleaned, they are placed in baskets over the fire place to

be stored.

There were significant differences detected between the different processing methods at ($P \leq 0.05$). The results showed that most people used the first method of processing (73 percent). It is important to take note of the fact that the above methods are used by different community members during the canarium season.

Pelomo et al., 1993 noted that there were songs associated with the processing of the canarium nut. This was mainly to keep the momentum of processing and packing the canarium as it was tedious work. When the communities were asked whether the practice of communities camping together to harvest the canarium still occurred, all respondents indicated that this was no longer done but that whoever was willing to go and harvest was welcome to do so.

Cultural importance of the canarium nut

When asked on the cultural importance of the canarium nut, the respondents noted feasts (95 percent) were the most important aspects of the nut to their culture. They also responded that it was important in the bartering system (52 percent).

The importance of the canarium to the local feasts is interesting to note in that the Malaitans make *"kata"* (canarium mixed with taro to make a pudding). If this pudding was not present in a celebration then the occasion was second-rate (Pelomo et al., 1996; M. Pelomo 2009, pers. comm., March). It identified the status of a person because the work associated with preparing the canarium nut for this feast cost time and red shell money in payment for the labour to prepare the feast.

Canarium nut in the bartering system

Respondents were asked about the items they used to barter with the canarium nut. The results indicated that 22 percent of the respondents would barter up to 20 one meter "*pinali"* (a pinali is a length of bamboo filled with canariam kernels in testa) for an eight foot length of red shell money. Around 33 percent of the respondents bartered the canarium for fish. The amount of *"pinali"* exchanged for fish varied from three to five depending on the size of the fish. In some households, they exchanged the *"pinali"* for sweet potato and taro.

Bride price in the Malaitan culture

Bride price is a custom that is explicit to the Malaitan people and it is paid by the family of the groom to the bride's family in an arranged or unarranged marriage (Buchanan-Aruwafu et al., 2003). In essence the bride price creates ties between families and it is seen as compensation to the bride's family for the loss of their daughter (Fugui, undated). Buchanan-Aruwafu et al., (2003) stated that the bride price can be as high as ten or more *"tafuli'ae"* (red shell money).

Shell money has increasing market value in the Solomon Islands. Research carried out by Peio, (2006) had the value of the shell money at S$650, and lately the price has increased to S$1,000 for an eight foot length (Scott, 2014). With the average market price of one *"pinali"* being S$11.89 at the time of this study, one red shell money was being exchanged for less than the actual market price value. An eight foot length red shell money which would be sold in the town markets for an average price of S$1,000 would only be worth S$237.80 if it were exchanged for 20 *"pinali"*. More research needs to be carried out in this area to better understand the difference in the exchange value of *"pinali"* for red shell money compared to its exchange value in the modern economy using the local Solomon Dollar.

The economic value of the canarium nut

The value obtained from the canarium revenue was compared with the value obtained by communities for their cocoa and copra production. This section describes the number of fruiting trees per hectare for the canarium in each household and the number that they are currently harvesting. It looks at the sale price of the canarium per kg and it provides three main scenarios to show the economic value of the canarium.

Number of fruiting trees and amount harvested

From the survey, the mean number of fruiting trees currently growing and available for harvesting was 110 trees per household per hectare. However only ten percent of the trees were harvested per hectare during the canarium season. From the ten percent of the trees harvested, the communities sold around 45 kg of canarium nuts with mesocarp.

Respondents who sold the canarium nuts and place of sale

The nuts were sold directly in villages/ roadsides (91 percent) and few of the respondents went to the Auki market (7 percent), to middlemen (1 percent) or to restaurants to sell

the canarium nuts (1 percent). Table 5 shows the different packaging methods as well as the average price which the canarium nuts were sold for per kg of kernels.

Comparing the current cost of production, revenue and profits derived from canarium to cocoa and copra

The calculations for the revenue, costs and profits made for each of the crop (canarium, cocoa and coconuts) are carried out on an annual basis per household and per hectare. The list of processing activities for each enterprise is seen in Table 6.

The average amount of canarium nuts harvested and sold per year per hectare per household was 45 kg (kernels in mesocarp). The nuts were sold for an average price of S$14.45 per kg. There is minimum capital costs associated at the rural level in the marketing of canarium. These costs mainly include the packaging methods used in the sales of the canarium. Most of the costs associated with canarium processing are labour. These costs include harvesting, cracking, baking and packaging of the canarium nut as well as the distance travelled to collect and to sell the canarium nuts. It is assumed that cost of labour is approximately 70 person days per annum to harvest 45 kg of canarium nuts (refer to Table 7).

Current profits for canarium, cocoa and copra

The average amount of wet cocoa bean harvested by a household is 2,244 kg/ha/year. This is the estimated amount on a per hectare level per household. One kg of wet cocoa beans sells for S$3.00 per kg (Vadnjal and Pelomo, 2014). There are no capital costs associated with cocoa production as communities in the villages usually sell the wet beans to the cocoa processors and do not need to dry or package them. The main costs involved would be labour which was estimated at 37 person days/ha per annum (Vadnjal and Pelomo, 2014).

