

IMPACT OF HOME GARDEN COCONUT CULTIVATION ON COCONUT KERNEL BASED INDUSTRIES IN SRI LANKA



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FOREWORD

Coconut, one of the predominant plantation crops in Sri Lanka, sustains the livelihood of many in the tropics and is considered the most important crop in terms of food security next to rice in the island.

The total annual coconut production in the country varies from 2300 to 3200 million nuts, depending on the weather as well as cultural, and management practices. The price of coconut fluctuates over a year due to supply variation. Fresh nuts usage for local consumption is nearly 2/3 of the total national nut production.

The smooth functioning of the coconut industry requires around 3,600 million nuts a year, given existing demand. However, since production has declined over the years, it is imperative to develop a strategic planning to increase production on the one hand and obtain a reduction in the wastage in local consumption. Declining production has, in addition, resulted in an inability to serve industrial requirements. It is in this context that this study considers the potential of home gardens for increasing coconut production.

The study is mainly oriented towards obtaining reliable evidence for policymakers to promote coconut cultivation at the home garden level and make informed decisions on coconut kernel based industries, in a context where Sri Lanka has reached a transitional stage where it has to cater to a huge demand for both processed products and fresh nuts in the international market. It is important to note that small-scale oil mills struggle to compete with imported palm oil as a result of flawed mechanism and policy procedures, lack of access to required technology and machinery. As a result, upgrading these mills is an area that warrant the attention of policy makers in view of increasing production efficiency.

Other recommendations include ensuring stable prices for coconut-based products, expanding industrial prospects, adoption of good management practices and standardization, and upgrading technological know-how that can enhance the prospects of the industry. I congratulate the research team for focusing on this important sector, a necessary exercise to enhance knowledge of the social, economic and political factors for the general public, producers, consumers, academics and of course policy-makers.

Malinda Seneviratne
Director/Chief Executive Officer

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EXECUTIVE SUMMARY

Sri Lanka is the fifth largest coconut producing country in the world. The total annual coconut production in the country varies from 2300 to 3200 million nuts, depending on the vagaries of weather, cultural and management practices. Price of coconut varies within the year, due to this supply variation. Major Objective is to identify the possibility of increasing coconut production through home gardens and the Specific Objectives to find out the factors influencing which cause coconut production and estimating the potential production in home gardens, to provide reliable evidence to policymakers to promote coconut cultivation in home garden level and Identify the impact of home garden coconut production on coconut kernel based industry in Sri Lanka.

This study was conducted in 384 households with home gardens in an extent less than 40 perches and 50 coconut kernel based industries in the Gampaha, Kurunegala and Puttalam districts in Sri Lanka registered under the Coconut Development Authority.

The study found that the local fresh nut consumption is nearly 2/3 from the total nut production and nearly 30 percent of the national production is dedicated to the industry.

Two varieties of coconut trees; DT hybrid and Tall varieties; are being mainly cultivated in most of the home gardens.

The average annual per capita consumption of coconuts in Sri Lanka is about 110 nuts, which is considerably higher than any other coconut producing country in the world. Two DT hybrid trees per household are adequate to fulfil the household coconut requirement of a four-member family while a considerable share is wasted due to inefficient milk extraction techniques.

The average number of coconut trees in a ten perch home garden was one. Nearly sixty-two percent of the home gardens have a possibility of gap filling, with one more coconut tree. The result indicated that about seventy-five percent of the households preferred to cultivate DT hybrid variety. Tall varieties were mainly cultivated by most of the home gardens (94%) compared to DT. Around 55% of Tall variety trees are more than 30 years old.

The results of this study shows that the maximum tree population was about 17 trees per 40 perch land, which produces an average of 35 nuts/tree/year (less than the recommended yield.) But the low production and productivity of coconut per unit area in the study area due to the presence of Incidence of pests, poor agronomical practices and poor extension services adversely affect the production.

In terms of the coconut kernel based industries, Sri Lanka has reached a transitional stage with huge demand for both processed products and fresh nuts in the international market. A total of 37 coconut based products— coconut oil, virgin coconut oil, desiccated coconut, coconut cream, milk, milk powder, copra, fresh nut and seed nut— are exported annually.

The main constraint (27%) of the coconut based product manufacturing industry is prevalence of unstable market conditions. The second issue was the lower demand for local desiccated

(16%) industry due to poor quality issues and labour shortage also doom the prospects of the industry.

When considering the main constraints in the coconut based manufacturing industry, low market shares for desiccated coconut (8%) is another issue highlighted by the manufacturers. Heavy market competition (4%) and climatic change (4%) also pointed out as issues in the sector. In addition, low profit margins, higher production cost, inability of applying for higher standard certification process, adulterations and use of chemicals are also mentioned as major constraints in the industry.

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ABBREVIATIONS

ARPA	Agriculture Research and Production Assistant
CCB	Coconut Cultivation Board
CDA	Coconut Development Authority
CGASL	Coconut Growers Association of Sri Lanka
COP	Cost of Production
CRI	Coconut Research Institute
CVDs	Cardiovascular diseases
DCS	Department of Census and Statistics
DC	Desiccated Coconut
DS	Divisional Secretariat
GDP	Gross Domestic Product
GIS	Geographic Information System
GND	Grama Niladhari Division
DSD	Divisional Secretariat Division
HARTI	Hector Kobbekaduwa Agrarian Research and Training Institute
HadCM3	Hadley Centre Coupled Model, version 3 General Circulation Model
IPCC	International Panel of Climate Change
VCO	Virgin Coconut Oil
WHO	World Health Organization

CHAPTER ONE

Introduction

1.1 Background of the Study

Coconut (*Cocos nucifera* L) is one of the predominant plantation crops in Sri Lanka. Coconut cultivation sustains the livelihood of many in the tropics and is considered the most important crop in terms of food security next to rice in Sri Lanka.

Origin of coconut in Sri Lanka traces a long history. Hence, many historical records provide proof for its significance as an ingredient in domestic consumption as well as in the commercial sphere. Coconut is a rain-fed perennial crop and a major plantation produce in Sri Lanka, which is grown in all districts. Around 55 percent of the area under the crop belongs to the 'COCONUT TRIANGLE' that is spread across districts of Kurunegala, Puttalam, and Gampaha.

Coconut is cultivated in an area of 1,095,982 acres and nearly 70 percent of the cultivation is concentrated in Kurunegala, Puttalam, Gampaha and Colombo. From the total cultivation extent; 917,307 acres are considered as small holdings (Coconut Development Authority, 2018). The smallholder sector in Sri Lanka occupies 83.7 percent of coconut cultivation lands signifying the important role played by the smallholder sector in national coconut production. The rest belongs to the estate sector where both private and public parties operate. Coconut is a highly popular crop due to its multiple uses. The tree is dubbed the "Tree of Life" or "Kapruka" (Pathiraja et al., 2015).

The major coconut growing areas in the North Western Province (NWP) in the Kurunegala and Puttalam districts and part of the Western Province (Gampaha district) constitute the Coconut Triangle, which account for 67 percent of the coconut growing area of Sri Lanka (Central Bank Annual Report, 2019).

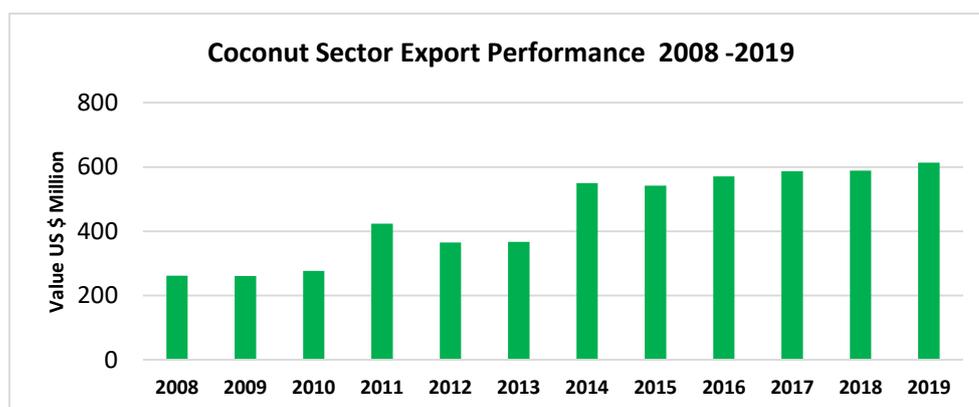
The rest of the coconut growing area is located in the Southern Province often denoted as the mini coconut triangle which includes Galle (12,543 ha), Matara (14,398 ha) and Hambantota (20,733 ha) districts. They together account for 47,674 ha of coconut cultivation (Coconut Cultivation Board, 2019).

Coconut is a commercially important plantation crop in Sri Lanka and the only plantation crop for promotion under the food production national plan in 2016-2018 under the Ministry of Agriculture.

The major exports include desiccated coconut, copra, coconut oil, coconut cream, coconut milk powder, coir and coir fiber products, coco peat, shell charcoal and activated carbon. Recently new products have entered to the export trade such as

virgin coconut oil (VCO), and coconut/king coconut water. According to the Coconut Cultivation Board data, coconut production during the last decade has averaged 2,761 million nuts per annum, of which about 70 per cent is domestically consumed directly in the form of fresh nuts. The balance is utilized by the copra and desiccated coconut processing industries (Coconut Development Authority, 2018).

Coconuts have contributed US \$ 609.77million in foreign exchange in 2019. The contribution of agriculture sector to the Gross Domestic Product (GDP) is about 7.42 %. The contribution of coconut sector to the Gross Domestic Product (GDP) is about 1% (Central Bank of Sri Lanka, 2019).



Source: Sri Lanka Export Development Board 2019

Figure 1: Export Performance of Coconut 2008-2019

The above figure indicates the export performance of coconut. From 2014 to 2017 the export performance indicates an upward trend. According to the data, 2845 millions of coconut nuts were harvested in 2016 and the harvest in 2017 is 2450 million nuts. Accordingly, a reduction of 14 percent of production was experienced in 2017 compared to in 2016 following the severe drought in the year 2016. It resulted in a decline of 395 million nuts in 2017. However, 2623 millions of nuts were harvested in 2018 (Coconut Development Authority, 2018).Coconut exports were at US\$ 613 million in 2020. It is an increase of US\$24 million compared to 2018.

Household fresh nut consumption in 2017 was 1655 million (Central Bank of Sri Lanka, 2019). The recorded ANCP (Annual National Coconut Production) for the period from January to August 2019 was 11 percent higher than the predicted total for the same period in 2019 (2020.4 million nuts). The recorded ANCP for the period from January to August 2019 (2240.5 million nuts) was about a 27 percent increase compared to the yield recoded in 2018 (1760.8 million nuts) (Coconut Research Institute Sri Lanka, Coconut Yield Forecast, October 2019).

1.2 Rationale for the Research

According to the opinion of the scientists and experts of the sector, several influential factors may have influenced reduction in the production of coconut. It has been estimated that fragmentations of coconut lands are accountable for the loss of over 260 coconut trees per day (Pieris and Kularathne, 2015). Accordingly, this high rate of felling of coconut trees affects the national coconut production as well as the domestic consumption and exports. Total land extent under coconut in the country has reduced from 416,253 ha to 394,836 ha from 1982 to 2002, which is a decline of about five percent (21,417 ha) of the total land extent (Coconut Cultivation Board data, 2018). This is mainly due to increased land demand for housing purposes which is a consequence of the population rise. As a result, potential per capita availability of coconut has reduced over time indicating that the production has not increased sufficiently to meet the requirement of growing population. Population surge also directly affects the coconut price. When considering the annual total nut production in 2017, it was 2450 million nuts (Central Bank of Sri Lanka, 2019). Annual domestic consumption is about 2000 million nuts or 70 – 80 percent of the total production, estimated at 116 nuts per capita. This will continually rise with the increase of population.

Stagnation in production along with increasing domestic consumption has created a critical shortage of nuts for industrial use. Of the total national production, only one third or 1000 million nuts are available for industrial use and the rest is domestically consumed as fresh nuts. This increasing population and increasing domestic requirement has already affected the national economy considerably. Due to high demand for domestic requirement, fulfilling the industrial requirement has become a second priority.

Another factor that affects coconut production is the impact of extreme climate events resulting from global climate change. Rainfall and temperature are important climatic factors that influence the coconut yield and the national coconut production (Peiris et al., 1995) upon which domestic culinary consumption and processing industry depend. Although the influence of climate variability has been quantified, high yield variations observed in recent years can be attributed to extreme weather events and climatic changes such as extended droughts and floods (Peiris et al., 1995). The annual production of coconut has shown no significant increase and stagnates between 2800 – 3000 million nuts. Farmer level actual average of production ranges from 2500 - 2800 nuts per acre whereas the potential yield of the new varieties varies between 22,000 – 24,000 nuts per acre (Fernando et al., 2007).

In 2016 and 2017 a sharp increase in coconut prices was witnessed due to climate change, shortage of monsoon rains in certain areas. The coconut yield dropped by 40-50 percent in the coconut triangle. The farm gate price increased to Rs. 55 and the retail nut price stood at Rs. 100/nut. During this time, the consumer suffered

immensely because of shortage of nuts, which ultimately led to high farm-gate nut prices. The scenario also made their processed products less competitive in the international market.

The other factor is inadequate fertilizer application by smallholder farmers. Pests and diseases also affected achieving an increased coconut production.

This causes the per nut value to increase. The potential per capita availability of coconut has reduced overtime, which is indicative of production not being increased on par with the requirement of the of growing population (Jayewardene,2018).

Cultivating coconut plants in home gardens may contribute to increase the coconut production of the country. Home gardens are the oldest land use activity, next only to shifting cultivation in the tropics (Kumar and Nair, 2004). It is suggested that almost all home garden systems have evolved to provide food and other requirements of households through generations under resource constraints such as population density, physical limits such as inaccessibility in the living area, insufficient market facilities, and scarcity of arable lands and capital in respective countries (Nair and Kumar, 2004).

In Sri Lanka today as the large scale coconut cultivations are disappearing due to the pressure on land specially for housing purposes, home gardens are the best option to increase coconut production in the country. Also developing high yielding varieties that can be accommodated by households, depending on the space availability of the home gardens, is a distinct advantage to promote coconut production at home garden level.

Government's effort in expanding the coconut cultivation in nontraditional areas (Anuradhapura and Moneragala and newly liberated areas in the Eastern Province) is restricted by the scarcity of available lands in these regions. Therefore, raising productivity of existing coconut lands is a plausible measure and under these circumstances performance of smallholders has become a necessity as the future of industry almost depends on coconut growers (Jayalath et al., 2006).

Issues faced by the coconut cultivation and the processing industry

- 1) Production recording less than the potential yield and productivity of coconut lands:
The potential yield of the recommended coconut cultivars under ideal conditions varies from 12,000 to 15,000 nuts /ha. The national average varies between 6, 000-6,250 nuts/ha. The gap is essentially due to reasons such as below average management practices, land degradation, overage plantations and the prevailing unfavorable climatic conditions and suboptimal planting density.

The major coconut export products include copra, Desiccated coconut(DC), coconut

cream, coconut oil, coconut milk powder, shell charcoal and activated carbon, coir and coir fiber products and coco peat. The other coconut products are consumed directly such as toddy, vinegar, arrack, treacle, jaggery, other coconut foods and beverages. New products have arrived in the export market as coconut paste, virgin coconut oil, coconut water and king coconut water. There is a significant demand for these products in the international market, but the industry cannot keep up with the raw material demand due to the prevailing low nut availability.

- 2) The fluctuating prices: The fluctuating farm-gate nut price affects the coconut industry. Annual fluctuations in nut prices vary from Rs.22.00– Rs. 70.00 in certain years, depending on the production and export capacity.
- 3) The cost of production per nut
The cost of production (COP) differs on the size of holding, nature of operation, and the level of management. In 2018 COP is Rs.18.84 per nut (Central Bank Report, 2018). Increasing input costs and high labour salaries affect both smallholders and estate owners. Mechanization of field operations in coconut lands is inadequate in Sri Lanka especially in the smallholder sector.
- 4) Insufficient supply of high quality seed/seedlings: Improved coconut seeds are produced in the seeds gardens of the Coconut Research Institute (CRI) and presently the CRI produces only about 50 percent of the national seed requirement. The balance is delivered from selected high yielding palms called 'plus palms', the selection is based on yield, weight of the husked nut and good agronomic characteristics of the mother palm. In the plus palm seeds, the pollen parent is not known and therefore the quality of the seeds may not be as good as the nuts coming from seed gardens.
- 5) Fragmentation of coconut lands: Coconut land fragmentation due to urbanization and industrialization is a grave issue in Sri Lanka. The country lacks comprehensive and effective land use policies. Records indicated that 7% of the coconut land had been lost from 1982 to 2002. At present due to serious land fragmentation, coconut plantations face a severe threat.
- 6) Damage caused by pests and diseases: The incidence of pests/diseases is a major limitation in coconut production in Sri Lanka, specially the black beetle, red weevil, coconut mite and Weligama Wilt Disease.
- 7) Extreme weather events: This is a major limitation to coconut cultivation and production. Rise in temperature and variation in rainfall have been recorded. High temperatures affect pollination resulting in fewer nuts per bunch and button nut fall, aggravating the effects of water scarcity.

- 8) Use of outdated machinery and equipment: Many processing industries use old and outdated machinery and equipment for processing. This has led to inefficiency in production and low quality of products (Coconut Research Institute)

Hence there is an excess demand for fresh coconut in the country. Therefore, cultivating coconut plants in home gardens may help increase the coconut production of the country as well as achieve self-sufficiency in coconut while reducing the domestic coconut demand. According to the Coconut Cultivation Board, two trees can fulfill the household coconut requirement of a 5-member family. A viable coconut growing sector will pave way for an adequate coconut supply which in turn will cater to domestic consumption and industrial production. Under the prevailing circumstances home garden can play a major role in this regard. Therefore, due attention and efforts should be directed at developing coconut production in home gardens.

1.3 Research Problem

As explained above, low production of coconut in the country has caused issues both in terms of consumption as well as industrial requirement. Therefore, to avoid any impending collapse of the coconut industry to meet the consumption requirement at the same time it requires an increase of coconut production. For this reason, this is to look into the approach of how the home gardens can be used to increase coconut production would be a highly desirable solution in the country.

1.4 Objectives

Major Objective

Identify the possibility of increasing coconut production through home gardens

Specific Objectives

- To find out the factors influencing which cause coconut production and estimating the potential production in home gardens.
- Finding means of minimizing the constraints of coconut cultivation and possible remedies for them at home garden level.
- To provide reliable evidence to policymakers to promote coconut cultivation in home garden level.
- Identify the impact of home garden coconut production on coconut kernel based industry in Sri Lanka.

1.5 Expected Outcomes

Increasing the total coconut nut contribution to the national production through coconut cultivation at home garden level.

CHAPTER TWO

Review of Literature

2.1 Coconut Cultivation in Sri Lanka

Coconut which is scientifically termed as *Cocos nucifera* (L.) is found mainly in tropic and sub tropic areas of the island. It is one of the most important rainforest trees grown in more than 90 countries in the world. The industry contributes about 0.7 percent to the Gross Domestic Product (GDP) and 3.3 percent to the total export earnings (Central Bank of Sri Lanka, 2017).

Coconut palm is called the "tree of life" because of its multiple uses (Assa et al., 2010). The earliest references to coconut cultivation in Sri Lanka were found in the Mahavamsa around 589 AD under King Agra Bodhi II (*Linage, D.V. 1958*). Coconut is considered a very special palm for its various domestic, commercial and industrial uses. The coconut industry is an essential source of foreign exchange and employment generation for Sri Lanka, and an important component of the Sri Lankan cuisine, nutrition and rural livelihood.

According to the land use in Sri Lanka. Coconut has been planted in the extent of 208,368 (ha) which is 3.18 (%) of the total land area in 2018 (Source: Land Use and Policy Planning Department, Ministry of Lands). Note: * (Rocky area, sandy Area, Unutilized lands & Bare Lands etc.) A total of 1,088,377 Acres are under coconut cultivation of which 173,974 acres are in the estate sector while 914,403 acres belong to the small holdings (Coconut Cultivation Board, 2019).

2.2 Varieties and Nutritional Value of Coconut

According to the literature, there are many health benefits of coconut products: cholesterol-lowering effect, reduction of the risk of cardiovascular diseases (CVDs), weight loss, improvement of cognitive functions, action as an antimicrobial agent, and others (Medical News Today, 2018).

There are different coconut varieties found in Sri Lanka. The Coconut Research Institute (CRI) recommends the following varieties.

Table 1: Varieties and Forms of Coconut Found in Sri Lanka

Tall X Tall (CRIC 60) improved variety
Tall X Tall cross
Flowers in 5-6 years
Suitable for all coconut growing areas
Production capacity:
12,000 nuts/ha/year
3.5 Mt copra/ha/year
Dwarf X Tall (CRIC 65) hybrid
Dwarf X Tall cross
Flowers in 3- 4 years
Specially recommended for home gardens
Production capacity:
Exceed 20,000 nuts/ha/year
5 Mt of copra/ha/year
Tall X San ramon (SRISL 98) hybrid
Tall X San Ramon cross
Large nut size and high copra productivity
Suitable for all ecological growing areas
Moorock tall
Estate selected tall variety
Recommended for wet zone
Plus palm
Seedlings obtained from selected palms

Source: The Coconut Research Institute (CRI) 2019

2.3 Coconut Yield and Food Security

The present coconut production in the country varies from 2,500 to 3,000 million nuts. The coconut sector strategic development plans focus mainly on increasing the yield. Approximately two thirds of the coconut production in Sri Lanka is consumed locally and the balance is used for coconut based industries and exported to various destinations as value added products (Coconut Development Authority, 2018)

There is a relation between home gardening and food security. Food security, as spelt out in the National Policy Framework of ‘Vistas of Prosperity and Splendour” and the Millennium Development Goals requires a nutritionally satisfactory and safe food supply at both national and household levels and reasonable supply of food during the year. Food security constitutes of availability, access and utilization. These components can simply be accomplished with home gardening. Home gardens directly contribute to household food security by increasing the food availability,

accessibility, and utilization. Self-sufficiency in coconut at home garden level will help enhance food security at home.

2.4 Place for Coconut in Home Garden

With regard to home garden concept various definitions exist. Home garden or household garden is a small-scale production system supplying plant and animal consumption and utilitarian items either not obtainable, affordable, or readily available through retail markets, field cultivation, hunting, gathering, fishing, and wage earning. Household gardens have a tendency to be located close to home for security, convenience, and special care. They occupy land bordering to field production and labour marginal to major household economic activities. Featuring ecologically adjusted and complementary species, household gardens are marked by low capital input and simple technology (Nifiez,1984).

Home garden is an area of land, individually owned, surrounding a house and usually planted with a mixture of perennials and annuals (Terra, 1954). There are a lot of benefits of having a home garden. Home gardens allow more profits for households. It can be classified into social, economic and environmental benefits.

Social profits of home gardening are yields raising the family's financial status significantly and the most fundamental social benefit being its direct contribution to household food security by increasing availability by enhancing food and nutritional security as it is a subsistence level of farming method and fulfills the day-to-day meal of a family

In an average family, the major share of its income is spent on purchase of food items. In most cases, family income has been found to be insufficient even to obtain this requirement. This causes malnutrition and other socio economic conditions amongst most low income groups in Sri Lanka. Well organized home gardens can provide the family food necessities which would relieve the families from malnutrition. Developed home gardens are found in many parts of the country. Coconut is an important component in Sri Lankans' diet, and is used extensively in cooking. About 22% of the calorific intake of Sri Lankans is derived from coconut (Biometry Division, CRI, 2008).

