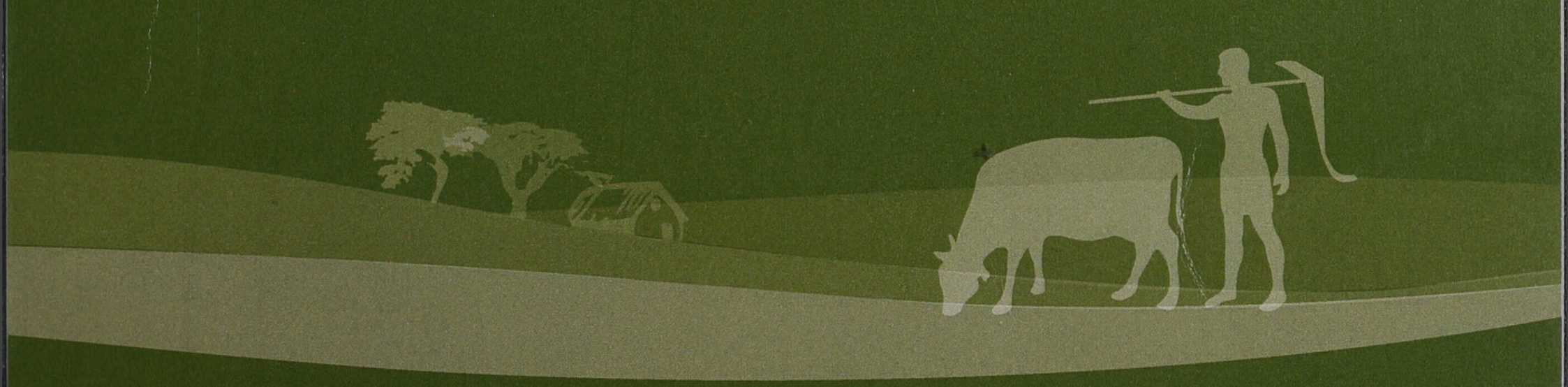
RESEARCH REPORT



MECHANIZATION IN OTHER FIELD CROP SECTOR : A SITUATIONAL ANALYSIS

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FOREWORD

Choice and the use of mechanized inputs into agriculture has a direct and significant effect on land and labour productivity, and the profitability of farming. In developing countries a shift from traditional labour-intensive production and post-harvest operations to mechanized labour-saving technologies is taking place across the agriculture sector due to rising labour scarcity, ageing of agricultural populations, increasing labour costs and development of modern value chains, increasing market and trade opportunities.

In Sri Lanka the National Agricultural Policy has been geared towards increasing domestic agriculture by increasing the cultivation of Other Field Crops. Therefore there is a need for considerable increase in the supply of this sector, which can be achieved both in terms of production and productivity through mechanization.

It has been found that almost the entire operation has been mechanized in the paddy production but in the other field crop sector though a variety of new machines have been developed and introduced adoption of such technologies has been minuscular. This issue of non-adoption needs to be addressed, for the country to reach its goal of self-sufficiency in the other field crop sector.

This study is a timely intervention in identifying the reasons for this poor level of mechanization of the other field crop sector in the country. It is hoped that this study would be beneficial to all stakeholders in this sector for them to gain insights into the farmers needs with regard to mechanization.

Haputhantri Dharmasena
Director

ACKNOWLEDGEMENTS

First and foremost the research team would like to thank all the farmers, local manufacturers and inventors of farm machinery and agricultural officials of the two districts of Moneragala and Ampara, who took time from their busy work schedules to help us understand the pros and cons of the mechanization of the other field crop sector. Also we would like to thank officials of the Farm Mechanization Research and Training Centre Mr. C. Balasoriya and Mr. G.A.M.A. Wijethunga for all the assistance.

The researchers are also thankful to Mr. Lalith Kantha Jayasekera former Director of HARTI under whose guidance the idea for this research was born and Mr. Haputhanthri Dharmasena Director HARTI for the support in assisting to publish the report.

We are indebted to the graduates who worked as casual investigators and helped collect reliable and descriptive data and information from the two districts. We also like to thank Mr. Amal Dissanayake Statistical Assistant HARTI for his work in the field and valuable insights. A thank-you is due to the secretarial staff Ms. Deepthika Rupasinghe and Ms. G.M V. Padmini of the division for their help in typesetting and assistance provided during the course of the study.

A thank-you to Ms. Suharshi Perera for the editing of the report and the publication unit for the final typesetting and page setting of the report. Finally we wish to thank HARTI staff for the support extended to us in various ways till the report was finally published.

Sharmini K.Kumara
P.R. Weerakoddy
S. Epasinghe

EXECUTIVE SUMMARY

The aim of the government is to achieve self-sufficiency in other field crop sector for crops such as maize, green gram, cowpea, finger millet, black gram and onions where 42 percent of the annual requirement of the country is still imported. This requires increase in the supply of OFC to be achieved both in terms of production and productivity. A prerequisite to increase agricultural production and improve labour productivity is the access to equipment and machinery to carry out farm operations. The introduction of mechanization to agriculture has normally brought about increases in both labour and land productivity in addition to reduction in the drudgery of farming operations.

OFC production is characterized by small scale operation and increased use of family and exchange labour where mechanization is limited and mostly confined to land preparation while activities such as weeding, planting and harvesting are still carried out manually. Seasonal fluctuations of labour availability are one of the main constraints which add to increase in the cost of production and restrict the area under expansion under OFCs.

Mechanization of farm activities saves cost, time and labour due to timeliness of operations, better quality of operations and exactness in the application of the inputs. In spite of both the given advantages of farm mechanization and the machinery introduced their adoption is restricted. Therefore farm mechanization needs to be a priority concern in the effort to achieve self-sufficiency targets in OFCs production.