On average, a household can produce up to 1,000 kg of copra on an annual basis. This amount is assumed to be harvested from a hectare based on calculations by (Young and Pelomo, 2014). Capital costs associated with copra production include the packaging materials used for copra. The main costs incurred were through labour which was estimated by Young and Pelomo (2014) at 150 person days per annum (refer to Table 8).

Comparing the potential profits which could be derived from canarium to the profits currently derived from cocoa and copra

From the research, it was estimated that the Malaitan communities has the potential to harvest 100% of the available canarium trees on one hectare. There is approximately 110 trees which are on one hectare of land and the communities can harvest up to 340,340 nuts or 1,158.35 kg canarium nuts with their mesocarp from all the available trees per hectare.

If an average family of seven members worked together to harvest the canarium nuts, the labour costs would be approximately S$12,900. Taking into consideration that only 39 percent of the nuts harvested were sold for cash, and that packaging costs would also increase, the estimated revenue potential of canarium is calculated at S$3,708/ha per household per annum. This is the income lost to the communities every canarium season (refer to Table 9).

Profit maximization with scarce labour

The best way to achieve a clear picture of sharing the scarce labour between the three crops, is to calculate for profit maximization. The results for profit maximization shows that the communities need to produce less copra as this gives them little return compared to canarium and cocoa. By producing 215.25 kg less of copra, more energy can be focused towards the production of the other two crops. This will give the best possible profits and will utilize the labour available (refer to Table 10).

DISCUSSION

The canarium nut has been a source of food for the communities in the past (Pelomo et al., 2003, Sulifoa, 2012) and the harvesting and processing skills involved were carried out by the communities as a team effort. There were songs and proper division of labour amongst the community members so that the work of harvesting and processing can be done efficiently (Sulifoa, 2012). All these efforts were needed so that the communities would be food secure.

The canarium nut was also used in the bartering system in the form of *"pinali"*, it was traded for red shell money. This shell money was used for bride price as well as for other traditional practices. The cultural knowledge and skills associated with the nut in the past showed that this was a part of their survival mechanism as the canarium nut provided food for these communities. With significant differences in the traditional processing methods used for the

canarium nut, it meant that communities were able to store the nuts for times when there was food shortage. Furthermore, their ability to barter it for fish or other staple crops ensured that they had a diverse diet. With communities no longer practicing the traditional harvesting of the canarium as a community effort, the economic potential of the canarium nut is also underutilized.

The introduction of cash crops into the communities around the 1920s, caused a shift in crop priorities for the males. The males have prioritized cash crops such as cocoa and coconut (in the form of copra) and have disregarded the processing of the canarium nuts (Sulifoa and Lameta, 2011). In turn, the females have taken on the responsibility of harvesting and processing the canarium nut. Due to the reason that there are cultural barriers which prohibits females to climb the trees and the fact that women are not as efficient at cracking and packing the canarium nuts, their productive capabilities have been reduced and the full potential of the canarium trees underutilized.

The research shows that one household can harvest an equivalent of approximately 340 thousand nuts (+/- 1 tonne) with their mesocarp per hectare per year. However, the communities are currently only harvesting 45 kg of canarium nuts with their mesocarp. There is a deficit not only in the amount of nuts harvested, but also in the amount of canarium nuts which could be consumed or sold by the communities.

Using the market price approach the monetary values for the canarium trees were estimated. The results show that with the decline in harvesting, the communities were making a loss with the sales of the canarium (Table 7 and Table 8). However, if they were to utilize the canarium nuts available to them, they would be gaining more profit compared to the other two crops (Table 9).

Research carried out by Sulifoa (2012) shows that the markets for canarium currently exist and the consumers on the capital of Honiara were willing to pay a premium price of S$50.00 per kg of dried canarium kernels, but communities were unwilling to meet the demand. Perhaps the real reason behind this lack of response is the amount of time and effort which needs to be invested in the processing of the canarium nut. In Table 6, the different steps taken to process the canarium nut in comparison to cocoa and copra is shown. In short, more work is involved and more people are needed to ensure that the canarium nuts are harvested and processed to its potential. Furthermore, the distance travelled to harvest the cash crops is closer compared to the distances required to harvest and process the canarium nuts (Sulifoa, 2012).

The study shows that to utilize the current labour available to the communities, a reduction in the amount of copra produced will enable them to utilize the potential amount of canarium nuts which can be processed and maintain the amount of cocoa currently processed (Table 10). Understanding how to utilize the scarce labour resource is important for diversification and decisions aimed at increasing crop diversity. Diversifying agriculture production helps to improve self-sufficiency, reduce the risks associated with natural disasters and price fluctuations (Increased food security and food self-sufficiency strategy, 2012).