The per capita consumption (National mean) of coconut by Sri Lankans by way of fresh nuts is estimated to be about 104 nuts/person/year.

2.5 Government Policy Programmes Conducted in Sri Lankan Home Gardening

Annually, different kinds of home gardening programmes are conducted by the government. The national development policy framework of the government now includes strategies to expand and improve food and timber productions.

1. Home Gardening Promotion Programme conducted in 2018 by the Ministry of Agriculture

The key objective of this programme is to implement 500,000 home gardens to ensure food and nutrition security of a family. In addition to achieving food and nutrition requirement of the family through a self-sufficient home garden, this would support on promotion of entire food production of the nation. The productivity of the site could be increased by vertical and horizontal spaces available in the garden and it is expected to extend the home gardens through decoration techniques. Objectives of the programme are encouraging women through “Sithamu” Women Farmer Organization and developing self-employment and fulfilling the food and nutrition requirements of the family to improve food consumer patterns of people.

2. “Haritha Lanka Programme”

Sri Lanka has developed the National Action Plan for the Haritha Lanka programme from 2009-2016. This project was intended to ensure that sustainability would not just remain a concept but would translate into practical reality. This programme has ten broad missions: Clean Air - Everywhere; saving the fauna, flora and ecosystems; meeting the challenges of climate change; wise use of the coastal belt and the sea around; responsible use of the land resources; doing away with the dumps; water for all and always; green cities for health and prosperity; greening the industries and knowledge for right choices (Wiersum K 2009).

3. “Api Wawamu-Rata Nagamu”

“Api Wawamu-Rata Nagamu”, a special development drive accelerated under the purview of Ministry of Agriculture was the national campaign to encourage towards production of indigenous food crops by adopting short term and mid-term strategies with the objective of saving foreign exchange. The project is implemented in keeping with the National Agriculture Policy of cultivating every inch of arable land implemented from 2007 to 2013. The main objectives of the programme are growing of 23 locally cultivated food crops by imposing import restrictions on same, ensuring the food and nutrition security of the people, reduction of foreign exchange required annually for food imports, increasing the income levels of the farmer community and the reduction of the use of chemical fertilizer by the increased utilization of organic fertilizer during the next few years. In order to achieve the above objectives, the following strategies are to be adopted increasing the selected crop production, make use of the state-owned farms for production purposes, cultivation of colony lands, private and state lands, promoting the production and utilization of organic fertilizer, promotion and dissemination, rationalization of marketing and minimization of post-harvest losses.

4. “Deyata Sevana”

the National Tree Planting Programme by planting 1,100,000 trees island wide was launched in 2010, aligning with the *Mahinda Chinthana* – Vision for the Future in realization of a “Greener Country”. This has been a sustainable environment initiative with multifaceted benefits— conservation of micro catchments, ensuring the nations water security, and enhancing important life support systems and positively contribute to the “Divi Neguma” programme as well. This mega tree planting programme played a commendable role in conservation of bio diversity and addressing global environmental issues such as climate change and land degradation.

5. “Divi Neguma”

“Divi Neguma” development program commenced by the Divi Neguma Development Department under the Ministry of Economic Development aimed at carrying out development activities that may be required to alleviate poverty and to bring about a society guaranteeing social equity, to promote the individual, family, group and community centered livelihood economic development activities, to ensure food security for each individual and family; and to mobilize and empower people to speed up national development.

6. “Deyata Kirula”

National Development Exhibition launched promotion programmes to enhance the bio diversity of the country. Upholding the objective there was a stall to showcase the importance of agro- biodiversity in the field of bio-diversity conservation explaining the importance of keeping higher species mixed in the home garden.

2.6 Effect of Climate on Coconut

According to the International Panel on Climate Change (IPCC), agriculture in low latitude countries is already operating at the maximum temperature limits for crop growth and at a greater production risk than the high latitude countries (IPCC, 2014a). For this cause, crop yield is expected to increase in mid and high latitude countries whereas in low latitude countries it is expected to decrease, with an expected local temperature increase of 1-2 °C. Further, an increase in frequency of droughts and floods is expected in these low latitude areas (IPCC, 2014a).

Coconut (*Cocos nucifera L*) is a rain fed perennial crop deeply rooted in the Sri Lankan culture, consumption and the economy. An analysis of the economic impact of climate variability on the coconut industry conducted using 1971-2001 data showed that 60 percent of the variation in coconut production can be explained by climatic factors and it incurs a loss of US\$32 million to US\$73 million in extreme shortages while

gaining an income of US\$42 million to US\$87 million in crop gluts (Fernando et al., 2007).

Coconut production forecasting studies have shown that annual coconut production is particularly sensitive to rainfall during January to March in the key coconut growing regions (Peiris et al., 2008). The maximum ambient temperature and relative humidity in the afternoon are the most significant variables in nut production (Peiris & Thattil, 1997). Another study presented that coconut production will decrease by 2040 under six climate change scenarios (Peiris et al., 2004).

According to climatic change predictions, coconut yield decrease may arise with increasing ambient temperatures. Predictable weather extremes may worsen the situation leading to frequent production variations and price fluctuations. The irreversible impacts during prolonged droughts may cause permanent losses. Processing industries may face uncertainties on stability of supply of raw material both in quantity and price terms. Further, these instabilities will affect domestic consumers. Therefore, the role of adaptation strategies in sustaining yield under climate change scenarios becomes critical. The above study highlighted the impact of potential climate change and adaptation strategies on the coconut industry value chain of Sri Lanka (Pathiraja et al., 2015).

2.7 Coconut Industry in Sri Lanka and the Current Situation of the Industry

Sri Lanka is a leading country in coconut production. It takes a significant part in the world coconut market mostly through the supply of desiccated coconut (DC). The Sri Lankan coconut industry is ruled by the Coconut Development Act No 46 of 1971 and is observed by the Coconut Research Board, the Coconut Cultivation Board (CCB) and the Coconut Development Authority (CDA). The coconut industry is protected by the Plant Protection Ordinance (1981), Plant Protection Act No 35 (1999) and the Coconut Land Fragmentation Control Act No.20 (2005).

In 2017, the export earnings from coconut was US \$598.19 million which is a 3% increase compared to that of 2016 (Coconut Development Authority, 2018). Since the coconut processing industry in the country, mainly the kernel based industries, has done well during recent years, much of this growth can be recognized mainly to the remarkable growth in the existing industries like Virgin Coconut Oil (VCO), fresh king coconut, coconut cream and coconut milk. The developing industries such as coconut-based arrack and coconut water have also contributed significantly to this incremental value, while the non-kernel based products such as bristle fiber, activated-carbon, geo-textiles also have a considerable effect on the growth of export earnings.

2.8 Policies on Coconut Sector

Coconut cultivations in Sri Lanka are owned mainly by the private sector (around 95%), but they operate under government regulations. This is because coconut is considered an essential and a major food ingredient in the Sri Lankan diet. It is also a major plantation crop that contributes to foreign exchange earnings. Therefore, it is necessary that the country adopts quarantine regulations and land use regulations to assure food security, employment and the earnings of the people. The Coconut Development Act delivers for action on the distribution of coconut land and land use policy, coconut land management and subsidy policy, coconut plant quarantine policy and coconut pricing policy and market mechanism which are the policies in operation in the coconut sector of the country.

According to the Plant Protection Ordinance No. 165/2, November 1981, no plant shall be imported into Sri Lanka, except under the authority and in accordance with the conditions of a Plant Importation Permits issued by the Director General of Department of Agriculture. This ordinance covers coconut and related plants as well. Government policy is to stimulate coconut cultivation and proper management of the industry through maintaining appropriate breakeven farm-gate prices for the growers and affordable market price for the manufactures (Jayewardene, 2018). At present the main contributing factor for farm-gate nut price is the prices of kernel-based products such as coconut oil, desiccated coconut and the substitute oil prices. Evidence has proved that price of substitute oils has a direct influence on the prices of the nuts and other coconut kernel-based products. Hence government has implemented a tariff policy on substitute oil to control competition with coconut oil prices since the price of coconut oil will determine the prices of nuts and other products of coconut.

The Sri Lankan government developed a climate change policy in 2012 for the country across all. Its aim was “to provide guidance and directions for all the stakeholders to address the adverse impacts of climate change efficiently and effectively” (Climate Change Secretariat of Sri Lanka, 2012). The policy objectives were to make the community aware of vulnerability, adaptation, mitigation, sustainable consumption and production and knowledge management. It aims at incorporating climate change aspects in development plans.

CHAPTER THREE

Methodology

3.1 Selection of Study Location

This study was conducted on households that possess home gardens in the land extent category of less than 40 perches (based on the economic statistics of the Department of Census and Statistics data, 2014) in the Gampaha, Kurunegala and Puttalam Districts in Sri Lanka. Then it was generalized to all home gardens in Sri Lanka. Therefore, the selection of these districts was done purposively to achieve the research objectives based on the budget, time duration and the labour force.

3.2 Methods of Data Collection

Both primary and secondary data was collected to achieve the research objectives. Key Informant Interviews, Focus Group Discussions, Structured Questionnaires Surveys and Case Studies were administrated to extract the required primary data from the study area.

Coconut subsidiary programmes implemented, recommended coconut management practices, the current status of the coconut production of the country were identified using secondary data of relevant documents, reports, journal articles, records and maps of the relevant areas. In addition, data of the Coconut Cultivation Board, Coconut Development Authority and Coconut Research Institute Sri Lanka was utilized as secondary data.

3.2.1 Key informant interviews

Key informant interviews conducted with the responsible officers (Officers of the Coconut Cultivation Board, Coconut Development Board, Coconut Research Institute, divisional coconut development officers, village level officers (Agricultural research and production assistants and Grama Niladhari of the relevant area) to collect information on the present status of coconut cultivation in the study area, prevailing issues and performance. This was done with the help of structured and guided schedules.

3.2.2 Focus Group Discussions

Further focus group discussions were held with the members of the farmer organizations in the relevant area in order to obtain details regarding the coconut cultivation. Focus group discussions were held with the participation of the officers of the Coconut Research Institute, officers of the Coconut Cultivation Board, officers of the Coconut Development Authority of the study area.

3.2.3 Structured Questionnaire Survey

Two questionnaire surveys were developed for this research: one for the home gardens and the other for all coconut kernel based industries registered under the Coconut Development Authority.

Questionnaire type one

A single visit personal interview using a structured questionnaire was adopted for every household in the sample. It was found 384 households possess a home garden in the extent less than 40 perches. The questionnaire survey focused on the general socio-economic status of households, coconut plantation management practices, coconut consumption pattern and the impact of the adverse weather conditions on coconut cultivation. This questionnaire survey was conducted from April to September 2019 on those 384 households.

Questionnaire type two

This questionnaire was designed targeting fifty coconut kernel based industries registered under the Coconut Development Authority. The survey was implemented in August and September 2019. It focused on production details of the industries, sales issues and the current status of production. 50 coconut kernel based industries in the Gampaha, Kurunegala and Puttalam districts in Sri Lanka registered under the Coconut Development Authority.

3.2.4 Case Studies

Case studies relevant to specific issues were used to achieve the objectives of the study. A few case studies were conducted to find the possibility of increasing household coconut production through home gardens.

3.3 Sample Selection and Questionnaire Surveys

According to the Department of Census and Statistics data in 2014, there are 546,596 households with home gardens in Gampaha, Kurunegala and Puttalam districts and there are 336914, 117451 and 92231 households respectively. The sample size was decided considering the margin of error and confidence level in a certain population. Depending on the above factors the number of households that are included in the sample vary. Therefore, in this study, a margin of error of 5% and a confidence level of 95% was considered. Then the required number of households with a home garden stood at 384. This was calculated using the sample size calculator (<https://www.surveysystem.com/sscalc.htm>).

Here the number of households to be sampled from each district, divisional secretariat and GND are calculated to reflect proportionate representation to make the data statistically valid.

Here, two divisional secretariats that contain the highest number of home gardens are selected from each district. Two Grama Niladhari Divisions (GNDs) which contain the highest number of home gardens are chosen in each selected DS. Finally, households with a home garden below 40 perches in each GND are selected randomly to constitute the sample.

3.4 GIS Maps

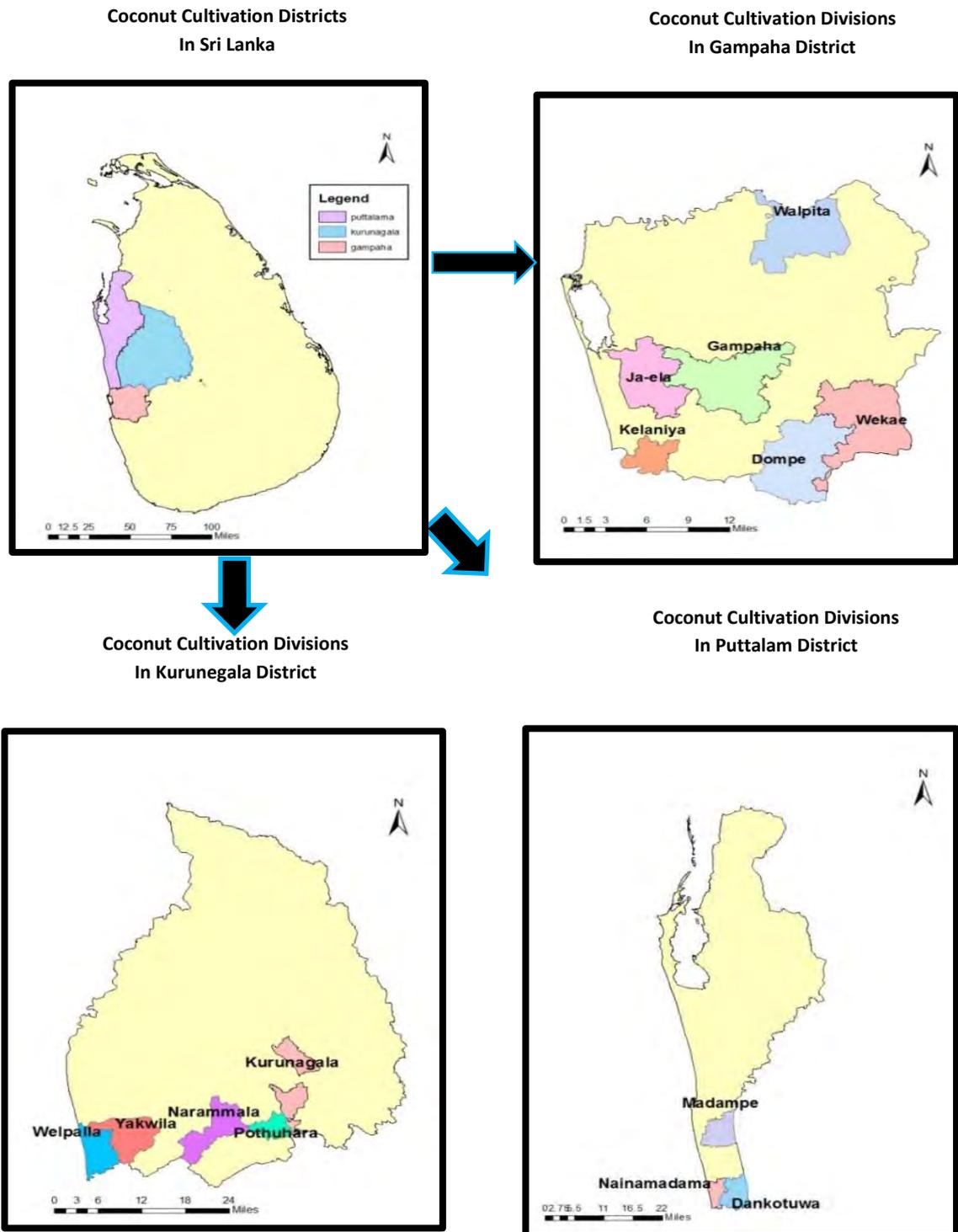
GIS maps were developed about the study area to indicate spatial distribution of the sample. GIS software was used to draw the maps and generate the maps to show the spatial distribution of the sample.

Table 3.1: Sample Distribution

District	Total No. of HHs with a Home Garden	No. of HHs to be Sampled in each District
Gampaha	336914	237
Kurunegala	117451	82
Puttalam	92231	65
Total	546596	384

Source: Author's survey data, 2019

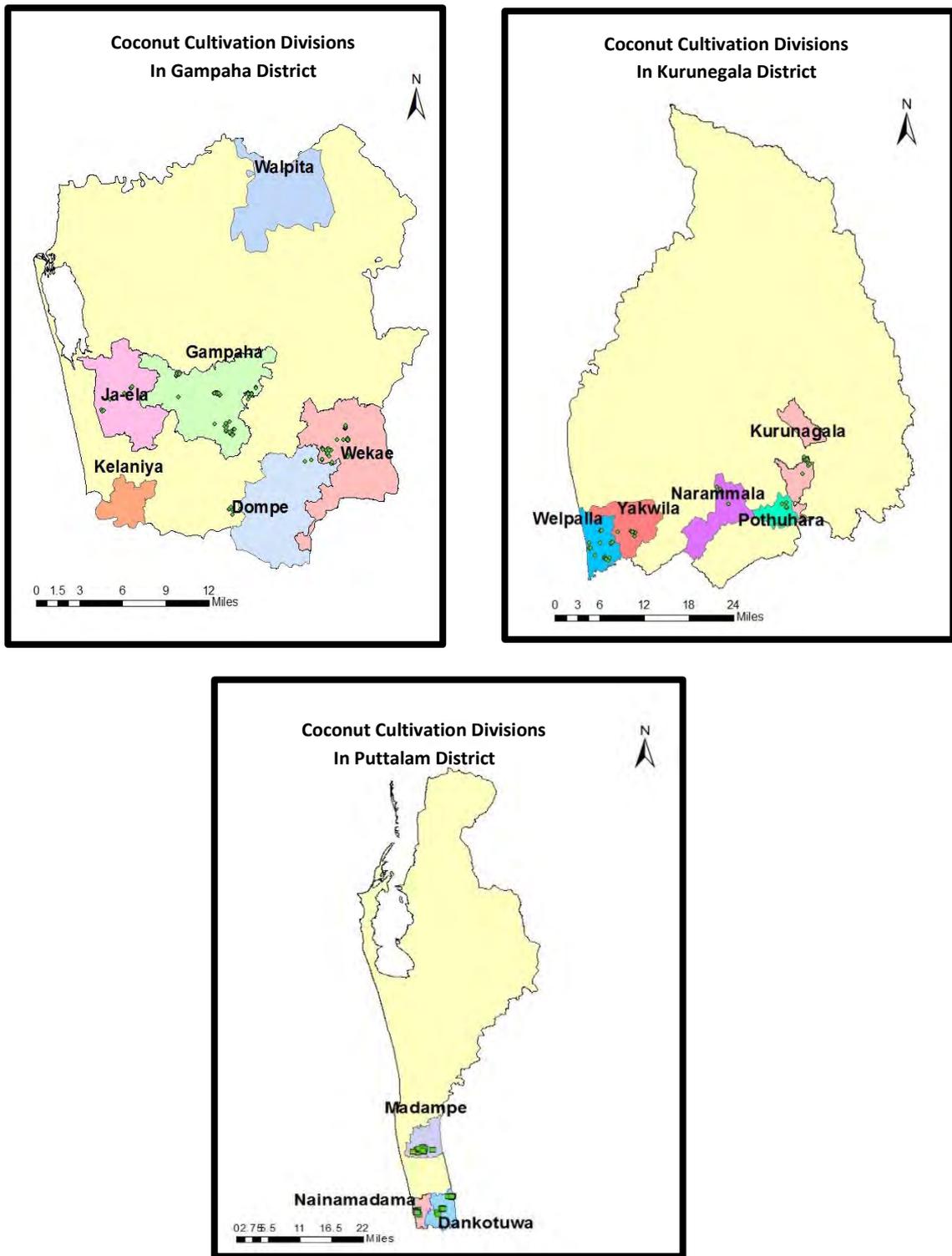
3.4.1 Distribution of the Selected Sample



Source: Author's survey data, 2019

Figure 3.1: Map of the Study Area

3.4.2 Home garden Locations of the Coconut Cultivation Divisions in the Sample Area at Gampaha, Kurunegala and Puttalam Districts



Source: Author's survey data, 2019

Figure 3.3: Map of the Study Area (Gampaha, Kurunegala and Puttalam Districts)

3.5 Data Analysis

Descriptive statistics and plots have been used in the initial phase of the statistical analysis. These tools enable us to identify the relationships in the data and determine directions for further analysis. Prior to analysis, the data was studied. For certain variables summary statistics such as mean, standard error and distribution of the data were used. Categorical data was presented as frequencies and percentages. To explore the determinants of production of coconut/ tree/year, a multiple logistic regression model was applied to estimate odds ratios (ORs) and 95% confidence intervals (CIs). Data was analyzed using SPSS.

Objective 1: Finding the factors which cause coconut production and estimating the potential production in home gardens

Cross-tabulations were applied to find the association of the factors vital to coconut production. In addition, descriptive statistics such as frequency distribution tables, percentages, graphical representations and arithmetic mean was used to describe the data.

The Multiple Logistic Regression Model

In logistic regression, attempt was made to predict the outcome of a binary response variable Y from several independent variables $X_1, X_2...$ etc. The binary response variable is in the form of log odds. The model equation is given below.

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \dots + \beta_p X_p \quad \text{--- (1)}$$

ln= natural log

p = probability of the reference binary response

β_0 = intercept

$\beta_1-\beta_p$ = parameter estimates of predictors X_1-X_p

X_1-X_p = predictor variables 1-p

The model attempted used average production of coconut/tree/year as the respond variable (whether production is below the average or not). The predictor variables were district, variety, irrigation method, recommended spacing between plants, whether fertilizer was applied or not, type of fertilizer, prevailing of insect pest attack, type of insects/pests, whether weeding was practiced or not, weeding method, whether moisture conservation was practiced or not, method of moisture conservation, age of bearings-palms, land size-group, animal inflicted crop damages have occurred or not.

Here, dependent variable was coded based on the average coconut production/tree/year according to CRI recommendation which is nearly 64 nuts/tree/year. Accordingly, once a tree produced 64 nuts or above per year, that was considered as production was on or above the average. Otherwise, production was considered below the average. Further, each variable code is displayed in annexure 1.

Interpreting the H-L GOF Test

The Hosmer and Lemeshow Goodness-of-Fit Test tests the hypotheses:

H_0 : Current model is adequate.

H_a : Current model is NOT adequate.

With this test, the null hypothesis should be accepted, because that means the model is a good fit (this is different from most of the hypothesis testing in general).

Objective 2: Finding the ways of minimizing the constraints of coconut cultivation and possible remedies for them at home garden level

Here, categorical data analysis (cross-tabulations) was mainly applied to find the ways of minimizing the constraints of coconut cultivation and possible remedies for them at home garden level. Similarly, frequency distribution tables, percentages, graphical representations and arithmetic mean were used as descriptive statistics in order to describe the data.