Even though a variety of new machines have been developed and/or introduced to mechanize various operations in OFCs production, adoption of such technologies lags behind the required level, sometimes not found at all. This study aimed at investigating into causality behind poor level of mechanization in OFC production both from supply and demand perspectives. Two districts of Ampara and Moneragala were selected as the location for this study by taking into account the physical location, the extent cultivated with OFCs, ethnic diversity, and state of poverty.

From the study one can garner certain facts with regard to the constraints in mechanization from the supply and demand angle. It is evident from the study that main constraint from supply side is the unavailability of farm machinery for variety of operations while the available machines have technical defects. With regard to the demand the constraint lies in the

incompatibility of machinery to suit the local farm environment coupled with attitudes of farming community to use of new technology. In addition there are other factors which compound this issue such as the poor awareness among farmers of available machinery, affordability due to high cost and poor farmer income. Perpetuation of this level of mechanization in the OFC sector is due to the constraints contributing both singly or/and collectively.

For the government to take policy decisions so as to invest on increasing the appropriate machinery the tradeoff between 'machine suits to farm' versus 'farm suits to machine' should be considered. The choice of machine to suit the farm the available options are while expediting farm level adoptive research for low cost, high tech efficient machines, improve the staff strength, tax concessions to import machines encourage farmers and agricultural and engineering students of universities and provide them incentives for innovations on farm machinery.

In addition other recommendations are that the Department of Agriculture should prioritize providing farm machinery at subsidized rates/under easy pay schemes. To improve farmer awareness strengthening of technology transfer through machinery demonstrations, the training programmes conducted by FMTC should be farmer driven programmes targeting farm mechanization and farmers should be formally made aware of the use, maintenance and advantages of farm machinery at appropriate meetings with relevant officials.

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LIST OF ABBREVIATIONS

AI	-	Agricultural Instructor
ASC	-	Agrarian Service Centre
DOA	-	Department of Agriculture
FMRC	-	Farm Mechanization Research Center
FMTC	-	Farm Mechanization Training Center
HARTI	-	Hector Kobbekaduwa Agrarian Research and Training Institute
ICRISAT	-	International Crop Research Institute for Semi-Arid Tropics
KPI'S	-	Key Person Interviews
OFC	-	Other Field Crops
PDA	-	Provincial Department of Agriculture

CHAPTER ONE

Introduction

1.1 Background

The present agriculture policy is calculated to enhance domestic agriculture and make the country self sufficient in local food supply by increasing the cultivation of Other Field Crops (OFCs). Accordingly, there is a sharp increase in the protection accorded to domestic agriculture. The aim is to make Sri Lanka self-sufficient in maize, red onion, finger millet, black gram, green gram, cowpea and soya bean by 2012 (Appendix 1.1) for which the government has allocated Rs.159 million. Presently about 160,000 hectares are cultivated annually under OFCs (Appendix 1.2). Nevertheless, the annual production of these crops does not meet the domestic requirement. Therefore, about 42 percent of the annual requirement is imported to supplement the large shortfall of domestic production. This signifies the need for considerable increase in the supply of OFCs, which is required to be achieved both in terms of production and productivity for which mechanization is seen as an alternative.

OFC production is characterized by small scale operation and increased use of family and exchange labour. At present in this sector as most studies show, 60 – 80 percent of the labour requirement is family labour while in paddy it is only 45 percent of the total labour requirement. At the moment mechanization of OFCs is limited and mostly confined to land preparation while activities such as weeding, planting and harvesting are still carried out manually. It has also been shown that the seasonal labour demand is high exceeding that of rice. This would suggest that one of the main constraints to expanding the extent under OFCs is labour. Seasonal fluctuations of labour availability not only increase the cost of production but also restrict the area expansion under OFCs cultivated by the small farmers.

Several studies have shown that farm mechanization enhances the overall productivity and production while lowering the cost of production. Mechanization of farm activities saves cost, time and labour due to timeliness of operations, better quality of operations and exactness in the application of the inputs. In spite of both the given advantages of farm mechanization and the machinery introduced their adoption is restricted. Therefore farm mechanization needs to be a priority concern in the efforts to achieve self-sufficiency targets in OFC production.

1.2 Problem Statement

Even though a variety of new machines have been developed and/or introduced to mechanize various operations in OFCs production, adoption of such technologies lags behind or sometimes not found at all. The Farm Mechanization Research Centre (FMRC) in Anuradhapura has developed a package of machinery for maize, some of which can be used for other OFCs such as green gram, cowpea, soya bean and groundnut. However preliminary investigations carried out in Ampara and Monaragala districts show that some farmers are not aware of such machinery, whereas others perceive that they do not suit their lands. Extension personnel state that there is need for a change in attitudes for which promotion programmes are required. They also find both pros and cons of FMRC machinery. Therefore mechanization of OFCs production is a multi-faceted problem. Therefore the identification of the factors perpetuating poor mechanization of OFCs production is the key problem addressed through this study.

1.3 Main Objective

The main objective of the study is to identify the reasons for the poor level of mechanization of the OFC sector in the country.

1.3.1 Specific Objectives

i. To explore the availability of farm machinery for the production of OFCs.
ii. To identify any technical constraints of the available machinery for OFC production.
iii. To investigate the other reasons for poor level of mechanization in OFC production.
iv. To explore possibilities of circumventing the said constraints and problems relating to mechanization of OFC production.
v. Provide policy recommendations that will optimize mechanization in OFC sector.