This brings the study to realize that the potential of the canarium can only be fully explored if policies were put in place to attract the males to assist the women in processing the canarium nut. Creating an enabling environment can be done in the form of supporting business ventures for the local women. With the assistance from the Solomon Islands Government and donor agencies capital costs for a canarium business start-up could be explored. Attracting males could be a challenge and perhaps the introduction of subsidies for labor payment may be needed. The aim is to keep the cultural values associated with the canarium nut alive, which will support the food security and overall well-being of the communities.

CONCLUSION

The canarium tree has been part of the Malaitan culture and has contributed to their food security and traditional way of life. The cultural skills and knowledge associated with the canarium are becoming extinct as males in the community have focused their attention on cash crops such as cocoa and copra production.

This study gives an idea of the potential profits currently lost due to a reduction in the amount of canarium nuts harvested. It shows the potential profits which could be made from canarium nuts if they were harvested to their full potential. Labour seems to be the main scarce resource in this case, and that the best allocation of labour would be through a reduction in the amount of copra produced. This would aid in utilizing the potential number of canarium nuts

which could be harvested and processed.

Creating an enabling environment for the women to process the canarium through entrepreneurial incentives and labor subsidies may be key to meeting the demand and provide local employment. This will help conserve the skills and knowledge associated with canarium nut harvesting and processing which is important for food security and the general well-being of the communities.

This study gives some idea on the potential value of the canarium nuts which would help inform polices to encourage crop diversification. The cultural ecosystem services provided by the canarium needs to be further studied.

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Table 1: Sex of respondents

Sex of respondent	Percentage
Male	79.0
Female	21.0

Table 2: Age group of respondents

Age	Percentage
Less than 20 years old	2.0
20 years - 29 years old	9.0
30 years - 39 years	26.0
40 years - 49 years	24.0
Greater than 50 years old	39.0

Table 3: Education level of respondents

Education level	Percentage
Primary	43.0
Secondary	18.0
Vocational	2.0
University	5.0
Theology	3.0
No formal education	29.0

Table 4: Household size of respondents

Household size	Percentage
1-5 members	32.0
6-10 members	63.0
11-15 members	4.0
16-20 members	1.0

Table 5: Packaging method used for canarium and price per packaging method

Packaging method	Percentage	Mean Price per packaging method (S$)	Mean price (S$) per kg of canarium kernels
Parcels of raw KIT (40 KIT per parcel)	13.0	1.33	2.66/kg (raw kernels in testa)
Bamboos (300 kernels/1m bamboo)	77.0	11.89	3.17/kg (dried kernels)
KIT in heap (40 KIT per heap)	9.0	1.00	2.00/kg (raw kernels in testa)
Buckets (13 kg KIT per bucket)	1.0	650.00	50.00/kg (dried kernels)
Average price for canarium per kg			**S$14.45/kg**

Table 6: List of processing activities associated with canarium, cocoa and copra production

Activities associated with Canarium production	Activities associated with Copra production	Activities associated with Cocoa production
Harvesting	Nut collection/harvesting	Harvesting
Carrying of the canarium nuts	Cutting	Tree maintenance
Depulping	Drying	
Cracking	Sorting	
Shell removal	Ramming	
Testa removal	Firewood cutting	
Storing of the nuts	Transportation of firewood	
Packing of the canarium nuts	Drier maintenance	
Transportation of canarium nuts to village for processing	Transportation to village	
Transportation of the canarium nuts to markets for selling		

Table 7: Comparison of costs of production for canarium, cocoa and copra

Factors of Production	Canarium production (S$/ha/annum)	Cocoa production (wet beans) (S$/ha/annum)	Copra production (S$/ha/annum)
Labour	2,100.00	4,500.00	1,110.00
Capital	10.00	0.00	150.00
Total cost of production*	2,110.00	4,500.00	1,260.00

Table 8: Comparison of the profits earned from canarium to the cash crops (cocoa and copra production

Revenue earned	Canarium production (S$/ha/annum)	Cocoa production (S$/ha/annum)	Copra production (S$/ ha/annum)
Gross revenue	650.25	6,732.00	1,600.00
Cost of production	2,110.00	4,150.00	1,260.00
Net profit*	(1,459.75)	2,582.00	340.00

* The net profit is displayed as the average amount per household per hectare per annum for the respective crop.

Table 9: Potential revenue from canarium production compared to cocoa and copra production if 100 percent of the trees were harvested

Revenue earned	Canarium production (S$/ha/annum)	Cocoa production (S$/ha/annum)	Copra production (S$/ha/annum)
Gross revenue	16,738.00	6,732.00	1,600.00
Cost of production	13,030.00	4,150.00	1,260.00
Net profit *	3,708.00	2,582.00	340.00

*The net profit is displayed as the average amount per household per hectare per annum for the respective crops.

Table 10: Profit maximization between the three crops taking into account the scarce labour available

Revenue earned	Canarium	Cocoa	Copra
Kgs produced/ha/annum/	1158	2245	784.75
household	430	150	37
Labour person days/ha/annum			
Capital $/ha/annum	50	0	150
Land $/ha/annum	0	0	0
Unit Price S$/kg	12.45		1.60
		3.00	
Maximum Profit			
Total Labour used		**S$6,554.17**	
		617	