Objective 3: To provide reliable evidence to policymakers to promote coconut cultivation at home garden level

Here, graphical representations, arithmetic means and standard errors were used to describe the data.

Objective 4: Impact of Home Garden Coconut production on the Coconut kernel based Industry in Sri Lanka

Here, categorical data analysis (cross-tabulations) was mainly employed to find the impact of home gardens coconut production on the coconut kernel based industry in Sri Lanka. Hence, descriptive statistics such as frequency distribution tables, percentages, graphical representations and arithmetic mean were used to describe the data.

3.6 Operationalization of Variables in Objectives

Present Situation of the Coconut Production in Sri Lanka

Variable	Meaning	Measuring
Coconut land Extent in Sri Lanka	To identify the coconut cultivation distribution in Sri Lanka	Measured as number of plants per acre in Districts
Coconut Production and Cost of Production	To identify the variations in coconut production and cost of productions	As number of nuts in 2019/2020 and as price of a nut
Utilization of Coconut	To identify the pattern of coconut utilization	Measured as amount of nuts utilized in different coconut products
Subsidy Schemes	To find out government support to the coconut cultivation and the issues	Qualitative data and as the amount of seedlings provided and the cost

Demographic Factors

Variable	Meaning	Measuring
Age	Age of the HH decision maker can impact the coconut cultivation in HG	Age in number of years ; Categorical variable
Education Level	Education level of the HH decision maker influences the coconut cultivation in HG	A categorical variable consists of primary to tertiary education
Employment	Employment of the HH decision maker influences the coconut cultivation in HG	By sector
No. of Family Members in HH	Number of family members in the family influence the coconut cultivation in HG	By number; A categorical variable
Family Income	Income level of the family can impact the coconut cultivation in HG	Cost per month; A categorical variable

Household Requirement of Coconut and Descriptive Data of Coconut Tree Population

Variable	Meaning	Measuring
Coconut Tree Population	To measure the existing tree density	Measured as number of plants in 40 perches
Coconut Production	To measure the current coconut productivity	Measured as number of nuts per tree
Types of Coconut Trees	To measure the composition of types of trees	Measured as a percentage

Descriptive Statistics of Factors Affecting the Production of Coconuts Management Practices in Coconut Cultivation

Variable	Meaning	Measuring
Weeding	To measure the percentage of the farmers who are practicing weeding	A quantitative variable and measured as the number of HH per district
Method of Weeding	To measure the percentage of the farmers who are practicing different types of weeding	A quantitative variable and measured as the number of HH per district
Pest Management	To measure the percentage of the farmers who are practicing pest management	A quantitative variable and measured as the number of HH per district
Moisture Conservation	To measure the percentage of the farmers who are practicing weeding	A quantitative variable and measured as the number of HH per district
Soil Conservation	To measure the percentage of the farmers who are applying fertilizer to their HG	A quantitative variable and measured as the number of HH per district

Social Factors

Variable	Meaning	Measuring
Present Condition of Plant Subsidiaries	To find out the present condition of plant subsidiaries	A qualitative data and measured by Likert Scale
Preferred Variety for Future Cultivation	To identify the farmers preference for future cultivation	A quantitative data and measured as a percentage
Training	Social and the government support on coconut cultivation	Participation for extension services, People who provide extension services, Number of times the extension services is provided, Satisfaction on extension services, Further extension needs

Prediction of Factors that Determine Production of Coconut Dependent Variable – Production of Coconuts

Independent Variable	Model Identification	
	Null	Alternative
District	Non-significant	Significant
Variety	Non-significant	Significant
Irrigation method	Non-significant	Significant
Recommended spacing between plants	Non-significant	Significant
Fertilizer usage	Non-significant	Significant
Type of fertilizer	Non-significant	Significant
Prevalence of insect/ pest attack	Non-significant	Significant
Type of insects/pests	Non-significant	Significant
Weeding	Non-significant	Significant
Weeding method	Non-significant	Significant
Moisture conservation in practice	Non-significant	Significant
Method of moisture conservation	Non-significant	Significant
Age of bearings-group	Non-significant	Significant
Land size-group	Non-significant	Significant
Animal inflicted crop damages have occurred or not	Non-significant	Significant

Industrial Overview

Variable	Meaning	Measuring
Coconut Production, Kernel Products Exports and Domestic Consumption	To find out the current coconut production, export quantities of kernel and domestic consumption	A quantitative data presented as quantity of nuts produced every year
Export Volumes of Different Coconut Kernel Products	To find out the current coconut export volumes of different kernel products to different countries	Quantitative data presented as volume
Coir fibre Products and Export Volumes	To find out the coir fibre products exported and the export volumes	Quantitative data presented as volume
Coconut Shell Products and Export Volumes	To find out the coconut shell products exporting and export volume	Quantitative data presented as volume
Export Volumes of Different Coconut Non-kernel Products by Destination	To find out different export volumes of coconut non-kernel products by destination	Quantitative data presented as volume
SWOT Analysis for the Industry	To find out the SWOT in coconut industry	by SWOT analysis
Main Constraints in the Industry	To find out the main constraints in the coconut based manufacturing industry	Qualitative data; Constraints faced by manufactures in coconut industry.

CHAPTER FOUR

Results and Discussion

Present Situation of the Coconut Production in Sri Lanka

4.1 Introduction

This chapter describes about the existing land use under coconut cultivation, coconut tree distribution in the country, present situation of the production of coconut, cost of production of the coconut in Sri Lanka, institutes in coconut sector and the subsidiary schemes.

4.2 Extent Under Coconut Cultivation in Sri Lanka

The main coconut growing areas are Kurunegala, Gampaha and Puttalam. These areas consist of the 57 percent, from the total coconut land extent. When considering Table 4.1, the land extent has increased to 1993 and in 2002 the cultivated land extent has declined. The total extent under coconut cultivation reported for the country at the Census of Agriculture 2002 was 394,236 hectares (975,640 acres) and the corresponding extent reported at 1982 was 443538 hectares. As such, a drop of about 5 percent in the extent is observed during the 20 years between 1982 – 2002. A significant portion of coconut properties in Sri Lanka (nearly 75%) belong to smallholders and the rest belong to the estate sector where both private and government companies hold ownership. The contribution of the smallholding sector to the total annual coconut production is 70%. Table 4.2 illustrates the distribution of coconut small holdings and estates by district and the king coconut estimated cultivated extent.

Table 4.1: Extent Under Coconut in Sri Lanka

Year	Million Ha	Million Acres
1800	0.057	0.14
1860	0.101	0.25
1893	0.263	0.64
1921	0.332	0.82
1929	0.435	1.07
1946	0.433	1.06
1962	0.466	1.15
1973	0.451	1.11
1981	0.416	1.02
1993	0.442	1.09
2002	0.395	0.98
2003/2014	0.444	1.1

Source: Census of Agriculture, Department of Census & Statistics, (2017)

Table 4.2: Distribution of Coconut Small Holdings and Estates by District and King Coconut Estimated Extent

District	Small Holding Sector			Estate Sector (Acres)	Total Sector (Acres)	King Coconut Estimated Extent (Acres)
	Systematic Cultivation (Acres)	Scattered Extent (Acres)	Total (Acres)			
Ampara	1,105	4,412	5,517	500	6,017	688
Anuradhapura	7,516	19,673	27,189	601	27,790	1,977
Badulla	1,204	3,461	4,665	405	5,070	331
Batticaloa	1,157	6,028	7,185	684	7,869	337
Colombo	4,368	15,843	20,211	1,537	21,748	3,001
Galle	3,141	12,670	15,811	2,309	18,120	2,541
Gampaha	31,267	84,690	115,957	17,595	133,552	4,765
Hambantota	11,905	30,476	42,381	1,888	44,269	1,524
Jaffna	832	7,930	8,762	172	8,934	799
Kalutara	4,675	17,191	21,866	1,266	23,132	2,908
Kandy	2,055	7,714	9,769	1,262	11,031	1,054
Kegalle	8,202	22,367	30,569	1,896	32,465	1,691
Killinochchi	973	1,314	2,287	155	2,442	88
Kurunegala	97,915	231,603	329,518	89,756	419,274	3,670
Mannar	1,482	4,243	5,725	19	5,744	123
Matara	3,399	11,376	14,775	2,757	17,532	2,520
Matale	8,307	20,188	28,495	4,274	32,769	596
Monaragala	7,588	18,089	25,677	632	26,309	796
Mulative	2,280	726	3,006	1,347	4,353	82
Nuwara - Eliya	309	1,023	1,332	14	1,346	68
Polonnaruwa	980	4,038	5,018	2,247	7,265	924
Puttalam	41,293	99,770	141,063	44,991	186,054	1,216
Ratnapura	11,654	29,874	41,528	1,364	42,892	1,781
Trincomalee	849	4,394	5,243	41	5,284	302
Vavuniya	2,712	1,046	3,758	963	4,721	281
Sri Lanka	257,168	660,139	917,307	178,675	1,095,982	34,063

Source: Economic-2013/2014- Agricultural Activities, Dept. of census and Statistics

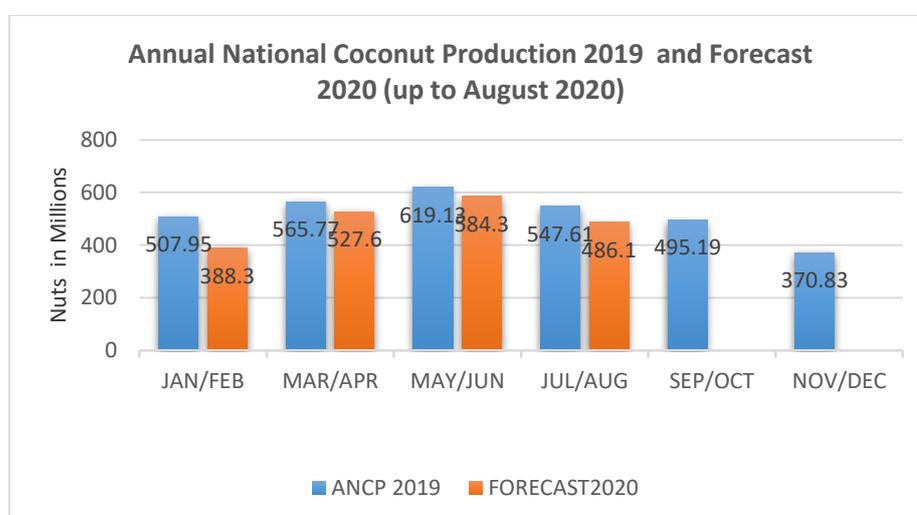
4.3 Extent under Home Gardens

Home gardens in Sri Lanka are active, sustainable food production systems and probably the oldest land use activity, secondary to shifting cultivation. It is one of the major methods of land use in Sri Lanka that has sustained to progress through generations within the Sri Lankan landscape to suit the socio-economic, cultural and ecological needs.

Over the years, the number and total area of home gardens have been increasing annually, the area under home gardens in Sri Lanka has been increased by about 1% (8,000 ha) annually since 1980 to 1992 (FSMP, 1995). Having recognized the importance of home gardens, the national development policy framework of the government of Sri Lanka now includes strategies to expand and improve food and timber productions in such landscapes in the country.

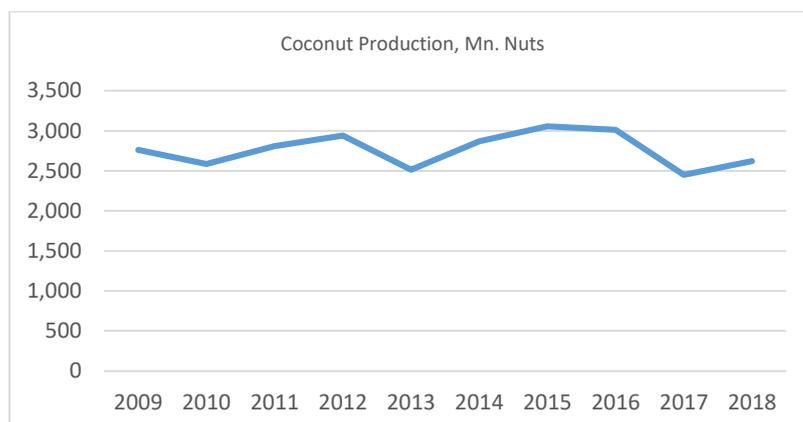
4.4 National Coconut Production and Cost of Production

The total annual coconut production in the country varies on the weather, cultural and management practices. The total coconut production in 2019 was 2240.5 Mn. nuts (CRI, 2019). Figure 4.1 and 4.2 indicate the coconut yield fluctuation during 2009-2018. Retail prices of a coconut are around Rs.90 a nut in 2017 December. There is a yield fluctuation around the year. Figure 4.3 indicates the fluctuation of cost of production, Rs. per nut from 2009-2018. Price of coconut fluctuated within the year, due to varied reasons. The farmgate price of coconut has dropped from a Rs.45/= to Rs. 28/= by August 15 of 2015. The year 2016 and 2017 experienced a drastic increase in coconut price owing to climate change conditions, caused due to changes in monsoon rains. In this period coconut production in the Coconut Triangle dropped to 40-50 percent and the weight of a nut reduced by 30-40%. In the meantime, farmgate price increased to Rs. 55/=.



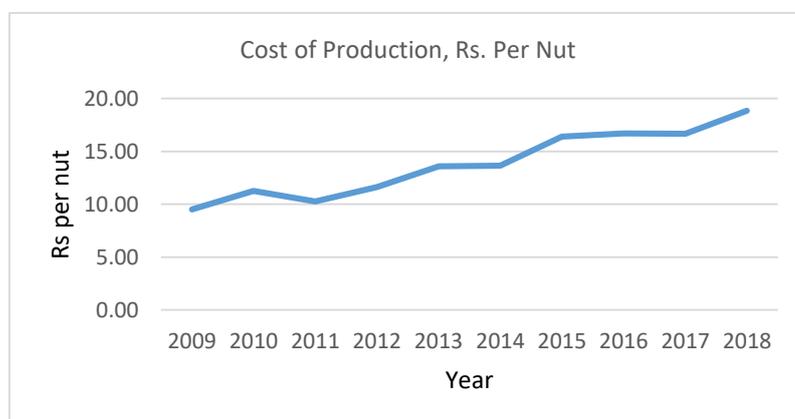
Source: The Coconut Research Institute (CRI), 2019

Figure 4.1: Annual National Coconut Production in 2019 and Forecast 2020 (up to August 2020)



Source: Author's survey data, 2019

Figure 4.2: Coconut Production, Mn. Nuts 2009-2018



Source: Author's survey data, 2019

Figure 4.3: Fluctuation of Cost of Production, Price per Nut from 2009-2018

4.5 Domestic Coconut Consumption

Table 4.4 indicates the coconut utilization pattern in 2017 and 2018. The fresh coconuts are a daily essential. The most important use of coconuts is to extract coconut milk in fresh form and utilize as a basic ingredient in domestic culinary preparations. According to Table 4.4, fresh nuts for local consumption is nearly 2/3 of the total nut production. Coconut oil, extracted from dried kernels, is also an important component in the Sri Lankan cuisine.

Table 4.3: Coconut Utilization Pattern - 2017/2018

Category		2017			2018		
		Qty MT	Nut Eqvt. (Mn. Nuts)	As a % of Total Nut production	Qty MT	Nut Eqvt. (Mn. Nuts)	As a % of Total Nut Production
1	Coconut oil production :	12,784	-	-	10,913	-	-
	Copra	7,700	66.92	2.73	6,678	63.44	2.42
	Pearings	5,084	-	-	4,236	-	-
2	Virgin Coconut Oil	14,243	170.92	6.98	12,377	169.57	6.46
3	Desiccated Coconut Production	29,557	266.01	10.86	24,625	221.63	8.45
4	Copra Exports	501	2.62	0.11	629	3.46	0.13
5	Fresh Nut Exports (Nos.)	10,232,185	10.23	0.42	1,432,640	1.43	0.05
6	Coconut Milk Production	32,867	106.82	4.36	34,925	139.7	5.33
7	Coconut Cream Exports	6,446	58.01	2.37	9,782	88.04	3.36
8	Fresh Nut For Local Consumption	-	1,655.51	67.58	-	1,793.83	68.39
9	Coconut Milk Powder Production	7,793	109.1	4.45	8,669	138.7	5.29
10	Seed Coconut (Nos.)	-	3.39	0.14	-	3.31	0.13
	Total Nut Production	-	2,449.53	100	-	2,623.10	100

Source: Author's survey data, 2019

4.6 Support Available in Coconut Sector of Sri Lanka

- 1) The Coconut Development Authority is a premier government institution involved in the development of this sector in Sri Lanka. They implement capacity building and scaffolding programmes for farmers as well as processors in three areas of farming practices, new product development and market linkages. The Institute also conducts auctions of coconut to enable farmers to fetch a well return on their produce.

- 2) Coconut Cultivation Board is another state body established for developing the coconut plantation in the island by an order published in the Government gazette notification dated 30th March 1972 under the powers vested as per the provisions of clause 01 of the Coconut Development Act No. 46 of 1971.

The functions and responsibilities of the Coconut Cultivation Board in terms of the above notification are as follows:

- Development and assistance in the development of the productivity of lands that are under coconut plantations.
 - Cultivation and assistance in the promotion and regulation in the cultivation of coconut lands.
 - Identification of land in coconut plantation that are suitable for inter-planting with other crops (including pasture) and promotion, direction and assistance in carrying out of intercropping programmes on such lands.
 - Promotion and regulation of assistance and practice of animal husbandry of lands under coconut plantations.
 - Specification, popularization, promotion and direction of proper cultivation practices in respect of the growing of coconuts and other crops in coconut plantations.
 - Providing training, advisory and extension to workers assisting the coconut industry.
- 3) The Coconut Research Institute (CRI) is a national institute founded in 1929 as the Coconut Research Scheme under the Coconut Research Ordinance No. 24 of 1928 to generate knowledge and technology through excellence in research towards increasing productivity and profitability of coconut.
The Institute has a team of scientists, qualified technical staff and resources and modern analytical facilities to support its research development. It promotes collaborative research with other national institutes and private sector organizations.

- 4) The Coconut Growers Association of Sri Lanka (CGASL)
The Coconut Growers Association of Sri Lanka (CGASL) was established in 1994 to promote common interests of all growers in the country. CGASL nurtures and stimulates interaction between growers in the districts, provinces through its regional committees and nationally by an executive committee. CGASL provides a platform to the grower to assist and coordinate with the Coconut Research Institute (CRI), Coconut Cultivation Board (CCB) and Coconut Development Authority (CDA).

The Ministry of Plantation Industry through its institutions, Coconut Research Institute (CRI), Coconut Cultivation Board (CCB) and Coconut Development Authority (CDA) assist the coconut agro industry. Its main task is to coordinate between these

institutions on behalf of the grower to obtain their inputs for the benefit of the CGASL members and thus ensure sustainable farm gate price for coconuts by addressing threats, such as uncontrolled imports of palm oil, other edible oils, and import of coconut kernel. The CGASL and Coconut Research Institute (CRI) have established a strong interactive relationship in meeting challenges of crop protection, transfer of new technology for increasing of productivity of coconut, intercrops, animal husbandry in a farming system. CRI also offers useful information such as crop prediction and management. CGASL & CRI works together in formulating policy for the industry. CGASL through its branch network assists the Coconut Cultivation Board (CCB) in the extension services for suitable agricultural practices and transfer of technology. It also assists in finding subsidies for farmers. The CGASL also makes representation on the Board of Governors of the National Institute of Plantation Management (NIPM) and identifies the need to improve on the quality of human resources which are essential for the wellbeing and growth of the coconut sector (CGASL, 2019).

4.7 Conducted Subsidiary Schemes till 2018

For developing the coconut industry, the government has introduced a series of subsidies from as far back as 1948. The present subsidy scheme commenced in 1957. Though many subsidiary schemes were implemented, the existing CCB scheme include many subsidy programmes covering the entire island. They are coconut rehabilitation (establishment of drainage and contour drains, filling vacancies, removal of excess palms, replacement of unproductive palms), replanting and under planting, new plantings, intercropping coconut with other crops, pasture development and subsidy for small holdings of less than an acre.

Infilling under coconut land rehabilitation programme

Maximum is 24 seedlings / Ac(Acers)and up to 1200 seedlings could be issued per person.

Subsidy program in new planting/replanting/under planting

64 seedlings are offered free of charge for lands from ¼ Ac. to 5 Ac.

Subsidy for hose irrigation

Rs.8000/- Ac is given and the maximum acreage is up to five acres.

Urban home garden programme

Early bearing high yielding seedlings are offered for urban home garden owners. Maximum 02 seedlings per home garden.

"Kaprukai Sipnanai" programme

- Two poly bagged seedlings are offered free of charge to Grade 6 school children.
- Book is provided along with maintenance guidelines for keeping records of growing seedlings.

"Divimagata Kapruka" home garden programme

Either Two coconut seedlings are offered free of charge per home garden or two poly bagged seedlings are offered in Rs.100/- per seedlings.

Subsidy for establishment of cattle/buffalo shed in coconut lands in order to promote organic fertilizer application

Maximum up to Rs. 35,000/- per 2 cattle or buffalos including a shed for calves or three cattle without calf shed.

"Kaprukai parapurai" Programme

Two poly bagged seedlings are offered to women with new born babies in order to make a healthy generation in future.

"Kapruka Ayojana" Credit Programme

Kapruka Ayojana" Credit Scheme is a concessionary financial assistance service conducted by the Coconut Cultivation Board (CCB) in collaboration with Participatory Financial Institutions (Banks) in order to provide investment capital for the development of coconut lands. Through the credit scheme, financial assistance is provided together with technical advisory services to the coconut growers on concessionary terms under 12 development categories. The primary objective of the financial assistance service is to facilitate development of coconut lands as whole farm units where integrated farming systems are encouraged to attain high productivity and production.

The long-term objective of "Kapruka Ayojana" scheme is to promote sustainable coconut based commercial agriculture in coconut lands in line with an enhanced sector contribution to the whole economy. The financial assistance service is conducted and coordinated by the Extension and Development Division of CCB and implemented through 18 regional offices island wide.

- Rs. 125,000/- /Ac. for new planting with intercrops
- Rs. 125,000/- /Ac. for replanting with intercrops
- Rs. 125,000/- /Ac. for rehabilitation of existing coconut land with intercrops
- Rs. 50,000/- /Ac. for rehabilitation of coconut land
- Rs. 25,000/- /Ac. for coconut growing as monocrop
- Rs. 150,000/- Ac. for establishing drip irrigation systems
- Rs. 125,000/- Ac. for establishing nursery to provide planting material for intercropping
- Rs. 50,000/- /Ac. for establishing hose irrigation systems for coconut plantations
- Rs. 150,000/- /Ac. for female cattle or buffalo rearing in adult coconut plantations
- Rs. 150,000/- /Ac. for five female sheep / goats and one male goat in adult coconut plantations.

Subsidy for production of organic fertilizers and application of organic fertilizers

- Rs.100/- promotional allowance/ 30kg of compost production (This is only for members of 'kapruka purawara').
- Rs.100/- promotional allowance/ palm for those who apply organic fertilizers. Maximum is up to 600 palms/person (conditional on the credit limit).