1.4 Study Methods

1.4.1 Study Location:

Ampara and Moneragala districts (Figure 1.1 and 1.2) were selected as the location for this study by taking into account the physical location, the extent cultivated with OFCs, ethnic diversity, and state of poverty. The

main reason for selection of the two districts is the extents of OFCs cultivated in the districts. Of the total extent of OFCs cultivated in the country, Moneragala ranks 2nd with 27172 ha and Ampara ranks 4th with 8956 ha under cultivation. A detailed discussion regarding the extents and production of OFCs is presented in Chapter two.

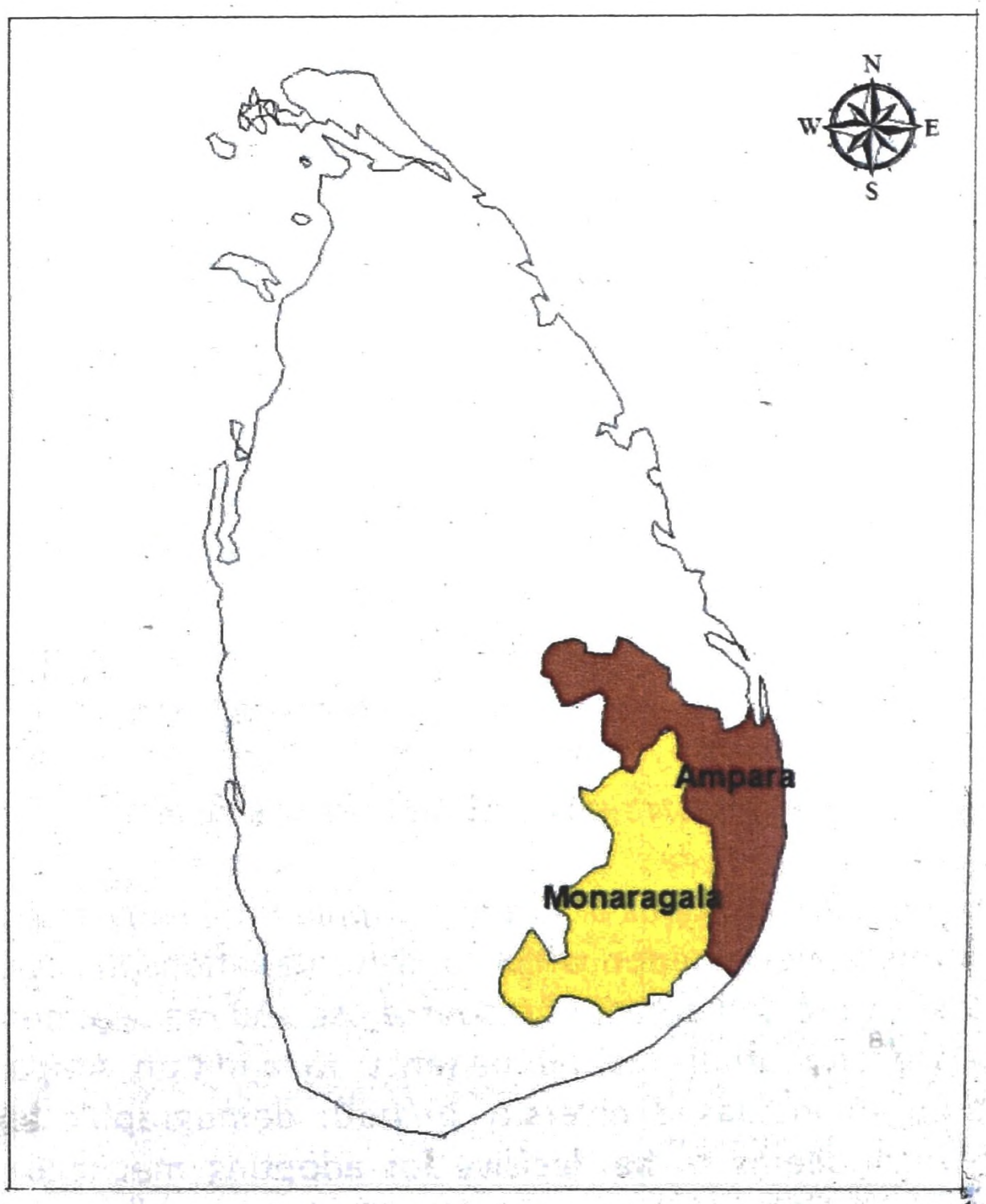
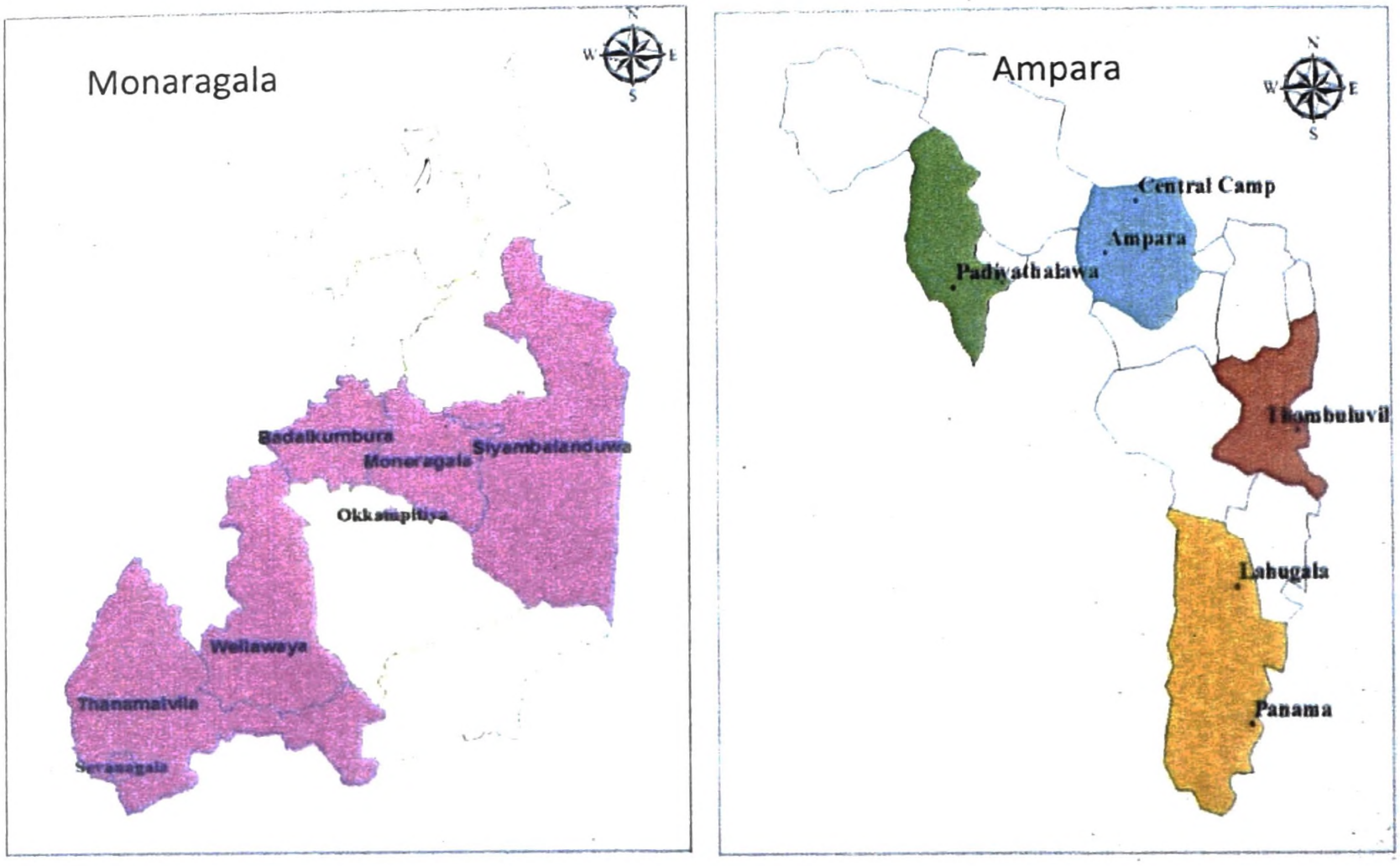