"Kapruka Purawara" Programme

- Subsidy for 'Kapruka purawara' home gardens. Maximum 05 seedlings are offered free of charge.
- Rs. 25,000/- /Ac. for field demonstrations maximum up to three acres
- Fare interest rate loan for coconut cultivation and small scale industries through a revolving fund system.
- Kapruka manpower insurance
- Training necessary for initiation of industries and self-employment is provided free of charge
- Establishing of community based nurseries and purchasing their seedlings
 - Recommended seedlings are provided at subsidized rates
 - Island wide extension service
 - Red weevil / Black beetle pheromone at a subsidized rate
 - Release of predators for mite control at a very low cost
 - King coconut seedlings are offered at subsidiary rates for farmers from ¼ - 5 Ac. to promote king coconut cultivation
 - Technical advice, training and discussions relating to technological know – how from CDO's offices, regional offices and training centers

Table 4.4 indicates the performance of the subsidy schemes in 2018 and Table 4.5 presents the issue of fertilizer and seedlings from 2010-2018.

Table 4.4: Performance of Subsidiary Schemes

No.	Subsidiary Scheme	Unit	Performance	
			Physical	Financial (Rs. Mn)
Seedling Distribution Programme				
1	New/Re/Under planting subsidy	Seedling	1040605	156.29
2	Rehabilitation subsidy (Infilling)	Seedling	198998	26.16
3	Home gardening programme	Seedling	578773	84.59
4	Coconut planting with tea	Seedling	44470	7.17
5	Northern coconut development project	Seedling	50847	4.84
6	Subsidy to promote maintenance of coconut seeding cultivated in previous years	Seedling	379340	4.2
Other Subsidy Details				
7	Coconut land rehabilitation subsidy	Ac	3402	91.47
8	Intercrop subsidy	Ac	2045	18.5
9	Irrigation subsidy	Ac	2135	17.46
10	Cattle shed building subsidy	Sheds	117	3.67
11	Subsidy to distribute predatory mites	Packet	388532	9.71
Total				424.06

Source: Coconut Cultivation Board 2019

Table 4.5: Issue of Fertilizer & Seedlings

Year	Fertilizer Issues (Metric Tons)	Seedlings Issues (In Thousands)
2008	29,131	1,670
2009	25,201	2,415
2010	5,456	2,432
2011	14,316	3,702
2012	Not available	6,882
2013	Not available	5,291
2014	37,266	5,852
2015	56,927	3,789
2016	35,081	2,624
2017	46,065	3,999
2018	52,804	3,435

Sources: Fertilizer issues – National Fertilizer Secretariat

Seedling issues – Coconut Cultivation Board
National Livestock Development Board
Kurunegala Plantations Ltd
Chilaw Plantations Ltd
Coconut Research Institute

CHAPTER FIVE

Results and Discussion

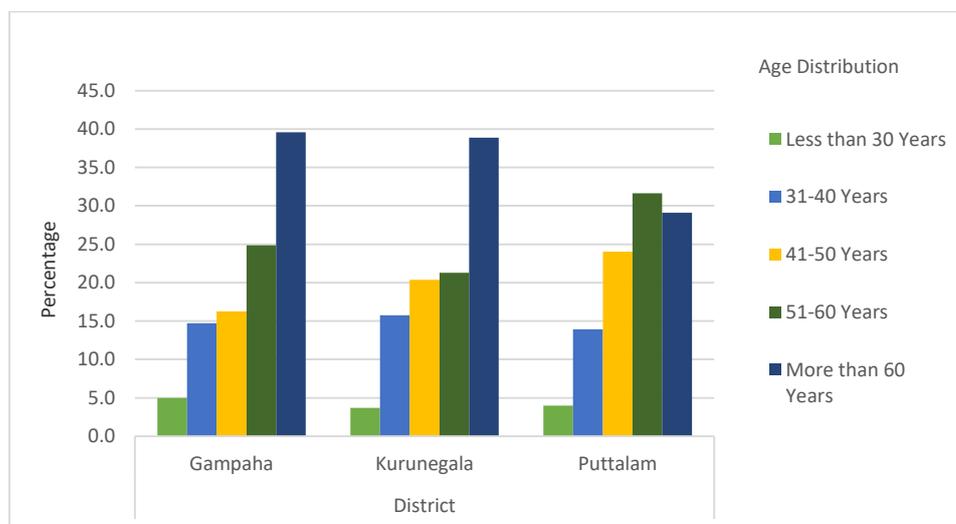
Socio-Demographic Characteristics of the Villagers in the Study Area and the Land Use Pattern of the Area

5.1 Introduction

This chapter presents an overview of the socio-demographic characteristics, economic level of the family members of the villagers in the study area and the land use pattern of the study area. Descriptive statistics is used to illustrate the findings of existing coconut tree distribution, production and productivity at household level in the study area.

5.2 Age Distribution of the Study Area

Age distribution of the population is presented in Figure 5.1 as categorical scale data, which shows that the age group below 30 years in the population is less than 5% in all three districts. Age more than 60 years represents the major part of the population both in Gampaha and Kurunegala districts. Around 40% belong to the age category of over 60 years in each district. The majority belongs to the age category of more than 60 years accounting for 45% of the sample population. According to statistics, the working age population in Sri Lanka, 30- 65 years, consists of about 60% of the population in the country (Central Bank Report, 2019).



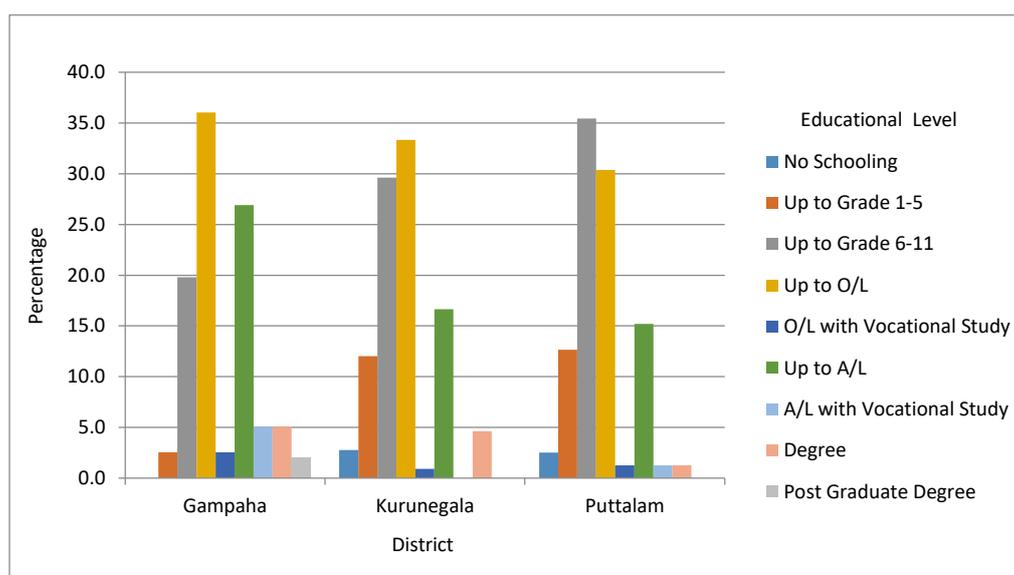
Source: Author's survey data, 2019

Figure 5.1: Age Distribution of the Study Area

5.3 Educational Level of Household Heads in the Sample Area

The survey counted the education distribution of household population. The educational levels of the household heads in the sample area are illustrated in Figure 4.2. A majority has not received a secondary education. In addition, most of them have studied up to O/L.

For instance, Figure 5.2 shows the education level of the selected households. Accordingly, majority in Gampaha (36 percent) and Kurunegala (33%) districts have educated up to O/L whereas in Puttalam it is grade 6 to 11 (35%) and up to O/L is 30 percent. A/L education follows the same pattern highest from Gampaha followed by Kurunegala and Puttalam. These observations are similar to the data in 2019 of the Department of Statistics.



Source: Author's survey data, 2019

Figure 5.2: Educational Status of the Household Heads

5.4 Employment of Household Heads

During the data collection, interviews revealed various activities which the household heads were engaged in. Further, an average of 11% of household heads mentioned that they worked in the government or semi government sector employment while 13.8 % mentioned that they worked in the private sector. Only 9.6% were engaged in self-employment in Gampaha and it was 10.2 and 13.9 in Kurunegala and Puttalam respectively. The government job holder percentage was high in the Gampaha district.

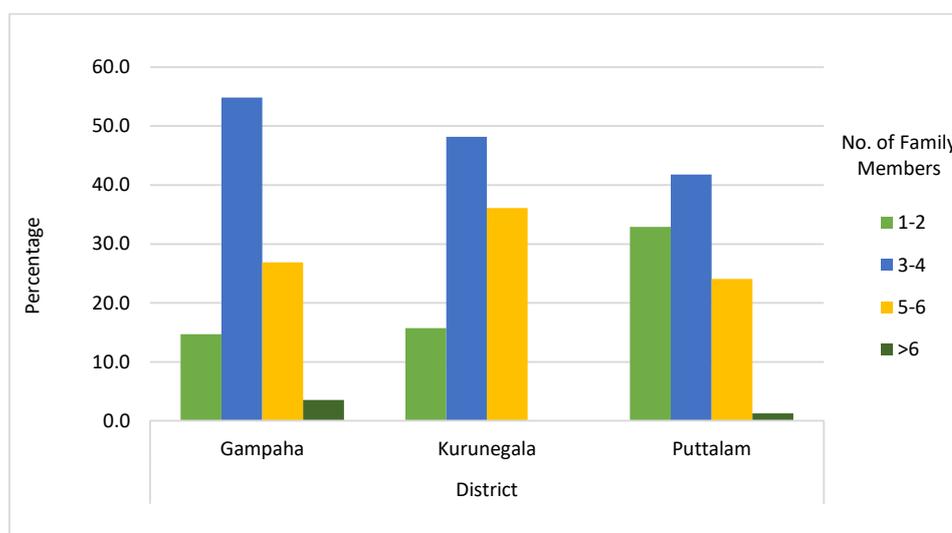
Table 5.1: Distribution of Primary Employment among Household

Employment	Gampaha		Kurunegala		Puttalam	
	Frequency	%	Frequency	%	Frequency	%
Farming	47.6	20.1	20.4	24.9	10.0	15.4
Agricultural Labour	1.2	0.5	0.8	1	0.8	1.3
Non-Agricultural Labour	5.9	2.5	3.4	4.2	6.8	10.5
Government Sector	34.8	14.7	6.0	7.3	6.2	9.6
Private Sector	39.1	16.5	8.8	10.7	6.8	10.5
Self-Employed	22.8	9.6	5.9	7.2	8.3	12.7
Foreign Job	4.0	1.7	0.9	1.1	1.6	2.5
Business	12.1	5.1	1.4	1.7	5.8	8.9
Skilled-Labour	10.9	4.6	10.6	12.9	6.2	9.6
Retired	30.1	12.7	13.0	15.8	4.1	6.3
Non-Employed	28.4	12	10.8	13.2	8.3	12.7

Source: Author's survey data, 2019

5.5 Number of Family Members in the Study Area

Average HH size of the sample is four, which is in accordance with the national statistics in 2018 (Central Bank Report, 2019). According to the survey data, the average number of children per family is two. This figure also agrees with the national statistics in 2018 (Central Bank Report, 2019).



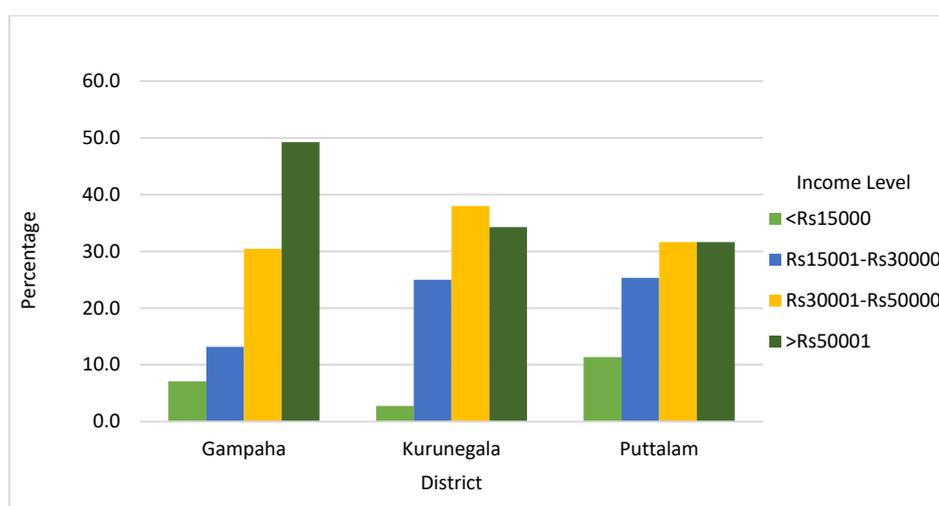
Source: Author's survey data, 2019

Figure 5.3: Number of Family Members in the Study Area

5.6 Monthly Income Level of the Households

Figure 5.4 illustrates the monthly gross income of households in three districts. Accordingly, around 30% of households had received a gross monthly income between Rs. 30,000/= and 50,000/=. Only 7.1 % was recorded with a monthly income fewer than Rs. 15,000/= in Gampaha, 2.8 % from Kurunegala and 11.4 % in Puttalam.

According to the Department of Census and Statistics, the average household income per month was Rs. 62,237/= in 2018 in Sri Lanka. The median household income per month in Sri Lanka was reported as Rs. 43,511/= in 2016. The real mean household income per month has been reported as Rs. 43,320/= based on 2009/10 (adjusted for the inflation of prices using National Consumer Price Index (NCPI)) showing an increase approximately of 15.8 percent from 2012/13 to 2016. The real median household income per month as reported was Rs. 30,285/= in 2016.



Source: Author's survey data, 2019

Figure 5.4: District- wise Variation of Monthly Household Income

5.7 Monthly Supplementary of the Household Coconut Requirement in the Sample Area

The results show that of 423 respondents interviewed, 59% of the families in Gampaha district fulfilled 100% of the household coconut requirement at home itself. Table 5.2 illustrates that 67% of the total population in Kurunegala and 70% from Puttalam also have met 100% household coconut requirement at their own home garden itself. Average monthly per capita coconut consumption was seven. This was established by average monthly per capita consumption quantities of selected food items in the Household Income and Expenditure Survey – 2016. According to the survey data, the median household income per month as reported was Rs. 30,000. They have to spend Rs.2100 to buy coconuts per month, which is a significant amount. It constitutes 7 %

of the monthly income. The Sri Lankan consumers spend 9 percent of their total food budget on fresh coconuts and coconut oil (Central Bank of Sri Lanka, 1997).

Table 5.2: Usage Pattern of Coconut in the Study Area

	Home Garden			Other Cultivation			Market		
	Gampaha	K'gala*	Puttalam	Gampaha	K'gala	Puttalam	Gampaha	K'gala	Puttalam
100%	105	83	55	0	2	0	41	24	5
90%	37	20	11	0	0	0	4	2	2
80%	5	3	0	0	0	0	0	0	0
75%	5	4	1	0	1	0	5	4	5
50%	15	7	5	2	2	0	14	12	5
25%	6	6	5	0	2	0	5	5	1
10%	4	0	1	0	1	0	7	1	1

* K'gala - Kurunegala

Source: Author's survey data, 2019

5.8 Coconut Tree Population

Data was analysed using descriptive methods to obtain information on frequencies, means, and percentages. According to the recommendations of the CRI recommendation, coconut tree density is 64 plants /acre. As per the results of the sample survey, only in 40 percent of the total number of plantations maintained their maximum plant density without a gap to plant a new plant in their home garden. Maximum of 17 plants can be accommodated in a 40 perch land. Sixty percent of the home gardens have a possibility of gap filling, in their home garden (minimum of one coconut tree). Coconut tree density in the home garden directly contributed to the level of HHs coconut consumption pattern. The results, in Table 5.3, indicate that there is no significant difference in all three districts. According to the findings, the average number of coconut trees in a ten perch home garden was one.

In an average family, the major share of its income is spent on purchase of food items. In certain cases, family income has been found to be inadequate. According to the Department of Census and Statistics, the median household income per month in Sri Lanka was reported as Rs. 43,511/= in 2016. Precisely planned home-gardens can provide the family food necessities which would prevent malnutrition. Well-developed home gardens can produce the daily coconut needs of the family.

According to the findings (Table 5.3), the average number of coconut trees in a ten perch home garden was one. Nearly an average of 62 percent of the home gardens (in a ten perch) has room to accommodate at least a one coconut tree.

Table 5.3: Coconut Tree Density in 40 Perch Home Gardens

District	No of trees (Below 40 perch home gardens)			Current average- No of trees in a home garden during the survey (Below ten perch land)	possibility of accommodating a one tree (Below ten perch land)
	Max	Min	Std. Deviation		%
Gampaha	17	0	5.387	1	54
Kurunegala	17	0	4.905	1	62
Puttalam	17	1	4.819	1	71

Source: Author's survey data, 2019

According to the findings (Table 5.3), Promote gap filling in home gardens, by planting coconut in the urban and semi-urban home gardens, depending on the space available. The research has identified (Table 5.3), the possibility of gap filling from one, two and three trees in the space available in the home gardens (Land extent less than 40 perches), in the study area.

Table 5.4: Possibility of Gap Filling in the Home Gardens

(Land extent less than 40 perches)

District	Possibility of gap filling from a one tree	Possibility of gap filling from two trees	Possibility of gap filling from three trees
Gampaha	29%	26 %	4%
Kurunegala	34%	30%	6%
Puttalam	38%	35%	8%

Source: Author's survey data, 2019

5.9 Coconut Production and Productivity in the Study Area (Coconut Nuts/Tree/Year)

Table 5.5: The Current Productivity (Nuts per Tree)

District	Nuts/Tree/Year		
	Max	Min	Std. Deviation
Gampaha	165	0	34.791
Kurunegala	185	0	39.554
Puttalam	193	14	36.02

Source: Author's survey data, 2019

The results of this study show that the maximum tree population was about 17 trees per 40 perch land (Table 5.3), which produces an average of 35 nuts/tree/year. The

average yield is 54.6% of the recommended yield per ha, CRI recommendations as nearly 80-100 nuts/tree/year for tall varieties and 100-120 for DT, CRIC 65 (Results show that the average of nuts produced per year per tree was 35. Low production and productivity of coconut per unit area in the study area could be due to the presence of pests, poor agronomical practices and poor extension.

5.10 Types of Coconut Trees (in percentage) in the Study Areas

Table 5.6: Types of Coconut and Tree Composition (in percentage) in the Study Areas (n=387)

District	Percentage	
	DT	Tall varieties
Gampaha	6.3%	93.7%
Kurunegala	9.3%	90.7%
Puttalam	2.7%	97.3%

Source: Author's survey data, 2019

Table 5.6 indicates the types of coconut palms grown in the study areas. Two varieties of coconut trees were physically observed and identified. DT and tall varieties are mainly cultivated by most of the home gardens. The preference for tall varieties at farm level could be attributed to its long harvesting cycle and resistance to droughts and diseases. Moreover, the result indicated that about 75% of the households preferred DT hybrid variety. Tall varieties were mainly cultivated by most of the coconut farmers (94%) compared to DT because half of tall variety trees are more than 30 years old at that time of survey and availability of the DT seedlings being very low. The preference for DT at farm level could be attributed to its early harvesting time and resistance to droughts and diseases.

CHAPTER SIX

Results and Discussion Factors Affecting Coconut Production in the Area

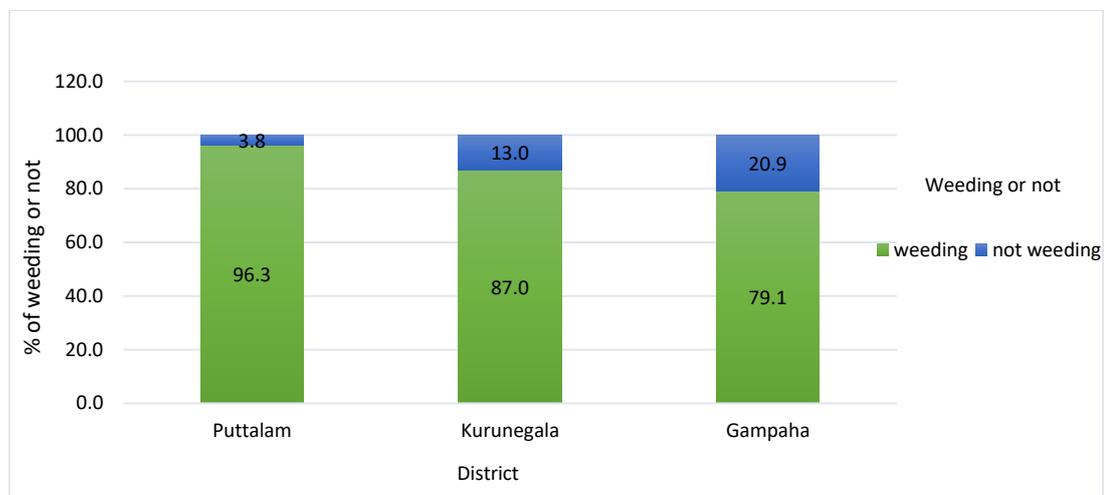
6.1 Introduction

This chapter describes diverse factors that determine production of coconut in the study area. At first, descriptive statistics of each variable will appear and finally multiple logistic regression model will interpret the results of each variable.

6.2 Factors Affecting Coconut Production

6.2.1 Weeding Practices

The results have revealed that 96% of the respondents in the Puttalam district practice weeding and nearly 4 % do not follow it annually as a management practice. Majority of the people in the study area also do weeding as a practice.



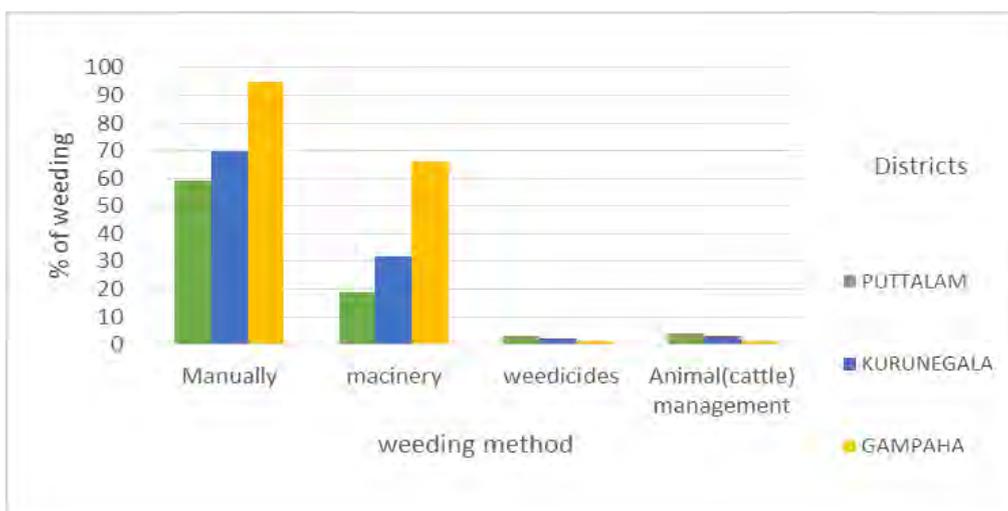
Source: Author's survey data, 2019

Figure 6.1: Weeding Practices by Household Heads (once a year)

6.2.1.1 Weeding Methods Used by Households

The results show that about 95% of the HHs practiced weeding manually in their home gardens in Gampaha. Also, the results indicate that about 45% of farmers have performed weeding twice a year compared to 36% and 33% who have performed once a year and three times a year respectively. According to the Coconut Research Institute, it is recommended to perform weeding twice a year particularly, before and

after the rainy season. Anyhow, very small percentage uses weedicides in every district.