Figure 1.1: Map of Study Locations



Map of Monaragala District

Map of Ampara District

Figure 1.2: Study Locations in Monaragala and Ampara Districts

Diversity in socio-economic conditions of farming population in any area of the country is a common phenomenon which leads to variations in access to agricultural inputs, nature and extent of resource use and management, and output marketing and other related benefits. In addition Ampara district demonstrates an increased diversity in both demographic and geographic terms which seems to be decisive for adopting mechanized operations in agriculture. Ampara district consists of all three main ethnic groups of Sinhala, Tamil and Muslims. Geographically OFCs producing farm fields in Ampara district can be categorized into two major landscapes; flat and the undulating lands. It was also affected by war. It is located 245 km from the FMRC where the machinery is developed, as a result no demonstration has been done except for the 'Deyata Kirula' programme.

Moneragala district has been a place which is renowned for chena cultivation in the early 70s and 80s. OFCs were cultivated in farms as a mixed crop. The district even today is one of the most poverty stricken districts in the country.

1.4.2 Data Collection Methods

There were 4 data collection methods used for the study:

1. Key Persons Interviews (KPIs) - List of persons interviewed are given in Table 1.1.
2. Focus Group Discussions (FGDs) -List of areas in which FGDs held is given in Table 1.2 and Table 1.3.
3. Farm Mechanization Demonstration - Prior to 2013/2014 *Maha* Season a demonstration of machinery was undertaken in two locations in Ampara district as a collaborative effort between HARTI, FMRC, DOA and the Provincial Department of Agriculture (PDA) in Ampara district. This provided an opportunity to farmers get hands-on experience on mechanized seeding in OFC production.

Table 1.1: List of Key Persons Interviewed

Ampara District Centre		
S.No.	**Name**	**Designation**
01	Mr. Senarath Dissanayake	Deputy Director, PDA Ampara.
02	Mr. A. Kalees	Deputy Director, DOA (Inter Provincial) Ampara.
03	Mr. S.U. Ranasinghe	Assistant Director, PDA Ampara.
04	Mr. L.K.S.T. Kumara	Assistant Director, DOA (Inter Provincial) Ampara.
05	Mr. S.W.L. Rajapaksha	Headquarters Agricultural Instructor (AI), Agricultural Extension Office, Padiyathalawa.
06	Mr. Buddika Pradeep	AI, Hulannuge.
07	Ms. W.P.M.S. Rajapaksha	AI, Lahugala.
08	Mr. M. Kokularaj	AI, Thambiluwil.
09	Mr. Saliya Hapugoda	AI, Namalthalawa.
10	Mr. Susantha Gunasekara	AI, Central Camp.
11	Mr. Palitha Gunarathne	AI, Pallamoya.
12	Mr. D.N.U.D. Kapuwatta	AI, Kolamalthalawa.
13	Ms. T. Jayani	AI, Thambiluwil.

Monaragala District		
01	Mr. H.K.C. Jayalath	Deputy Director, PRA, Ampara.
02	Mr. Gamini Senaratne	Deputy Director, DOA (Inter Provincial), Monaragala.
03	Mr. Dilshan H. Mahadurage	AI, Ethimale.
04	Mr. K. Ranaweera	AI, Ethimale.
05	Mr. T. Sampath	AI, Monaragala.
06	Mr. P. Ramanayaka	AI, Badalkumbura.
07	Mr. W.K.I.A. Nilantha	AI, Bodagama.
08	Mr. Sujith	ARPA, Sevanagala.
Farm Mechanization Research and Training Centre		
01	Mr. C. Balasoriya	Director, FMRC, MI.
02	Mr. G.A.M.A. Wijethunga	Engineer, FMRC, MI.

Source: HARTI Survey Data, 2014

Table 1.2: Details of Focus Group Discussions Held in Monaragala District

ASC/AI Range	Study Site	No. of Farmers	Crops Grown
Ethimale	Ethimale	30	Maize
Siyambalanduwa	Buddama	20	Maize
Ethiliwewa	Ethiliwewa	20	Maize
Okkampitiya	Maligawila	7	Maize
Sevanagala	Nugegalayaya	5	Green gram, Groundnut, Finger Millet
Ethimale	Willowewa	11	Maize, Cowpea, Finger Millet
Sewanagala	Kiriibbanwewa	30	Green gram, Finger Millet
Badalkumbura	Badalkumbura	9	Maize, Green gram, cowpea, Sesame, Groundnut
Thanamalwila	Kiwulara	3	Groundnut
	Total	135	

Source: HARTI Survey Data, 2014

Table 1.3: Details of Group Discussions Held in Ampara District

ASC/AI Range	Study Sites	No. Farmers	Crops Grown
Padiyathalawa	Kolamanthalawa	43	Cowpea
Namalthalawa	Namalthalawa	90	Maize, Green gram, Cowpea
Panama	Panama	20	Maize
Lahugala	Lahugala	20	Maize
Namalthalawa	Namaloya	15	Maize, Green gram,
Namalthalawa	Polwaga janapadaya	15	Maize, Green gram, Cowpea
Central camp	Central camp	15	Green gram, Groundnut, Maize
Thambivuvill	Vinayakapuram	13	Groundnut
Pallamoya	Pallamoya	12	Maize
Total		253	

Source: HARTI Survey Data, 2014

1.5 Data Analysis and Presentation

Data collected from various sources was analyzed and presented in tables and figures.

1.6 The Report

The introductory chapter is followed by chapter two which gives a comprehensive overview of production and mechanization of OFC production in study locations. This chapter is followed by a chapter on the availability of farm machinery for OFC cultivation and a chapter on awareness and use of farm machinery for OFC production in study locations. The final chapter of the report presents the conclusions and recommendations.

CHAPTER TWO

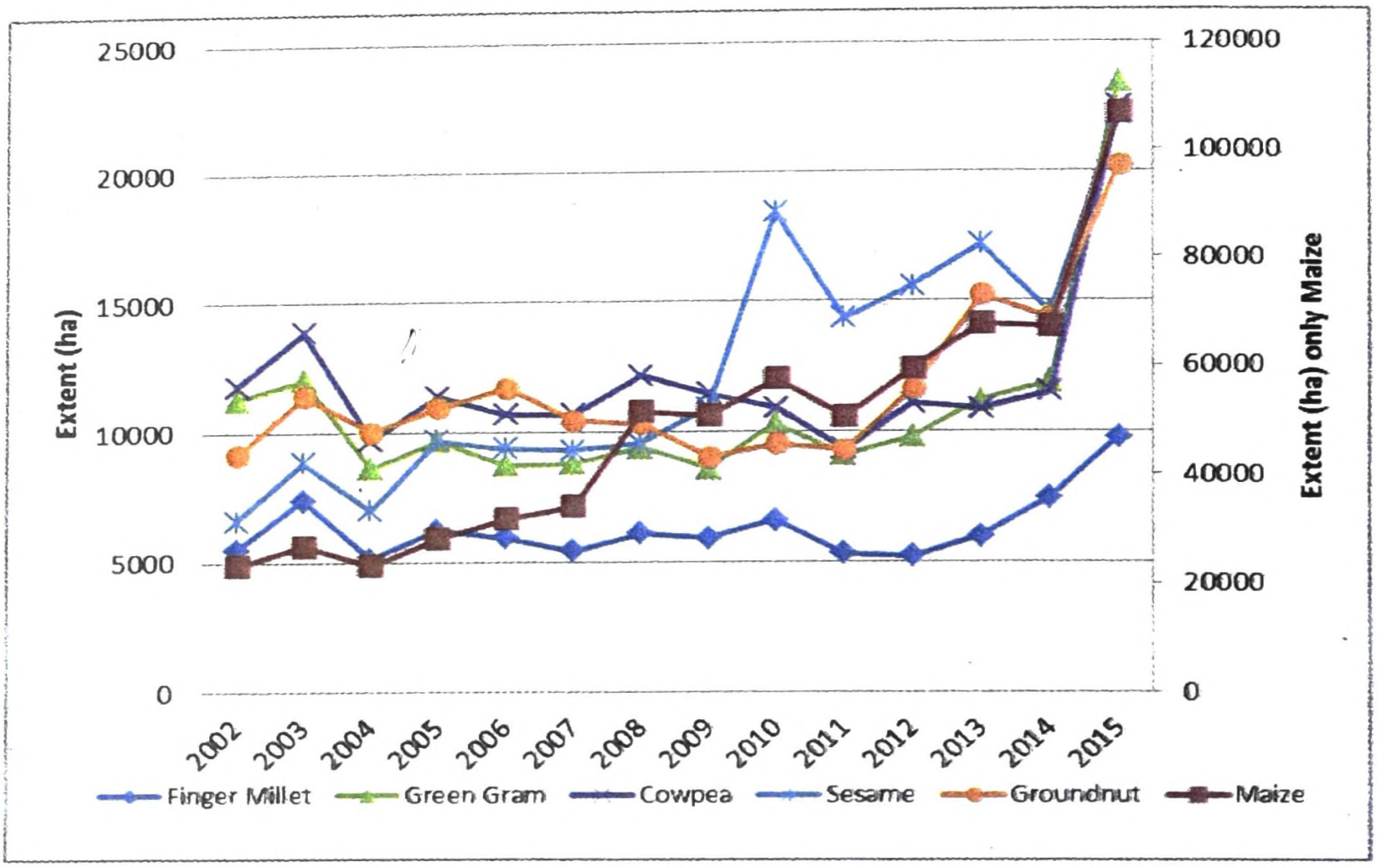
An Overview of Production and Mechanization of OFCs in Study Locations