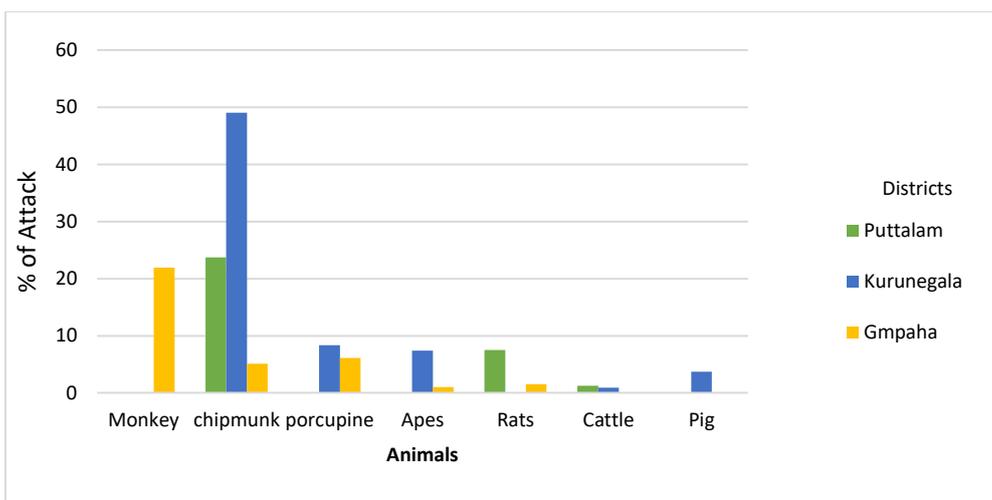


Source: Author's survey data, 2019

Figure 6.2: Weeding Methods Used by Households

6.2.2 Damage Caused by Pests

Figure 6.3 indicates different types of pests that damage coconut trees in the study area. The results show that about 49% and 24% of the HHs in the Kurunegala and Puttalam districts respectively, experiencing the problem of chipmunks in home gardens. About 22% of the HHs in the Gampaha district experience monkey menace.



Source: Author's survey data, 2019

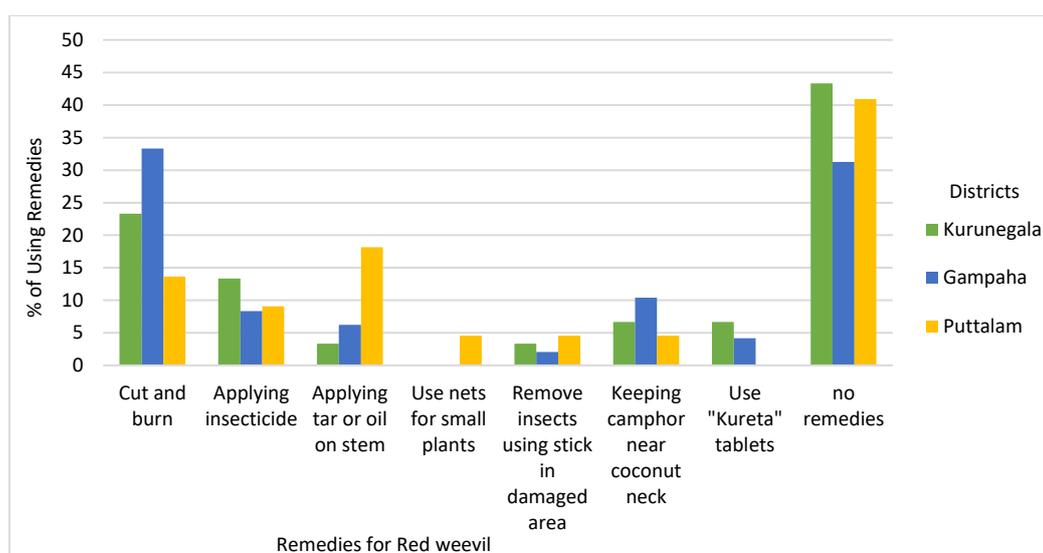
Figure 6.3: Extent of Damage Caused by Pests and Insects

6.2.3 Remedies Used by Households in Pest Management

The study reveals that 30% of HHs in the Gampaha district and more than 40% from Kurunegala and Puttalam districts have not practiced any method for pests management, while 10.7% of the farmers used Spike-thwart traps like Hook-nails, Bike spoke, Wires and Wood stick to control and destroy beetle. HHs in the Kurunegala, Gampaha and Puttalam districts practice removing (cut) and burning trees 23%, 33% and 14% respectively while 18% in Puttalam district applied the tar or oil on stem. It was 3% of HHs in Kurunegala district.

Accordingly, various management practices are used to control coconut pests in the study areas.

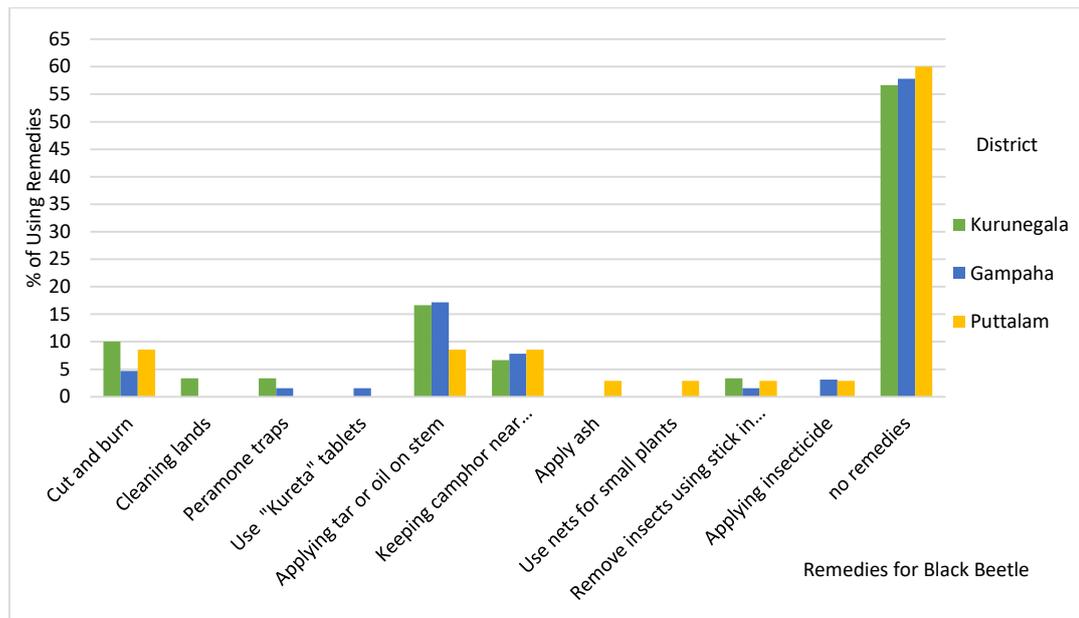
Remedies Used for Red Weevil by Households



Source: Author's survey data, 2019

Figure 6.4: Remedies Used for Red Weevil by Households

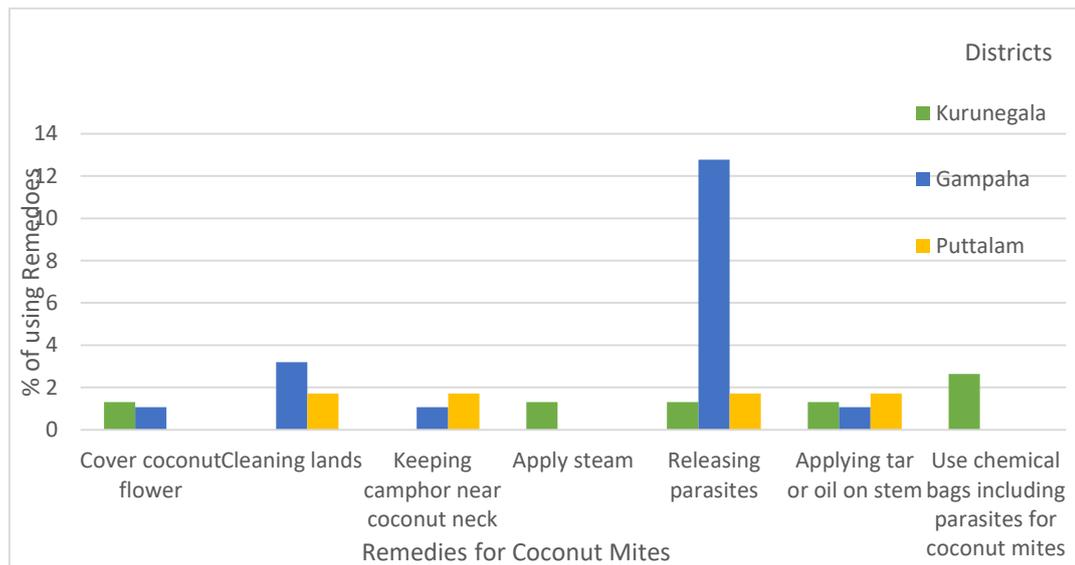
Remedies Used for Black Beetle by Households



Source: Author's survey data, 2019

Figure 6.5: Remedies Used for Black Beetle by Households

Remedies Used for Coconut Mites by Households



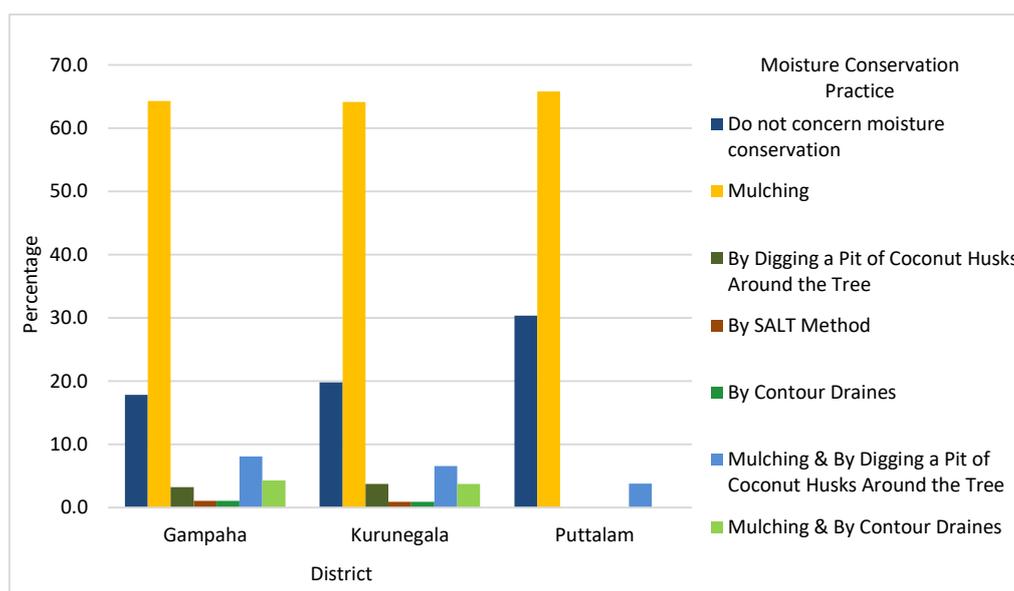
Source: Author's survey data, 2019

Figure 6.6: Remedies Used for Coconut Mites by Households

6.2.4 Soil and Water Conservation

The study reveals that 30% of HHs in the Puttalam district and more than 17% from Kurunegala district and Gampaha district have not practiced any soil and water conservation method. More than 60% of HHs in the study area do mulching as a soil conservation method.

Only 4% of the HHs had adequately provided contour and other drains in the study area. In the study area, soil conservation seems to be satisfactory. Hence the reason may be that most of the coconut holdings draw subsidies for various purposes, and to qualify for these subsidies soil conservation is essential.

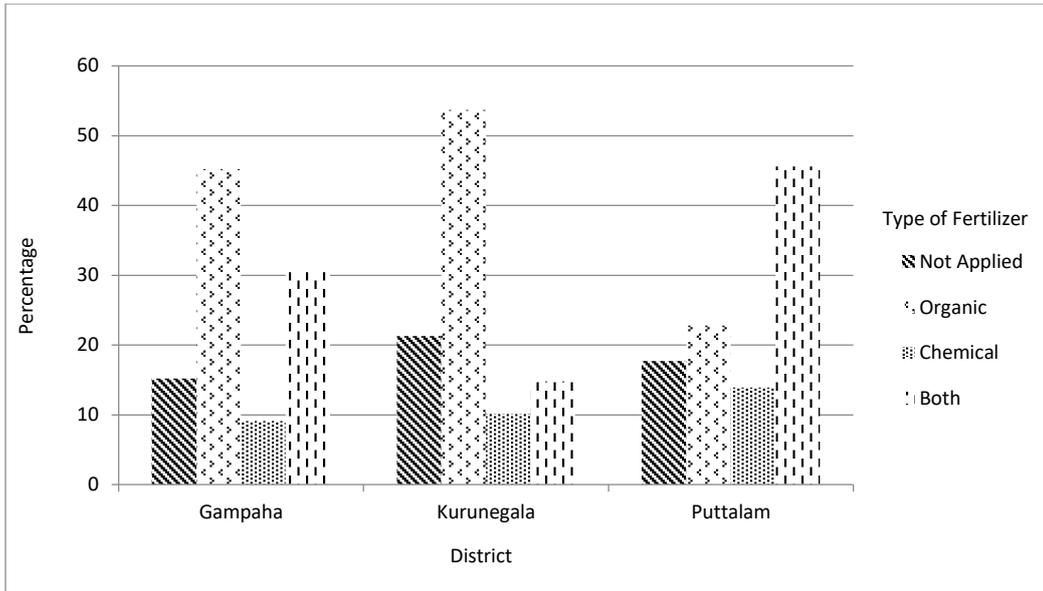


Source: Author's survey data, 2019

Figure 6.7: Soil and Water Conservation Methods used by HHs in the Study Area

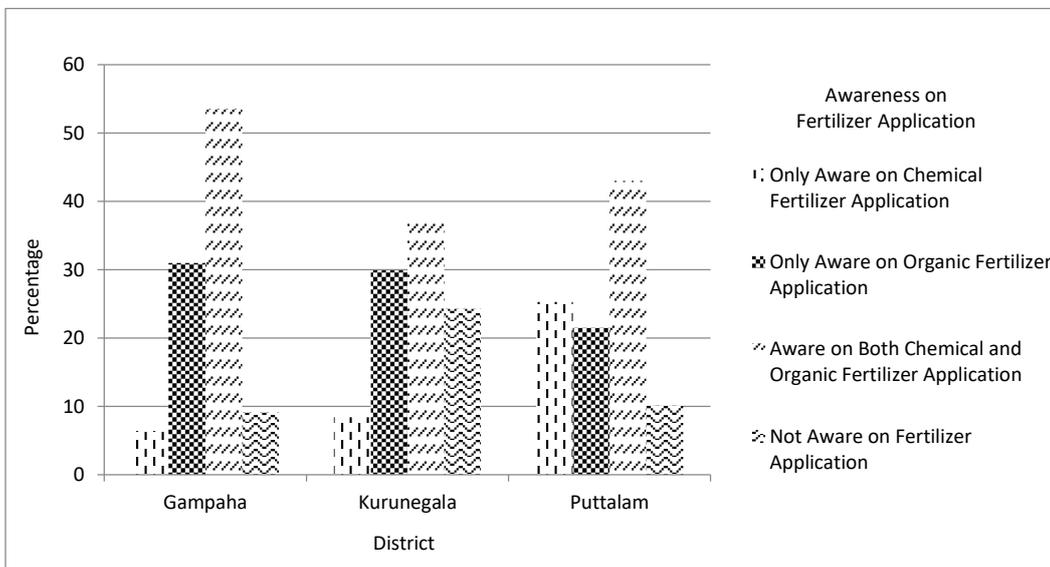
6.2.5 Application of Fertilizers by Households in the Study Areas

According to the results, 30, 23 and 14 households in Gampaha, Kurunegala and Puttalam districts respectively have not applied fertilizers. Further, Figure 6.8 illustrates the application of fertilizers by HHs in the study areas. During the discussion with the farmers it was noted that the limited supply and price of the fertilizers could be a factor for not using fertilizers. Figure 6.9 indicates HH awareness on fertilizer application. It focused only about awareness on fertilizer application and not about application of recommended level.



Source: Author's survey data, 2019

Figure 6.8: Application of Fertilizers by the Households in the Study Area (as per recommendation)



Source: Author's survey data, 2019

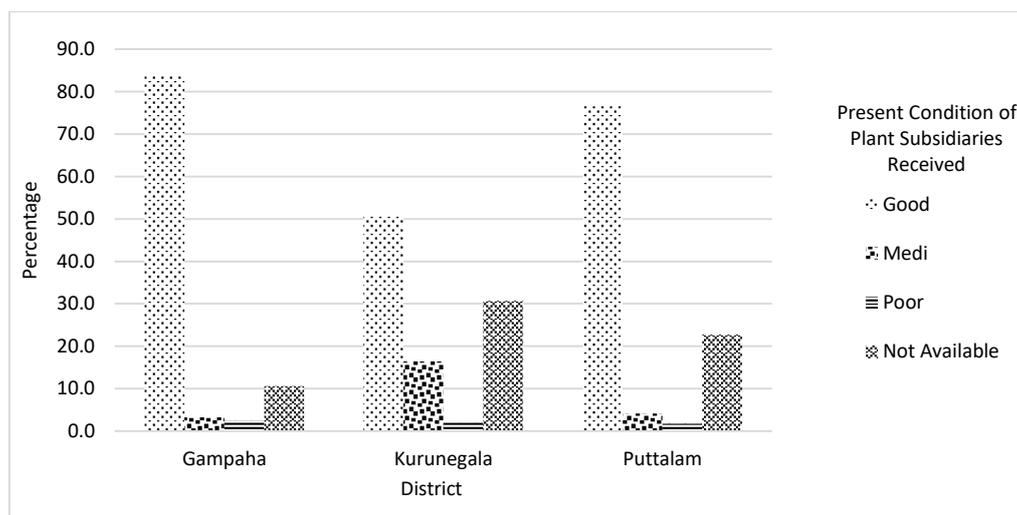
Figure 6.9: Awareness on Fertilizer Application

6.2.6 Coconut Cultivation Extension

6.2.6.1 Present Condition of the Plant Subsidy Received in the Study Area

Figure 6.10 indicates the present condition of the subsidies received by the HHs during the last three years. In the Gampaha district more than 80% was in good condition

while it was 75 % in the Puttalam district and only 50% in the Kurunegala district. The majority of the sample area had received their coconut subsidies from the government subsidy programmes.



Source: Author's survey data, 2019

Figure 6.10: Present Condition of the Plant Subsidiaries Received in the Study Area

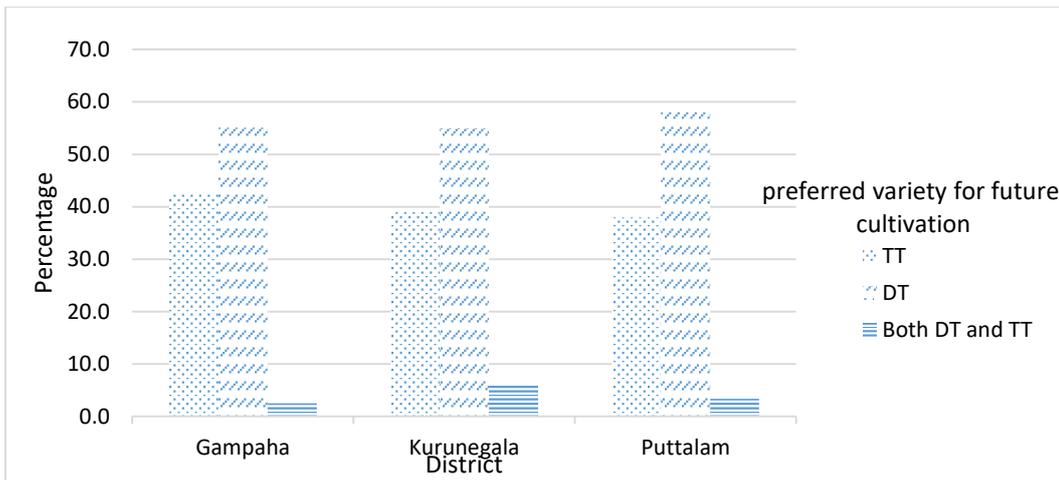
Table 6.1: Way of Obtaining Plants for Further Cultivation by Households

		Means of obtaining plants for further cultivation					Total
		As a subsidy	Buy from outside	From neighbours	Concessionary price	Own plantation	
District	Gampaha	130	4	0	20	3	157
	Kurunegala	71	3	1	17	3	95
	Puttalam	36	4	1	16	1	58
Total		237	11	2	53	7	310

Source: Author's survey data, 2019

6.2.6.2 HHS' Preferred Variety for Future Cultivation

The HHs covered in this study were individually contacted and their observations recorded on each variety with regard to their level of satisfaction and varietal preferences. Accordingly, more than half of HHs preferred D x T hybrids. High yield, early bearing and good nut size were the major reasons for satisfaction with the hybrids. The tall cultivars including T x T were preferred by nearly 40% due to the thick kernel and cream, high yield and long life time of the tree, in all three districts.

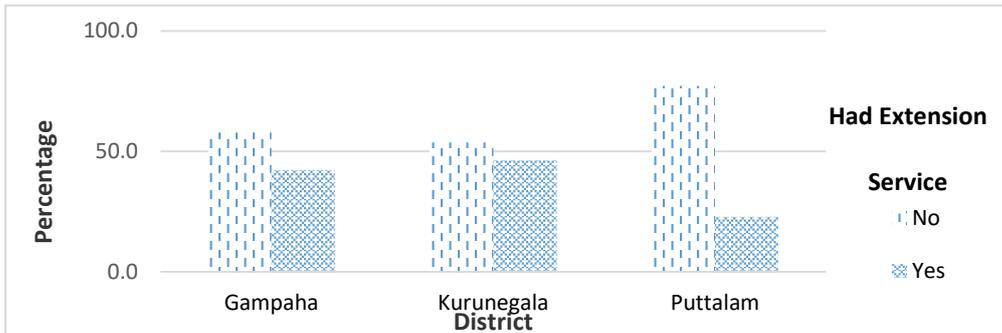


Source: Author's survey data, 2019

Figure 6.11: Preferred Variety for Future Cultivation by Households

6.2.6.3 Training Obtained on Coconut Cultivation

Monitoring and evaluation of the programmes are very important in extension services. Low adoption rates of management practices were the main issues observed during the survey. These practices can be eliminated with proper guidance. More than half the people from each district had not received any extension service granted by the government.