The objective of this chapter is to provide a justification as to why the study selected the two major OFC producing districts, Ampara and Moneragala. The chapter details out the extents in hectares and production in metric tons of OFCs from district level to Agrarian Service Centre (ASC) level. There is also a comparison of national figures of the OFC with district level figures. Level of mechanized operations in major OFC production in two districts with labour, machinery and input cost data from DOA is also given in this chapter.

2.1 National Extent and Production of OFCs

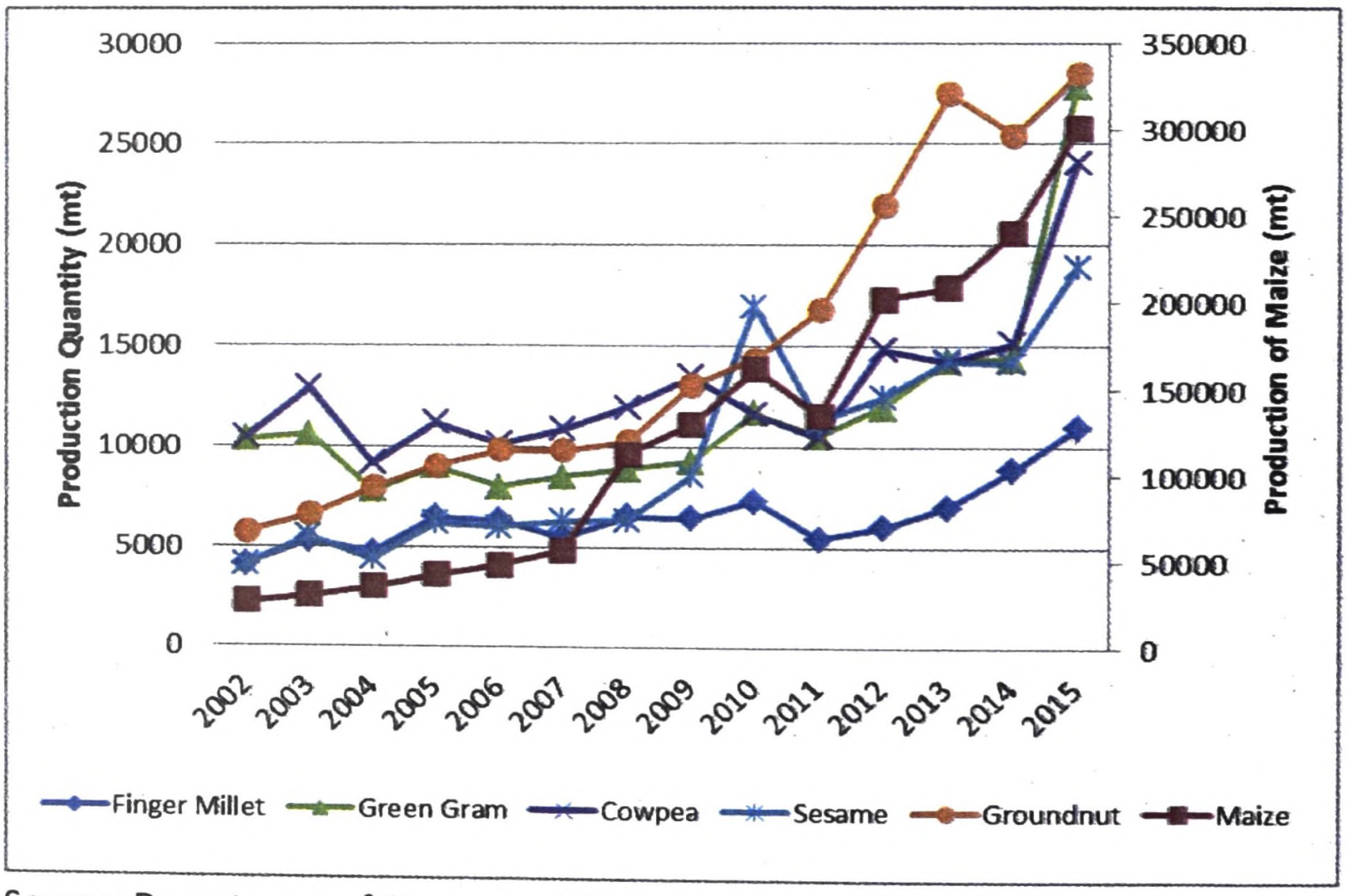
Data (Appendix 2.1 and 2.2) demonstrate that there has been an increase in the extents cultivated under OFCs for the past ten years. Under the National Food Production Campaign set up in 2007 there was a concerted effort to increase the extent and production of OFCs. The main crops under this programme were maize, cowpea, finger millet, green gram, groundnut and black gram. Accordingly the total extent of OFCs was increased from 91772 ha in 2002 to 161165 ha in 2013. The greatest extent among the OFCs has been for maize, a crop for which the government had placed emphasis in the early 2000 to curtail the imports into the country. From 23413 ha in 2002 the extents have increased nearly by three-fold (67722 ha) in 2013.