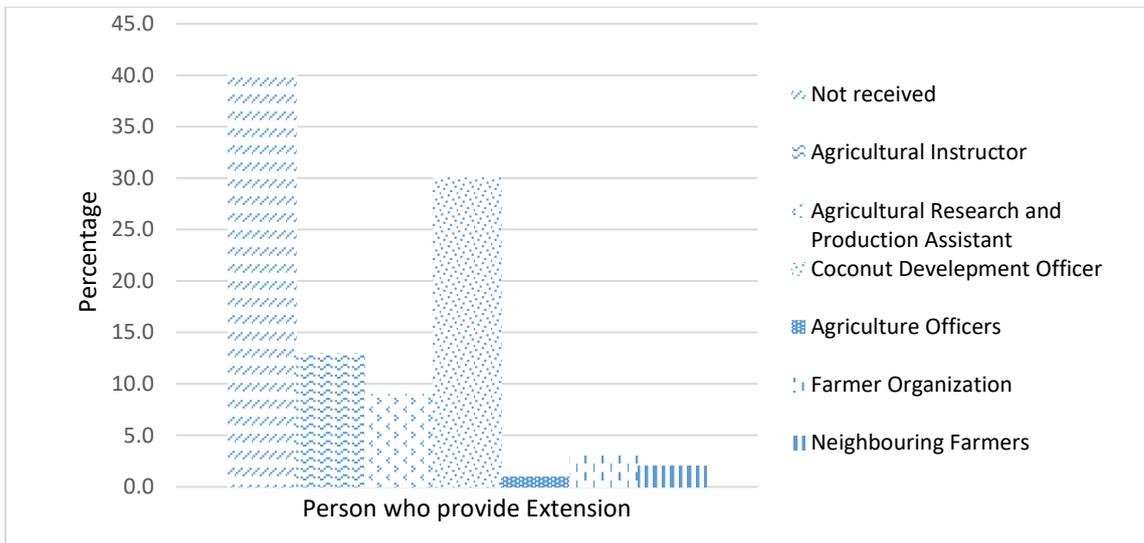


Source: Author's survey data, 2019

Figure 6.12: Extension Services Received in the Last Two Years

6.2.6.4 Government Resource Personnel for Coconut Cultivation

According to the findings, 40% of the respondents mentioned that they did not receive any advisory service from government officials and there was no monitoring and evaluation mechanism for the already implemented coconut home gardening programmes in the study area. According to them, Agriculture Research and Production Assistant was the mostly visited officer in the study area followed by the Coconut Development Officer (CDO) in the area.

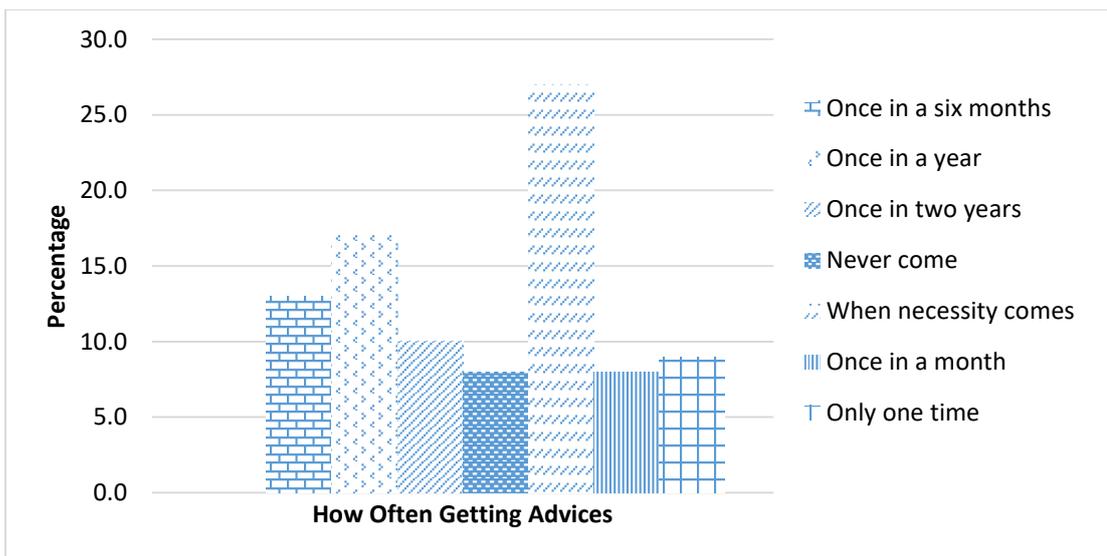


Source: Author's survey data, 2019

Figure 6.13: Source of Information on Coconut Cultivation

6.2.6.5 Frequency of Visits by Government Officers to Home Gardens

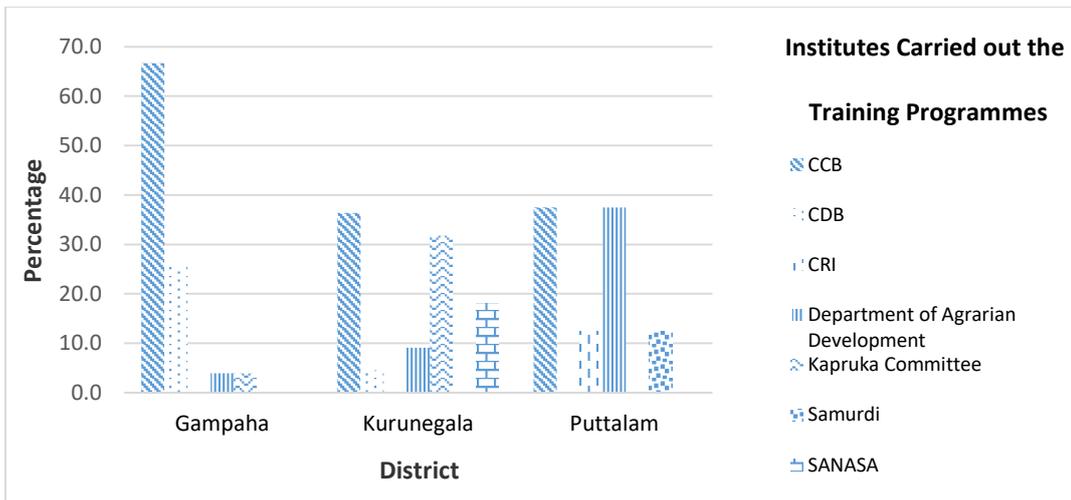
Figure 6.14 presents the frequency of visits by government officers to home gardens during the period of 2015 to 2019 April. According to the results, 45% of the HHs did not have an idea about the extension services and officers visited their residences. Moreover, 27% of the respondents mentioned that it was once in two years.



Source: Author's survey data, 2019

Figure 6.14: Frequency of Visits by Government Officers to Home Gardens

Below Figure 6.15 describes the percentage of training programmes held on each district by different organizations in the study area.

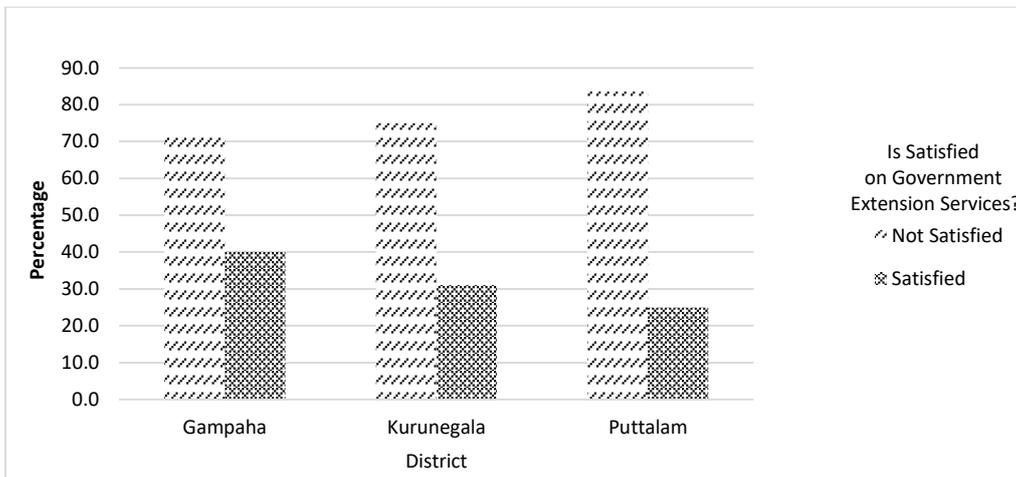


Source: Author's survey data, 2019

Figure 6.15: Institutes that Carried out the Training Programmes

6.2.6.6 Satisfaction on the Extension Services Received

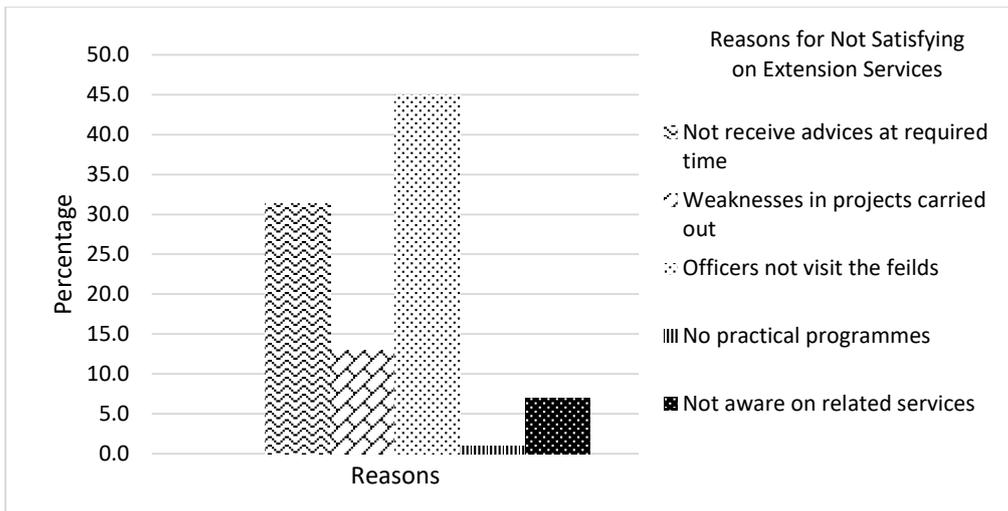
According to the results, 34% of HHs had received any kind of advisory service in 2016 to 2018. However, 51% of HHs had not received any officer encouragement or guidance within the last three years.



Source: Author's survey data, 2019

Figure 6.16: Satisfaction about the Extension Services Received

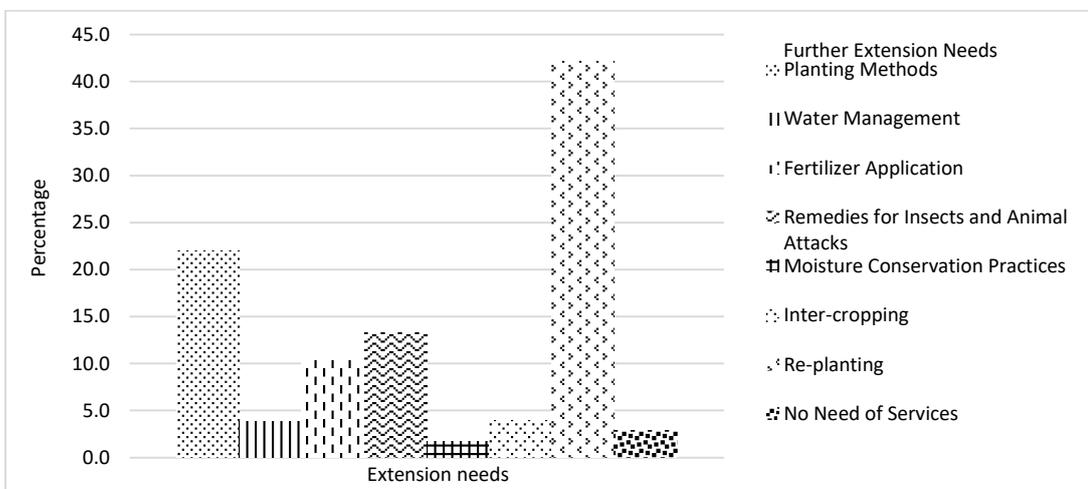
Figure 6.17 describes the percentage of reasons for not being satisfied on extension services by households in the study area.



Source: Author’s survey data, 2019

Figure 6.17: Reasons for Not being – Satisfied on Current Extension Services

Figure 6.18 illustrates further extension needs of the households in the study area.



Source: Author’s survey data, 2019

Figure 6.18: Demand for Further Extension Needs

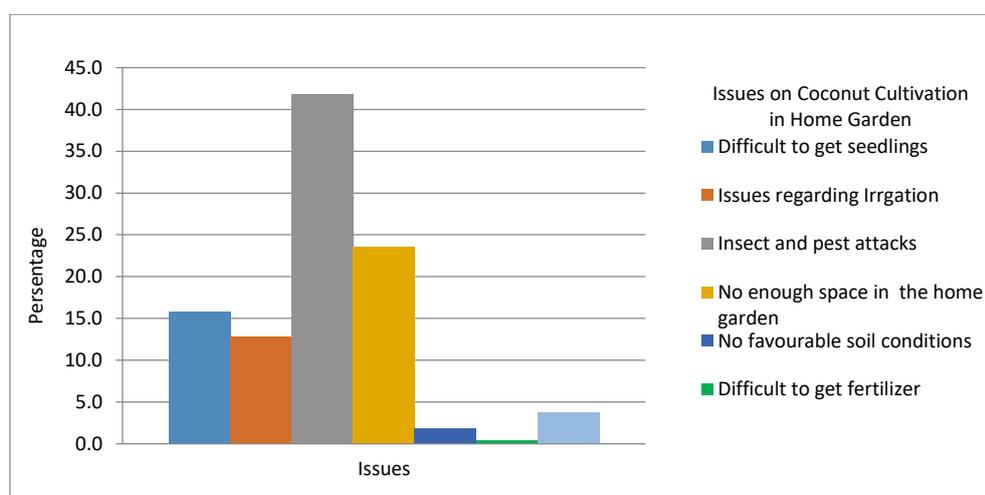
6.2.6.7 Establishment of Community-Based Organizations

‘Kapruka Samithi’ is a major community based Programme implemented by the Ministry of Plantation Industries through the Coconut Cultivation Board. This is a national Programme implemented in several Divisional Secretariat Divisions (DSD) in the country. According to the research findings, more than 70% households had a good impression about this community based organizations (‘Kapruka Samithi’) in the study area. But more than 50% of these organizations were not functioning properly and continually in the study area.

The society will be empowered to initiate many activities such as, promotion of planting, replanting, filling vacancies and starting coconut nurseries using selected mother palms to meet seedling requirements. These societies once established will commence small/medium scale industries to manufacture many products such as coir rope, brooms, charcoal and ornamentals and develop a coconut value chain for local and export markets. Under this programme financial support, subsidies and credit facilities will be provided.

6.2.6.8 Problems Faced by Agricultural Households on Coconut Cultivation

Agricultural households face various problems such as climatic issues, financial issues, absence of good price for final production, lack of storage facilities, limited access to advanced technology and drought was the common problem faced by cultivators during the year 2017.



Source: Author's survey data, 2019

Figure 6.19: Problems Faced by Agricultural Households on Coconut Cultivation

6.3 Prediction of Factors which Determine Coconut Production

For the analysis, 356 out of 384 households that possess home gardens (less than 40 perches) in the study area have been employed in multiple logistic regression analysis and the remainder has been ignored as missing. Here, production was above the average in 196 home gardens while production in the rest of the home gardens was below the average. According to the Omnibus Tests of Model Coefficients (Table 6.4), p-value of the Model row is less than 0.05 which indicates that the model is significant.

Table 6.2: Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	180.412	32	.000
	Block	180.412	32	.000
	Model	180.412	32	.000

Source: Author's survey data, 2019

Further, model fits the data due to the p-value of Hosmer and Lemeshow Test (Table 6.3) which is more than .05. According to the model summary (Table 6.4), Nagelkerke R Square is 0.532. That means that 53.2% where the coconut production is below the average or not can be explained by the predictor variables.

Table 6.3: Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	9.447	8	.306

Source: Author's survey data, 2019

Moreover, total accuracy of the model is good owing to overall percentage of the Classification Table 6.5 is on or above the 80%.

Table 6.4: Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	309.462 ^a	.398	.532

a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

Source: Author's survey data, 2019

Table 6.5: Classification Table

	Observed		Predicted		
			Whether Production is Below the Average or Not		Percentage Correct
			Production is Below the Average	Production is Above the Average	
Step 1	Whether Production is Below the Average or Not	Production is Below the Average	117	43	73.1
		Production is above the average	25	171	87.2
	Overall Percentage				80.9

Source: Author's survey data, 2019

Table 6.6 shows the significant values of each predictor at 95% confidence interval (CI). Here, the significant (sig.) value is the probability value associated with the adjusted odds ratios represented by exp. (B) at 95% CI for each predictor. The lower and upper values are the limits of the 95% CI associated with the adjusted odds ratio. Accordingly, if the significant value of a certain independent variable is on or less than 0.05, that variable can be identified as significant at 95% CI.

Table 6.6: Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1 ^a	Fertilizer Application	2.284	0.554	16.992	1	0.000	9.815	3.313	29.076
	No Pest Attacks	0.873	0.418	4.355	1	0.037	2.394	1.055	5.435
	Effects of Animals	-0.664	0.343	3.743	1	0.050	0.515	0.263	1.009

a Variable(s) entered on step 1: District, Variety, Irrigation Method, Recommended Spacing between Plants, Fertilizer Application, Type of Fertilizer, Pest Attack, Insects Pests, Weeding, Weeding Method, Moisture Conservation, Method of Moisture Conservation, Age of Bearings Group, Land Size Group, Effects of Animals

Source: Author's survey data, 2019

Here, the Figure depicting observed groups and predicted probabilities has been attached in annexure-2. Accordingly, only fertilizer application, pest attack and effects of animals were found to be significant predictors for the production of coconut at 95% CI. None of the other variables considered for the model were significant predictors according to the sample analyzed.

According to the analysis home gardens with fertilizer application were 9.82 (95% CI, 3.31 to 29.08) times more likely to give a coconut production on or above the average than the home gardens without fertilizer.

Moreover, the odds of having a coconut production on or above the average in a home garden was 2.39 (95% CI, 1.06 to 5.44) times greater for home garden which had not had pest attack versus those that were susceptible to pest attack.

Finally, when paying attention to activities of animals, it has been revealed that the home gardens with animal activity are 0.515 (95% CI, 0.263 to 1.009) times less likely to yield production on or above the average than the home gardens that do not experience animal activities. On a similar note, home gardens which were not subject to by animal activity had 1.94 (95% CI, 0.99 to 3.80) times greater possibility of having a coconut production on or above the average than the home gardens that are subject to crop raiding by animals.

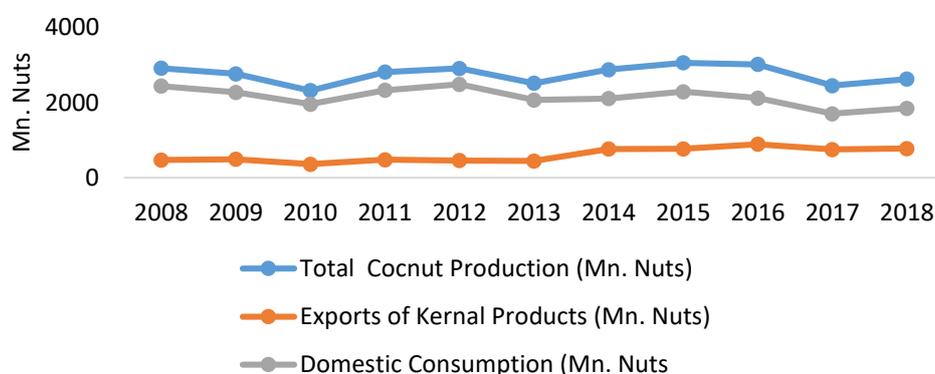
CHAPTER SEVEN

Results and Discussion Coconut Kernel based Industries in Sri Lanka

7.1 Industrial Overview

Sri Lanka's coconut industry is governed by the Coconut Development Act No. 46 of 1971 and monitored by the Coconut Research Board, the Coconut Cultivation Board and the Coconut Development Authority. In addition, the coconut industry is protected by the Plant Protection Ordinance (1981), Plant Protection Act No. 35 (1999) and the Coconut Land Fragmentation Control Act No. 20 (2005) (Jayewardene, 2018).

Sri Lanka is the fifth largest coconut producing country in the world. Currently, country produces 2,500-3,000 million nuts per annum and 30 percent of production is dedicated to the industry. Of industry products 776 million nuts are being exported and another 53 million consumed locally. A wide range of coconut based products are exported annually and earned a revenue of Rs.91 billion in 2017 and Rs.95 billion in 2018 (Coconut Development Authority, 2018). Around 140,000 direct employment opportunities in growing, processing, trading and other activities are associated with the sector (Export Development Board, 2012). Hence, at present, there is an emerging market for coconut based products in both domestic and overseas (Figure 7.1). In 2014, exportation of kernel products has nearly increased by 72% due to sudden demand for organic products triggered by health concerns. Thereafter, a relatively stable foreign market was observed up to end of 2018. The pattern of domestic consumption has paralleled the production throughout the years. The lowest nut production was reported in 2017 due to prolonged drought conditions and it had a negative impact on both local and international markets.



Source: Coconut Development Authority, 2018

Figure 7.1: Coconut Production, Kernel Products Exports and Domestic Consumption

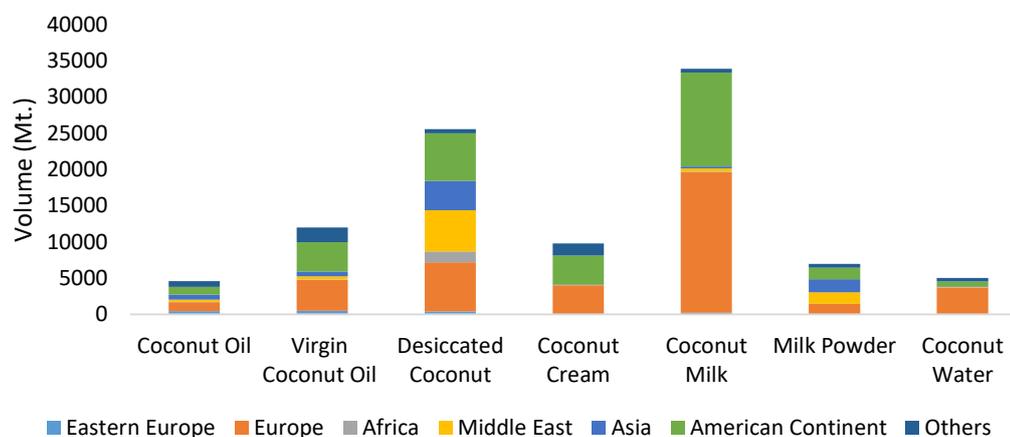
There were 547 registered coconut based product exporters around the country in 2018 and 80 – 85 percent contribution was originated from the Coconut Triangle. Products of these exporters were classified into seven compartments. Currently, there are around 50 mega size coconut based product manufacturers around the country and Silvermill Group of Companies (Giriulla Mills Limited) holds the market leadership in the industry. Mega players approximately consume 100,000 – 150,000 nuts per day (Coconut Development Authority, 2018). Jafferjee Brothers, Hayleys Group, Jacobi Carbons Lanka (Pvt.) Ltd. and Canro exporters are also major players in the industry (Export Development Board, 2012). Further, 17 brokers and 237 coconut estate dealers were registered in 2018 (Ministry of Plantation Industries, 2018). Thus, there is a great demand for industrial purposes. Coconut grown in Sri Lanka has unique characteristics since it delivers thick shell, favorable kernel taste and strong fiber. Therefore, Sri Lanka has a comparative advantage over coconut in the world market. In general, consumption of fresh coconut in household level generates 40 percent wastage and this includes milk, dust, fiber, water and shell. Coconut derived products are exported to more than 90 countries around the globe covering Eastern Europe, Europe, Africa, Middle East, Asia and the American continent.