Figure 2.1 and 2.2 shows the extents and production of some OFCs with predicted figures for the years 2014 and 2015. The data illustrate the increasing trends in both extent and production of all major OFCs including maize, cowpea, finger millet, green gram, sesame and groundnut over time.



Source: Department of Census and Statistics, Various Years

Figure 2.1: National Extent under OFCs



Source: Department of Census and Statistics, Multiple Years

Figure 2.2: National Production of OFCs

2.2 Extent under OFCs in Study Locations in Comparison to National Level - 2013

Ampara and Moneragala when ranked in comparison to island wide extents Monaragala is the 2nd with 31,161 ha and Ampara ranks 6th with 8,345 ha (Table 2.1). Under the National Food Programme Ampara and Moneragala are two districts among a host of other districts in the country which were chosen for an increased production drive for OFCs such as maize, green gram, cowpea and groundnut (MOA, 2007). The largest extents cultivated island wide under OFCs is for maize cultivation with over 67,722 ha and the second in line is sesame crop with only 17,151 ha under cultivation in 2013.

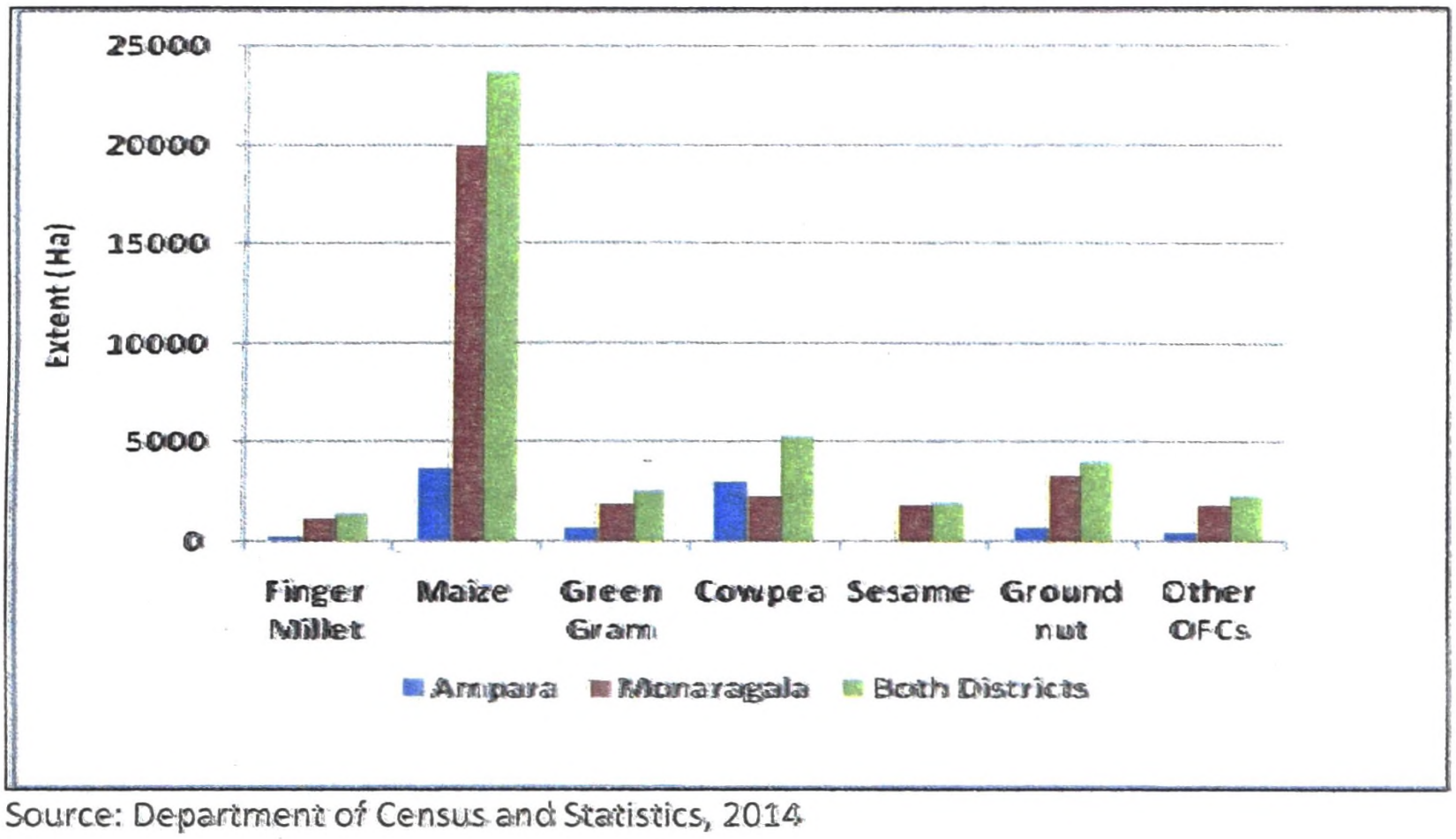
When the extents and production of OFCs in study locations are compared to the national level statistics Monaragala district is the number one groundnut producer and the second in regard to several other OFCs such as maize, finger millet, green gram, cowpea and sesame. Accordingly the district has been the second prominent OFC producing district in the country. Within the district maize ranks as number one with 64 percent of the total extent under OFCs in the district whereas groundnut occupies 11 percent. Among the other major OFCs are cowpea (7%), green gram and sesame (each 6%) and finger millet (4%) as shown in Table 2.1.