7.2 Coconut Based Products

Coconut products are broadly categorized into two sections: kernel and non-kernel based products. A total of 37 coconut based products are exported annually and 18 comprise of kernel based products. Sri Lanka was able to earn Rs.47,979 million and Rs.46,744 million by exporting kernel and non-kernel based products respectively in 2018. Coconut oil, virgin coconut oil, desiccated coconut, coconut cream, milk, milk powder, copra, fresh nut and seed nut are considered the most popular products. From 2015 Sri Lanka stepped into foreign markets by exporting virgin coconut oil, coconut cream, milk and milk powder. The current focus of industry is to advance kernel based products furthermore since it has done relatively well during the recent years. Thus, industrial growth could be propelled through giving more emphasis on industries like virgin coconut oil, fresh king coconut, coconut cream and coconut milk.

Products originated through fiber, shell and other parts of the coconut tree are considered as non-kernel coconut based products. Fiber mattress, shell charcoal, activated carbon, coir products and coconut wood are some of the popular non-kernel products. Exponential world market demand is reported for coconut based products with “green” and “sustainability” concepts. Hence, coconut has provided a base for the emergence of diversified industrial activities. Further, a large number of small and medium scale enterprises (e.g. brushes, booms, coir pads, husk chips, coir geo textiles, carpets, mats, and ropes) have emerged using coir fiber and yarn and also coconut ekel as the principal raw material. These industries directly contribute to enhance rural livelihood development. It is apparent therefore, that coconut plays an important role in national industrial growth.

In 2018 out of seven kernel derived export products the highest recorded product (33,878 mt.) was coconut milk (Figure 7.2). More than half of coconut milk was exported to European countries. Further 38 percent was exported to the American Continent. Thus, these markets have a relatively higher demand for coconut milk over the years compared to the other parts of the world. The second highest exports (25,556 mt.) were recorded for desiccated coconut. Half of the desiccated coconut was exported to Europe (27%) and the American Continent (26%). Middle Eastern countries (22%) also indicate similar interest for desiccated coconut. Thus, Sri Lanka has good market prospects for these two products.

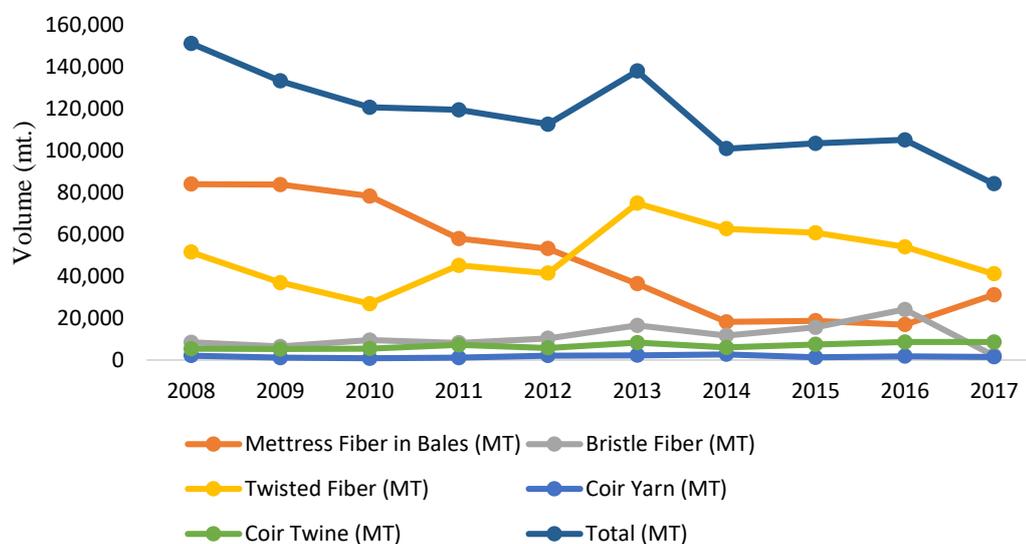


Source: Coconut Development Authority, 2018

Figure 7.2: Export Volumes of Different Coconut Kernel Products by Destination in 2018

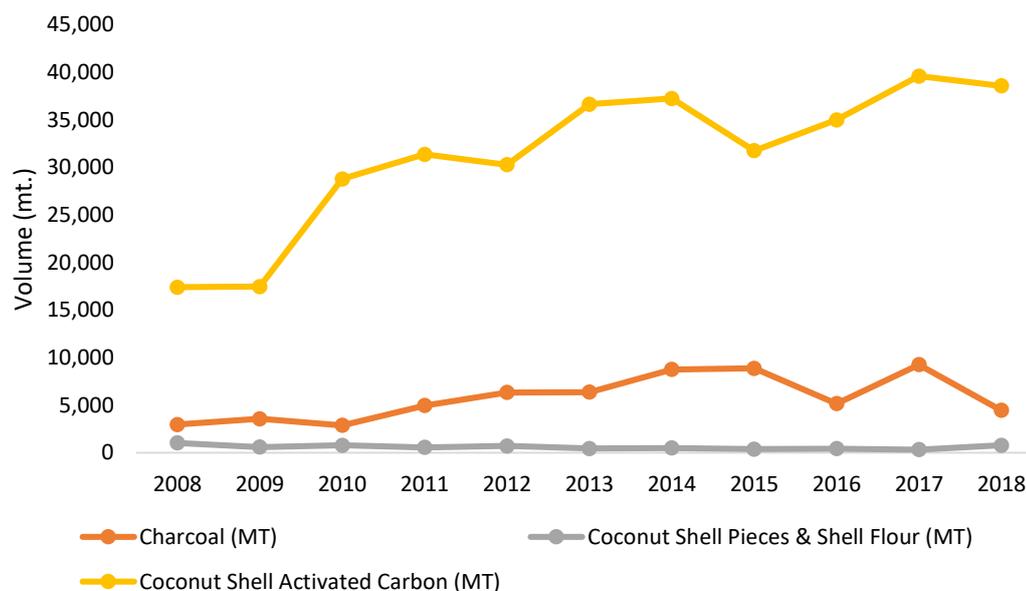
Other than coconut milk and desiccated coconut, another booming industry is the virgin coconut oil. In 2018, 12,006 *metric tonnes* of virgin coconut oil were exported and 70% of it were exported to both Europe and the American continent. The virgin coconut oil industry was rapidly developing, generating a large number of industries in the field of coconut oil manufacturing. A total of 80 institutions were registered in 2016 for virgin coconut oil adding positive prospects to the oil industry in Sri Lanka (Ministry of Plantation Industries, 2018). Apart from virgin coconut oil, new demanding trends were observed in the areas of powdered coconut milk, coconut cream and coconut water over the recent past. Coconut water industry is becoming a very lucrative industry which is capable of earning higher foreign income. However, coconut water is being wasted as an unutilized material in many coconut kernel based industries. Hence, there should be a proper mechanism to capture and use this valuable by product. Fascinatingly, the Europe was the leading customer of coconut oil, virgin coconut oil, desiccated coconut, coconut cream, coconut milk and coconut water in 2018 followed by the American continent. Thus, these two markets have a strong influence on coconut based exports in Sri Lanka. Subsequently, Middle East also has a relatively fair interest on coconut based products.

Most prominent non-kernel products are made out of coir fiber (38%). This is further categorized as finished fiber products (85%) and unfinished fiber products (15%). In 2012 onwards, boom in the demand was noted for twisted fiber and at the same time a downward trend was observed for mattress fiber in bales (Figure 7.3). This was due to increased preference for spring mattresses in the world market. Export market for coir twine and coir yarn illustrated relatively stable patterns in export volumes.



Source: Coconut Development Authority, 2018

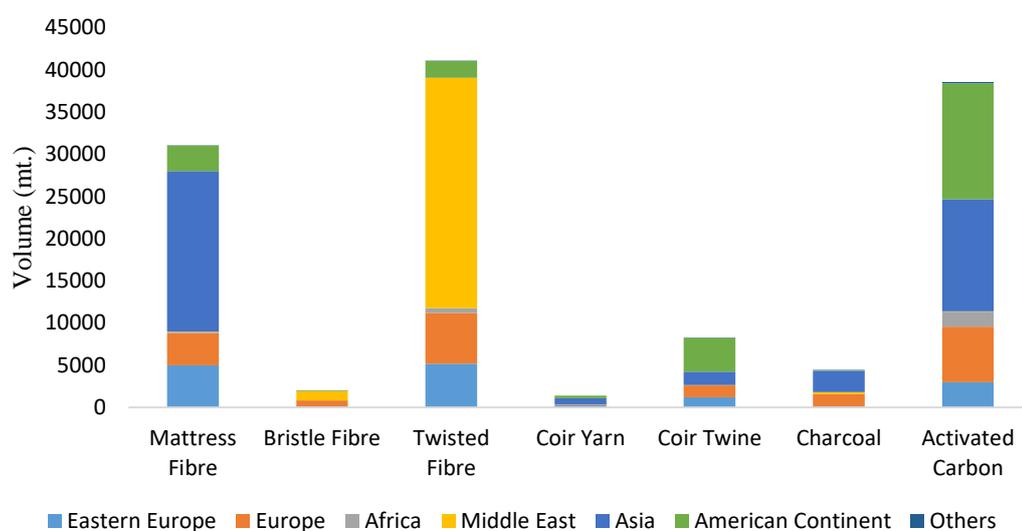
Figure 7.3: Coir Fiber Products and Export Volumes from 2008 – 2018



Source: Coconut Development Authority, 2018

Figure 7.4: Coconut Shell Products and Export Volumes from 2008 – 2018

An increasing trend was observed for coconut shell activated carbon after 2009 due to higher demand in the world market (Figure 7.4). Coconut shell activated carbon offers high surface area, extensive micro-porous structure which makes it an exceptional absorbent of molecules that are more difficult to remove. Furthermore, these coconut shell activated carbons are particularly attractive for water and critical air applications as well as point-of-use water filters and respirators. A very high surface area characterized by a large proportion of micro pores, high hardness with low dust generation, excellent purity, with most products exhibiting not more than 3-5 percent ash content and a renewable and green raw material are some of the unique characteristics of coconut shell activated carbon (Carbon Activated Corporation , 2019). Contribution of coconut shell pieces and dust to the total coconut shell based exports were relatively trivial during the last 10 years of period. However, shell powder has good durability characteristics, high toughness and abrasion resistant properties. Therefore, it is suitable for long standing use. In Asia coconut shell powder is widely used for the manufacture of insect repellent in the form of mosquito coils.



Source: Coconut Development Authority, 2018

Figure 7.5: Export Volumes of Different Coconut Non-kernel Products by Destination in 2018

Twisted fiber, activated carbon and mattress fiber were the most popular non-kernel derived exports in 2018 (Figure 7.5). More than half (67%) of the twisted fiber was exported to the Middle East. Nearly similar proportions of activated carbon have been exported to American continent (36%) and Asia (34%). Further, the highest volumes (61%) of mattress fiber have been exported to Asia. European (12%) and American (10%) contributions were trivial in this case. Half of the coir yarn production was exported to Asia. Further, 23 percent and 21 percent were exported to the Eastern Europe and American continent respectively. Similarly, more than half quantities of charcoal were exported to Asia. Thus, most of the non-kernel products were exported

to the Asian, Middle East and American continents. European contribution was comparatively lesser than that of the kernel based products. Therefore, Sri Lanka has to carefully focus on two different product categories due to the demands of two different markets.

7.3 The Role of Government and Its Contribution

The coconut derived industry in Sri Lanka is highly state facilitated, monitored, evaluated and supported. Over the past years the government has introduced a number of programmes and policy facilitations for the industry to uplift and strengthen the sector. The coconut industry falls under the purview of the Ministry of Plantation Industries and Export Agriculture. Three bodies namely: Coconut Cultivation Board, Coconut Research Institute and Coconut Development Authority, function under the Ministry for the development of the industry. These three institutes are established to achieve three different goals. However, concurrent work flow is must to develop the coconut industry in Sri Lanka.

The Coconut Cultivation Board mainly focuses on the coconut cultivation process by providing required inputs such as credit facilities and vital inputs such as seeds and fertilizer. In other words, the development of coconut growing industry through programmes is aimed at increasing coconut production and productivity by popularizing modern input utilization and replacement of old palms, maximizing economic utilization of lands cultivated with coconuts, training of cultivators, extension and demonstration. It delivers different credit facilities for establishing new plantations, intercropping, replanting, rehabilitation of coconut lands, deployment of irrigation schemes, establishment of coconut nurseries and integrated coconut plantation management. The role of the Coconut Research Institute is scientific research in respect of the growth and cultivation of coconut palms, prevention and cure of diseases and pest, experimentations on associated crops and animal husbandry in coconut plantations (De Silva, 1979). The Coconut Development Authority is the main responsible entity for coordinating and centralization of the functional boards. It intends to facilitate exporters of coconut based products to enable them to establish contacts with overseas networks of buyers (Coconut Development Authority, 2020).

In addition, quality assurance of coconut based products is also executed under the supervision of the Coconut Development Board. Quality is assured by accrediting Quality Assurance Methodology on ISO 22000:2005 Food Safety for the coconut kernel based products (except industries manufacturing traditional coconut oil, copra and coconut shell based products) (Coconut Development Authority, 2016). Thus, issuance of microbiological and physical quality assurance certificate for coconut products are also carried out. Also, non-kernel based products are assured by making International Quality Certificates such as Good Manufacturing Practices Quality System. Apart from quality assurance, provision of credit and subsidies are common.

Recently, two new industrial credit schemes: “Kapruka Nipayum Diriya” implemented by the Peoples’ Bank and “Kapruka Jaya Isura” by Divisional Development Banks were also introduced to the sector. Training programmes, especially for non-kernel derived products (shell based ornamental products, ekel brooms, door mat, coir yarn and brushes) were also conducted to disseminate state-of-the-art knowledge. Furthermore, equipment was distributed to the trainees to carry out the industry unabated. Newly established industries are located in the areas of Nuwara Eliya, Polonnaruwa, Kandy, Jaffna, Monaragala and Kurunegala (Coconut Development Authority, 2016).

7.4 SWOT Analysis for the Industry

Analysis of Strengths, Weaknesses, Opportunities and Threats are vital for any industry in order to understand its capabilities and potentials.

7.4.1 Strengths

- i. World’s fifth coconut producing country with annual nut production of roughly around 2,500-3,000 million nuts and having a total of 1,095,982 acres.
- ii. Ideal agro-ecological and environmental condition to cultivate coconut (maximum ambient temperature and relative humidity in the afternoon are the most significant variables in nut production) (Pathiraja, et al., 2015).
- iii. Continuous government support to the industry (i.e. range of credit facilities, different subsidies for various inputs, provision of technical know-how and facilitation of industrial oriented training, regulation and maintenance of quality, policy support and auctions).
- iv. Good source of foreign exchange (95 billion) and income generation (140,000 direct employments in growing, processing, trading and other activities are associated with the sector).
- v. Well-established foreign markets (Europe, America, Asia, Middle East, Africa and Oceanic). Exports are spread over 90 countries.

7.4.2 Weaknesses

- i. Low nut productivity compared to other countries in the region (Other countries claim to collect more than 12,000 nuts per hectare whereas the figure is mere 7,000 in Sri Lanka).
- ii. Lack of adopting standard plantation management practices.
- iii. Increase of cost of production and relatively unstable farm gate prices.
- iv. Unsystematic planning of nut distribution among household consumption (70%) and industry (30%) leads to market instability (recent incident compelled the government to permit the import of frozen coconut kernel to mitigate the rising price for the edible coconut in 2017/18 period). Not understanding the changing utilization pattern of coconut.

- v. Wastage up to 40 percent in household fresh coconut consumption which is not converted into the industry.
- vi. Quality standards cover only limited coconut based product range (industries manufacturing traditional coconut oil, copra and coconut shell based products are not covered under the standards).
- vii. Raw fiber industry is not up to the international standard in primary level.

7.4.3 Opportunities

- i. The demand for coconut and its value-added products keeps increasing exponentially with the growing acceptance of coconut water, virgin coconut oil and coconut butter as health supplements.
- ii. Possibility of expanding new market opportunities for non-kernel based products in Europe and America.
- iii. Possibilities of expanding new market opportunities for kernel based products in Asia, Middle East and Africa.
- iv. Opportunities for new value added products in international markets (i.e. Nata-de-coco, coconut chips, coconut squash and other confectionary).
- v. Potential land for coconut cultivation in Southern and Eastern regions of Sri Lanka.
- vi. Partnership prospects with regional countries to seek new processing techniques for virgin coconut oil, desiccated coconut, coconut milk/cream and packed tender coconut. (i.e. India)

7.4.4 Threats

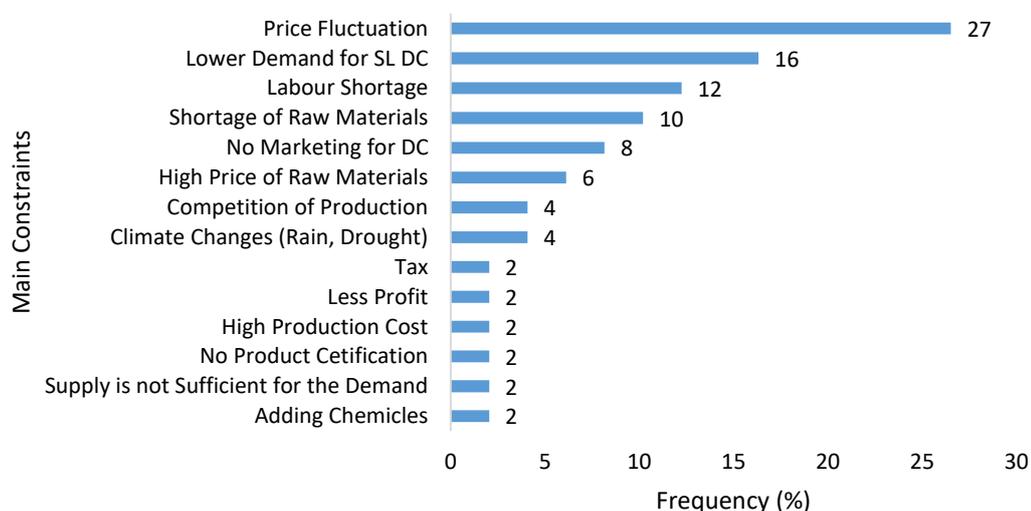
- i. Experiencing rapidly changing climatic conditions in Sri Lanka. Sri Lanka is a South Asian tropical island and there is evidence that its climate has changed. An annual temperature increase of 0.016^oC was observed during the period 1960 to 1990 across the country as a whole. The day time maximum and night time minimum mean air temperatures have increased by 0.021^oC and 0.02^oC per year respectively (Pathiraja, et al., 2015). Coconut is a perennial crop and perennial cropping systems are thought to be more vulnerable to climate change because they are long established.
- ii. Effect of substitutes (Palm oil and its derivate are considered strong substitutes. Soya bean oil, sunflower oil, rapeseed oil, tallow and groundnut oil are also considered substitutes for coconut oil).
- iii. Prevalence of strong competitors within the industry (i.e. Indonesia, the Philippines, India and Brazil).
- iv. Land fragmentation and clearance cause dwindling of coconut plantation extent.
- v. Issues in meeting the international standards for some coconut based products. This is prominent in the non-kernel based product categories.
- vi. Regular pest and diseases attacks damage coconut plantations causing slow industrial growth.

Based on above criteria, following results were obtained from the survey

7.5. Main Constraints in the Industry

A leading constraint (27%) of the coconut based product manufacturing industry is the prevalence of relatively unstable market conditions (Figure 7.6). As a result, both producers and manufacturers suffer heavily. Thus, this has a direct impact on the market share in both local as well as international level.

The second issue is the lower demand for local desiccated (16%) industry due to poor quality products. Manufacturers highlighted upgrade of mills as a preventive measure. The third one is the labour shortage (12%) for processing and other activities. Labour shortage is a common issue in other sectors as well. This is prominent in the agriculture and plantation sectors. Both production and manufacturing processes are affected and ultimately would lead to increased cost of production. As highlighted earlier, limited supply and unplanned allocation of raw materials are also a constraint in the industry. This results over supply and shortage situations creating unpredictable market prospects. This is an adverse condition for the industry. This dilutes commercial level planning process creating major lapses in the industry.



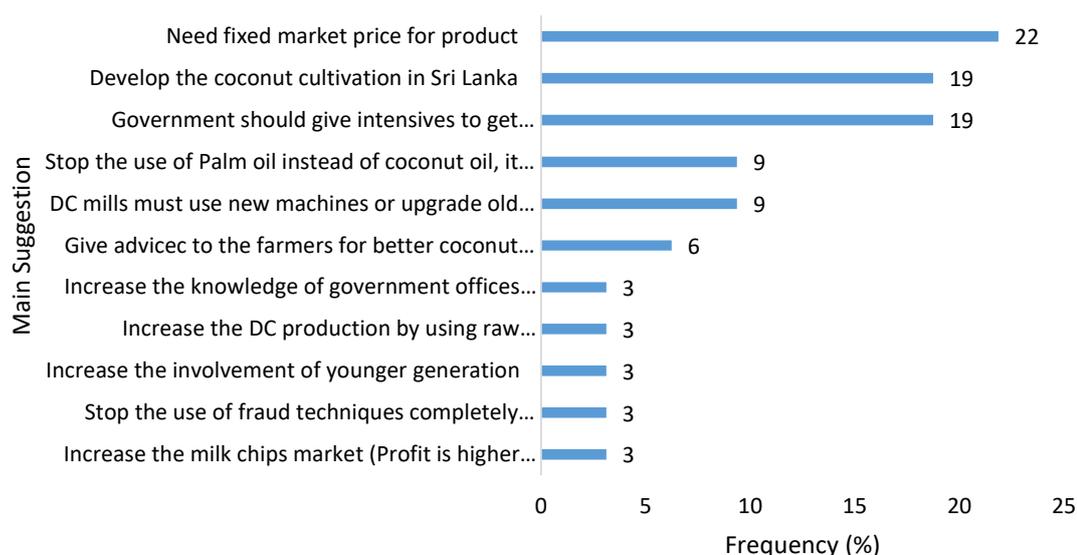
Source: Author's survey data, 2019

Figure 7.6: Main Constraints in the Coconut based Manufacturing Industry

Low market shares for desiccated coconut (8%) are another issue highlighted by the manufacturers. Heavy market competition (4%) and climatic change (4%) are also identified issues in the sector. In addition, ad-hoc tax changes, low profit margins, higher production cost, inability of applying for higher standard certification process, adulterations and use of chemicals are also mentioned as major constraints.

7.6 Main Suggestions to Improve the Industry

The study revealed that, coconut based production industry requires a stable price (22%) for its outputs (Figure 7.7). Stable market could create promising prospects within the industry. Hence, coconut based production industry is an ideal industry for the rural development through encouragement of small and medium scale enterprises around the country. However, in order to expand industrial prospects, it is essential to increase the production and productivity (19%) simultaneously in plantations. The study also highlighted that productivity of coconut production is much lower in Sri Lanka compared to other Asian countries. Adoption of good management practices are required to overcome this issue. Similarly, manufacturers highlighted the need of modern technological know-how (19%) in the processing sector in order to maintain high standards. This is a vital aspect when meeting international market requirements. At the same time, increased productivity requires increased product manufacturing to retain market stability.



Source: Author's survey data, 2019

Figure 7.7: Main Suggestions of Coconut based Product Manufactures

It has also been suggested to restrict the importation of palm oil (9%). However, it is important to understand that, a total ban on palm oil is not plausible. Thus, there should be a proper mechanism and policy procedures related to importation of palm oil. Similar, frequency was placed on upgrading of desiccated coconut mills (9%). It is highlighted that, these mills require new machinery to increase production efficiency. Also, upgrading of old mills would be definitely worthy with increased market prospects. Next, the need to increase small scale production and coconut home gardening (6%) has also been highlighted. This could possibly overcome issues related to household consumption. Increasing the knowledge of government officers and farmers on coconut related industries, regular inspection on production process and focusing on coconut milk chip industry are also other suggestions made by manufacturers.

CHAPTER EIGHT

CONCLUSION AND RECOMMENDATIONS

8.1 Conclusions

This study was conducted in 384 households with home gardens in the land extent less than 40 perches and 50 coconut kernel based industries in the Gampaha, Kurunegala and Puttalam districts in Sri Lanka registered under the Coconut Development Authority.

The total annual coconut production in the country varies from 2300 to 3200 million nuts, depending on the effect of weather, cultural and management practices. The price of coconut was fluctuating heavily over a year due to supply variation.

Fresh nuts usage for local consumption is nearly 2/3 of the total national nut production. Two varieties of coconut trees were observed and identified. DT hybrid and tall varieties were mainly cultivated in most of the home gardens. The preference for tall varieties at farm level could be attributed to its long harvesting cycle and resistance to droughts and diseases. Moreover, the results indicated that about 75% of the households preferred to cultivate the DT hybrid variety. The preference for DT at HH level could be attributed to its early flowering, ability to plant near the house due to its shortness and resistance to droughts and diseases. Tall varieties were mainly cultivated by most of the home gardens (94%) compared to DT. Around 55% of tall variety trees are more than 30 years old. During the data collection period availability of the DT seedlings was found out to be very low.

The average annual per capita consumption of coconuts in Sri Lanka is about 110 nuts and it is considerably a higher number of nuts than any other coconut producing country in the world. According to the field survey data, two coconut trees (with the yield of nearly 100 -120/nuts/tree/year from DT hybrid variety) are adequate to fulfil the household coconut requirement of a four-member family by using blender or stone grinder to extract coconut milk.

Our survey study observed that average HH size is four in the study area and the annual household coconut requirement was observed as nearly 360 nuts. According to the coconut research institute data, 30% - 40% from the domestic requirement was waste due to the traditional method of extracting coconut milk. This amount can be minimized by using blender or stone grinder to extract coconut milk. This household fresh coconut wastage 40 percent, can use for industrial purposes.

According to the survey data, the median household income per month as reported was Rs. 30,000. They spend Rs.2100 to buy coconuts monthly, which is a considerable cost, which is 7 % of the monthly income. The Sri Lankan consumers spend 9 percent of their total food budget on fresh coconuts and coconut oil.

Coconut tree density in the home garden directly contributed to the level of HHs coconut consumption pattern. The results indicated that there is no significant difference in all three districts. According to the findings, the average number of coconut trees in a ten perch home garden was one. Nearly 62 percent of the home gardens (in a ten perch) have a possibility of gap filling, with one more coconut tree.

The results of this study show that the maximum tree population was about 17 trees per 40 perch land, which produces average of 35 nuts/tree/year. The recommended yield CRI recommendations as nearly 80 - 100 nuts/tree/year from tall varieties or 100 - 120 nuts/tree/year from DT hybrid varieties. But the low production and productivity of coconut per unit area in the study area due to the presence of pests, poor agronomical practices and poor extension services.

Our results show that 49% and 24% of the HH in Kurunegala and Puttalam respectively, experienced the problem of chipmunks in their home gardens. About 22% of the household in Gampaha are affected by monkey menace. The study reveals that 30% HHs in Gampaha and more than 40% from Kurunegala and Puttalam did not practice any method for pests management, while 10.7% of the farmers used spike-thwart trappings like hook-nails, bike spoke, wires and wood stick to control and destroy beetle pests. HHs in Kurunegala, Gampaha and Puttalam practiced remove (cut) and burn trees at 23%, 33% and 14% respectively, 18% in Puttalam applied tar or oil on stem, while it was 3% of HHs from Kurunegala.

According to the analysis, fertilizer application, pest attack and effects of animals were found to be significant predictors for the production of coconut nuts. According to the analysis, home gardens with fertilizer application were 9.82 times more likely to produce a harvest on or above the average than those without fertilizer.

Similarly, the study reveals that 30% of household in Puttalam and more than 17% from Kurunegala and Gampaha did not practice any soil and water conservation method. More than 60% of HH in the study area practice mulching as a soil moisture conservation method.

According to the findings, 40% of the respondents mentioned that there is no monitoring or evaluation programme in the study area for home gardens. According to them, Agriculture Research and Production Assistant was the mostly visited officer in the study area followed by the Coconut Development Officer in the area. Hence, the most demanded training requirement was for replanting and planting methods by HHs.

Based on these findings, we conclude that the density of coconut tree per hectare in the study area, which is low by 60.8% of the recommended population density. Furthermore, quantities of the nuts produced per hectare are very few by 54% compared to the recommended yield. Therefore, it is important to encourage farmers

through training on various agronomical practices so as to produce the recommended rate/hectare. On the other hand, it was noted that the production factors such as fertilizers observed not to be used by majority farmers (96%) and extension service is poor in the coconut growing areas. Moreover, farmers were unable to process different byproducts.

Considering the coconut kernel based industries and based on the SWOT Analysis for the Industry, Sri Lanka has reached a transitional stage where it has to cater to huge demand for both processed products and fresh nuts in the international market. As per the existing demand for nuts in the country, the coconut industry in Sri Lanka requires around 3,600 million nuts for smooth operation. The current level of nut production is only between 2,300 and 3,200 million. Therefore, it is necessary to develop a strategic plan to increase the national nut production while minimizing wastage in local coconut consumption.

Considering the kernel based industries, the main constraint (27%) of the coconut based product manufacturing industry is prevalence of relatively unstable market conditions. The second issue was the lower demand for local desiccated (16%) industry due to poor quality products. This is why manufacturers highlighted upgrading of mills as a plausible preventive step. The third one is the labour shortage (12%) for processing and other activities. Shortage of raw materials (10%) also highlighted as the fourth constraint in kernel based industry.

Both production and manufacturing processes are affected and the ultimate result would be increased production cost. As highlighted earlier, limited supply and arbitrary allocation of raw materials are also constraints. This results in over supply and shortage situations, creating unpredictable market prospects. This creates an adverse impact on the industry.

Low market shares for desiccated coconut (8%) is another issue highlighted by the manufacturers. Heavy market competition (4%) and climatic change (4%) were also pointed out as issues in the sector. In addition, ad-hoc tax changes, low profit margins, higher production cost, inability to apply a higher standard certification process, adulteration and use of chemicals are also mentioned as major constraints.

8.2 Recommendations

1) Recommendations for Households

- a) Promote gap filling in home gardens, by planting coconut in the urban and semi-urban home gardens, depending on the space available. The research has identified the possibility of gap filling from one, two and three trees in the space available. This is with the objective of meeting the domestic culinary needs of the household.

District	Possibility of gap filling from a one tree	Possibility of gap filling from two trees	Possibility of gap filling from three trees
Gampaha	29%	26 %	4%
Kurunegala	34%	30%	6%
Puttalam	38%	35%	8%

Source: Author's survey data, 2019

b) Preferred Variety for Future Cultivation by Households

The HHs covered in this study was individually contacted and recorded their observations on each variety including their satisfaction or preferred variety for future cultivation by households.

Preferred Variety for Future Cultivation by Households	Gampaha	Kurunegala	Puttalam
D X T hybrids	55%	56%	58%
Tall varieties	41%	37%	39%
Preferred both varieties.	2%	6%	4%

Source: Author's survey data, 2019

- c) People of the study area have to spend an average of Rs.2100 monthly to buy coconuts (Rs. 55 per nut), which is a considerable expense. It is 7 % from the average monthly earnings of a median household income per month in Sri Lanka. Monthly coconut expenditure will increase proportionately to the prevailing nut price.

According to the field survey data, two coconut trees (with the yield of nearly 100 -120/nuts/tree/year from DT hybrid variety) are enough to fulfil the house hold coconut requirement of a 4-member family. Our survey study observed that, average HH size is four in the study area and the annual household coconut requirement was observed as nearly 360 nuts. (This amount can reduce by using blender or stone grinder to extract coconut milk).

- d) The coconut sector strategic development plan focuses mainly on increasing yields to achieve a target of 3,600 million nuts/year. Under the current situation 3000 million coconuts enough to fulfill the country domestic and industrial requirement. Nearly 2000 million nuts required to fulfill the domestic usage as fresh nuts. 600 million nuts required for industrial usage. 30% - 40% from the domestic requirement waste due to the traditional method of extracting coconut milk (nearly

800 million nuts). This amount is 30% from the national production. By using blenders and grinding stones, we can reduce this problem.

- e) Annually coconut trees are damaged due to pest attacks. The yield loss records at 15% from the national production. By controlling pest damage, more production can be directed to the industrial requirement. This indicates that the control for coconut pest in HG is an important factor in coconut production.
- f) According to the analysis fertilizer application can a vital predictor for the production of coconut. Home gardens with fertilizer application were 9.82 times more likely to give a coconut production on or above the average than the home gardens without fertilizer. According to the survey data, that 30% HH in Puttalam and more than 17% from Kurunegala and Gampaha did not practice soil management and have led to erosion and severe soil degradation. Identify the requirement of Improve soil management through a series of workshops, mass media and training. And promote the use of organic manures to develop sustainable soil fertility and use of both inorganic and organic fertilizers.
- g) Kapruka Samithi is a major community based programme implemented by the Ministry of Plantation Industries through the Coconut Cultivation Board. The initiative will help promote coconut cultivation at home garden level. The society will be empowered to initiate many activities such as, promotion of planting, gap filling, replanting, and management practices. Make these communities based organizations function full force will help initiate various activities such as, promotion of planting, replanting, vacancy filling and establishing coconut nurseries using selected mother palms to meet their seedling requirements.
- h) The study suggests that technologies that were developed and recommended during the study period should be introduced to coconut growers. Moreover, the government should strengthen the capacity of the extension services in the study areas while strengthening the linkage between input suppliers and coconut farmers so as to ensure availability, accessibility and affordability of inputs such as fertilizers and seedlings.
- i) Development of improved coconut cultivars and mass propagation of seeds. Development of improved cultivars with high yield and biotic/abiotic resistance is one of the key factors necessary to improve coconut production in the country.

Recommendations for industries

- a) There were 547 registered coconut based products exporters around the country in 2018 and 80 – 85% contribution originated from the coconut production triangular. Coconut products are broadly categorized into two sections: kernel and non-kernel based products.

The survey data highlighted, mainly coconut kernel based production industry requires stable prices (22%) for its outputs; stable market could create promising prospects within the industry. Coconut based production industry is an ideal industry for rural development through encouragement of small and medium scale enterprises around the country. However, in order to expand industrial prospects, the production and productivity (19%) must be simultaneously increased in plantations.

- b) The study also highlighted that, productivity of coconut production is much lower in Sri Lanka compared to other Asian countries. Adoption of good management practices are required to overcome this issue. Similarly, manufacturers highlighted the need of modern technological know-how (19%) in the processing sector in order to maintain high standards. This is vital when meeting the requirements of international markets. At the same time, increased productivity required increased product manufacturing to retain market stability.

2) Main Suggestions Made by the Coconut based Product Manufactures

- a) According to the small scale oil mills, it is difficult to compete with the palm oil price, by introducing new technology and machinery; they can compete with the palm oil price. According to the survey data, should be a proper mechanism and policy procedures related to importation of palm oil. Palm oil and its derivatives are considered as strong substitutes. Other than that, soya bean oil, sunflower oil, rape seed oil, tallow and ground nut oil are also considered as substitutes for coconut oil.
- b) Similar, frequency was placed on upgrade of desiccated coconut mills (9%). It is highlighted that, these mills require state of new machinery to increase production efficiency. Also, upgrading of old mills would be definitely a worthy cause with increased market prospects. Coconut oil production was reduced as coconut oil producers were not able to compete with low quality imported edible oils of low price. Also The survey data highlighted kernel based industries less utilization of nuts for coconut oil production, when coconut farm gate price is high.

It is highlighted that, desiccated coconut mills require new machinery to increase production efficiency. Also, upgrading of old mills would also be useful with increased market prospects. Restricting the import of palm oil and other edible oil is important as coconut oil producers are not able to compete with low quality imported edible oils that are available at low price. Also the survey data highlighted when coconut farm gate price is high, kernel based industries, less utilized of nuts for coconut oil production.

- c) Increasing of small scale production and coconut home gardening (6%) to overcome issues relating to the household consumption.
- d) The demand for coconut and its value-added products keeps increasing exponentially with the growing acceptance of opportunities for new value added products in international markets (i.e. Nata-de-coco, coconut chips, coconut water, virgin coconut oil and coconut butter, coconut squash and other confectionary). Manufacturers in minor frequencies should be focused upon. Possibilities of expanding new market opportunities for kernel based products in Asia, Middle East and Africa should be explored.
- e) Improve and promote technology dissemination methodology
There is a significant gap between technology development and technology dissemination in the country. Transfer of technologies generated by research to the stakeholders is the final component of the technology generation process. The knowledge of government officers and farmers on coconut related industries, regular inspection on production process should be enhanced.
- f) Poor access to markets and market intelligence: It is important to identify new markets through market research, participation in exhibitions, trade fairs etc. It is also necessary to encourage processors to find new markets by providing guidance and incentives.

It is noted that only about 30% of the growers practice fertilizer application while moisture conservation measures adaptation is far below the expectations. During drought periods it was found that estates and home gardens which practiced moisture conservation methods seldom experienced yield dips.

- g) Management of large coconut lands to achieve the maximum yield per tree to increase the national production. Management of soil fertility in coconut lands, coconut replanting Programme and improving and promoting technology dissemination methodology are proposed measures.

REFERENCES

- Assa, R. R., Konan J., L. Physicochemical characteristics of kernel during fruit maturation of four coconut cultivars (*Cocos nucifera* L.). *Afr J Biotechnology*. 2010; 9(14):2136-2144.
- Carbon Activated Corporation, (2019), *Coconut shell activated carbon is known for high hardness and low dust*. [Online] Available at: <https://activatedcarbon.com/products/coconut-shell-activated-carbon/> [Accessed 25 January 2020].
- Central Bank of Sri Lanka. (2018), *Economic and Social statistics of Sri Lanka*. Central Bank of Sri Lanka, Colombo, Sri Lanka.
- Central Bank of Sri Lanka, *Annual Report (2017)*, Central Bank of Sri Lanka.
- Climate Change Secretariat of Sri Lanka. (2012), *The National Climate Change Policy of Sri Lanka*. Ministry of Environment, Sri Lanka.
- Coconut Development Authority Act No. 46 of 1971 for development of coconut industry is the Coconut Development Authority.
- Coconut Development Authority, *Sri Lanka Coconut Statistics (2017)*, Coconut Development Authority, Sri Lanka.
- Coconut Development Authority. (2018), *Sri Lanka Coconut Statistics*. Coconut Development Authority, Colombo, Sri Lanka.
- Coconut Development Authority, (2020), *Welcome to CDA*. [Online] Available at: <https://cda.gov.lk/web/index.php?lang=en> [Accessed 14 January 2020].
- Coconut Development Authority, (2016), *Annual Report*, Colombo: Coconut Development Authority.
- Coconut Development Authority, (2018), *Sri Lanka Coconut Statistics*, Colombo: Coconut Development Authority.
- Coconut Development Authority, (2019), *Sri Lanka Coconut Statistics*, Colombo: Coconut Development Authority.
- Coconut Development Authority, (2020), *Welcome to CDA*. [Online] Available at: <https://cda.gov.lk/web/index.php?lang=en> [Accessed 14 January 2020].
- Coconut Cultivation Board, (2019), *Monthly Bulletins*, Coconut Cultivation Board Sri Lanka.
- Coconut Cultivation Board, (2018), *Monthly Bulletin, July*, Coconut Cultivation Board Sri Lanka.
- Coconut Research Institute, (2019), *Monthly Bulletin, July, volume 4*, Coconut Research Institute, Sri Lanka. Coconut Research Institute document – APCC country paper
- Coconut growers association of Sri Lanka [Online] Available at: <https://www.cgasl.lk/web site> [Accessed 14 January 2020].
- Department of Census and Statistics, DCS, (2002), *Agriculture Census*. Department of Census and Statistics, Sri Lanka.
- Department of Census and Statistics, (2018), *Sri Lanka Census of Agriculture*: Department of Census and Statistics, Colombo, Sri Lanka.
- Department of Census & Statistics, (2014), *Agricultural data collection survey 2014*, page 15, Colombo, Sri Lanka.

- De Silva, H., (1979). *The Coconut Industry in Sri Lanka: An Analysis of Government Intervention Measures*, s.l.: Australian National University .
- Department of Census and Statistics, (2008), Food Balance Sheet: Department of Census and Statistics, Colombo, Sri Lanka.
- Department of Census and statistics (Agriculture and Environment Statistics Division) [Online] Available at: <https://www.surveysystem.com/sscalc.htm>. [Accessed 14 January 2020].
- Export Development Board, (2012), *Industry Capability Report: Cocount & Coconut Based Products*, Colombo: Export Development Board, Sri Lanka.
- Fernando, M. T. N., Zubair, L. M., Peiris, T. S. G., Ranasinghe, C. S., & Ratnasiri, J. (2007). Economic value of climate variability impacts on coconut production in Sri Lanka AIACC Working Papers. The AIACC Project Office, International START Secretariat, Washington, DC.
- FSMP. 1995. Srilanka Forestry Sector Master Plan (1995 - 2020), Forestry Planning Unit of the Ministry of Agriculture, Lands and Forestry, Battarmulla, Srilanka.
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 COCOS, 2010,19: 41 – 50.
<http://www.itnnews.lk/local-news/second-coconut-triangle-introduced/> (Accessed on 08.05.2019).
- <http://www.srilankabusiness.com/coconut/coconut-export-performance.html> (Accessed on 30.11.2018). (by Jayantha Jayewardene, Sri Lankan Coconut Industry: Performance, Challenges and strategies for future Development, December 1, 2018, Former Chairman, Coconut Research Board, Sri Lanka daily news)
- Household Income and Expenditure Survey – 2016 Final Results (January to December 2016), The Department of Census and Statistics (DCS) V DEPARTMENT OF CENSUS AND STATISTICS Ministry of National Policies and Economic Affairs
- IPCC. (2014a), Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Coconut and climate change Australasian Agribusiness Perspectives, Paper 106 Pathiraja Page | 21 Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
- Jayawardana.C, (2018), Drastic-decline-in-coconut-farm-gate-price-requires-authorities immediate-action, [online] 21 August. Available at: [http://www.dailymirror.lk/features/Drastic decline-in-coconut-farm-gate-price-requires-authorities-immediate-action](http://www.dailymirror.lk/features/Drastic%20decline-in-coconut-farm-gate-price-requires-authorities-immediate-action) [Accessed 26 December 2019].
- Jayewardene, J., (2018), *Sri Lankan coconut industry: performance and challenges for the future*. [Online] Available at: <http://www.sundayobserver.lk/2018/12/02/news-features/sri-lankan-coconut-industry-performance-and-challenges-future> [Accessed 15 November 2019].

- Jayalath K. V. N. N. Pathiraja 1, P. M. E. K. Jayasinghe-Mudalige 1, U. K 2 a n d. Fernando M. T. N 3 (2006), Effect of Land Size on Productivity of Coconut Cultivations in Sri Lanka: An Empirical Investigation, land size on productivity of coconut second symposium on plantation crop research ,page 368-376.
- Kumar, B.m. and P.K.R. Nair. 2004. The enigma of tropical homegardens. *Agroforestry Systems*. 61:135-152.
- Land Use and Policy Planning Department, Ministry of Lands 2019 data
- Liyanage, D.V. (1958), Varieties and forms of coconut palm grown in Ceylon. Ceylon. pp. 1–10.
- Medical News Today. (2018), Coconut oil: healthful or unhealthful? [Online] Available at: <https://www.medicalnewstoday.com/articles/320644.php>. [Accessed 30 July 2018].
- Ministry of Plantation Industries, 2018. *Progress Report 2018*, Colombo: Ministry of Plantation Industries.
- Nifiez, V. K. (1984), Household gardens: Theoretical considerations on an old survival strategy. Unpublished Manuscript
- Pathiraja, P., Griffith, G., Farquharson, R. & Faggian, R., (2015), The Sri Lankan Coconut Industry: Current Status and Future Prospects in a Changing Climate. *Australasian Agribusiness Perspectives*, pp. 1-23.
- Peiris, T. S. G., and Kularatne, J.D.J.S. (2015), Sri Lanka: Evidence from Long-Assessment of Climate Variability for Coconut and Other Crops: A Statistical Approach. *Int.J. of Coc. Res. & Dev., (CORD)*, 24(1): 35-53.
- Peiris, T. S. G., Thattil, R. O. and Mahindapala, R., (1995), An analysis of the effect of climate and weather on coconut (*Cocos nucifera*). *Experimental Agriculture*, 31, 451-60.
- Peiris, T. S. G., Hansen, J. W., & Zubair, L., (2008), Use of seasonal climate information to predict coconut production in Sri Lanka. *International Journal of Climatology*, 28(1), 103-110. doi: 10.1002/joc.1517
- Peiris, T. S. G., & Thattil, R. O., (1997), Assessment of the effects of environmental factors on yield of coconut (*Cocos nucifera* L.). *The Journal of the Coconut Research Institute of Sri Lanka (cocos)*, 12, 17.
- Peiris, T., Wijeratne, M., Ranasinghe, C., Aanadacumaraswamy, A., Fernando, M., Jayakody, A., et al., (2004), Impact of climate change on coconut and tea industry in Sri Lanka. Paper presented at the 2nd AIACC regional workshop for Asia and the Pacific, Manila, the Philippines.
- Terra, G.J.A., (1954), Mixed garden horticulture in Java. In: *Malayan Journal of Tropical Geography*, Vol. III.
- Varietal Classification of New Coconut (*Cocos nucifera* L.) Forms Identified from Southern Sri Lanka
Varietal Classification of New Coconut (*Cocos nucifera* L.) Forms Identified from Southern Sri Lanka
- Wiersum K.F., (2009), Community forestry between local autonomy and global encapsulation: *quo vadis* with environmental and climate change payments? Paper first community forestry international workshop ‘thinking globally—acting locally: community forestry in the international arena’ Pokhara, Nepal, September 15–18, 2009. [Online] Available at: <http://edepot.wur.nl/157269>. [Accessed 21 January 2020].