In comparison with Ampara district cowpea occupies the largest extent in 3000ha in 2013 as the number one cowpea producer in the country. However, according to district data, Ampara predominates maize production occupying 3,692 ha (44% of the total extent under OFCs in the district) in 2013 with cowpea being the second prominent crop in the district. Green gram, groundnut, finger millet and sesame are among the other major OFCs produced in Ampara district with around 106 ha occupied by black gram, onions and soybean altogether (Table 2.1).

Table 2.1: Extent of OFCs in Study Locations in Comparison to National Level - 2013

Crop	Sri Lanka		Ampara				Monaragala				Both Districts		
	ha	Island Rank	ha	%	District Rank	Island Rank	ha	%	District Rank	Island Rank	ha	%	Island Rank
Maize	67,722	1	3,692	44	1	4	20,092	64	1	2	23,784	35	1
Finger Millet	5,951	9	214	3	5	8	1,144	4	6	2	1,358	23	2
Green Gram	11,147	5	624	7	3	4	1,893	6	4	2	2,517	23	2
Cowpea	10,815	7	3,000	36	2	1	2,291	7	3	2	5,291	49	1
Sesame	17,151	2	96	1	6	12	1,803	6	5	2	1,899	11	2
Groundnut	15,197	3	613	7	4	6	3,404	11	2	1	4,017	26	1
Other OFCs	33,182	-	106	1	-	-	534	2	-	-	640	2	-
Total	161,165	-	8,345	100	-	6	31,161	100	-	2	39,506	25	-

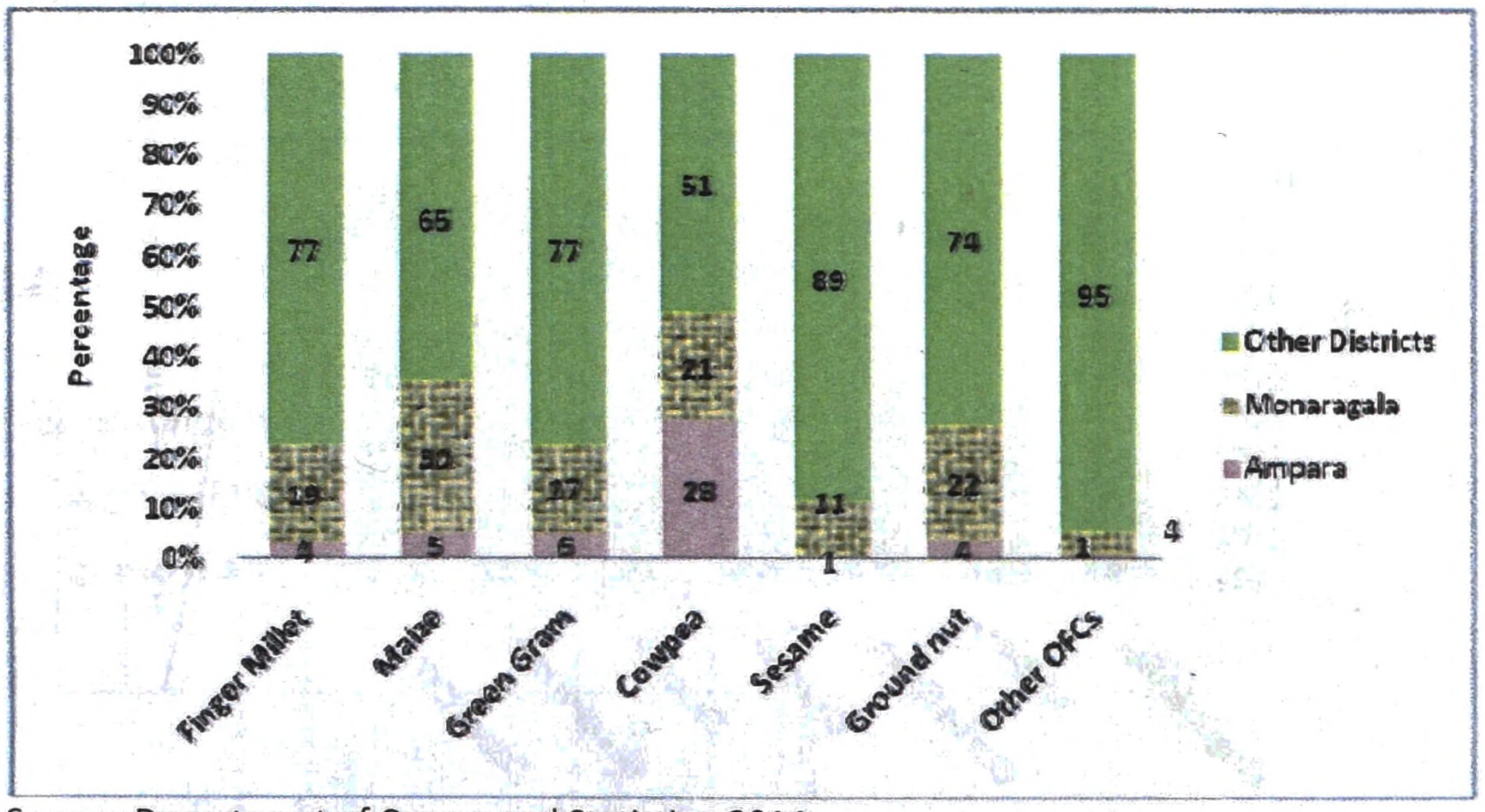
Source: Department of Census and Statistics, 2014



Source: Department of Census and Statistics, 2014

Figure 2.3: Extent of OFCs in Study Locations - 2013

In general both districts collectively and Monaragala district individually predominates maize production followed by cowpea, groundnut, green gram, sesame and finger millet respectively in decreasing order (Figure 2.3). Ampara district too follows the same order except for sesame production which is less in this area.



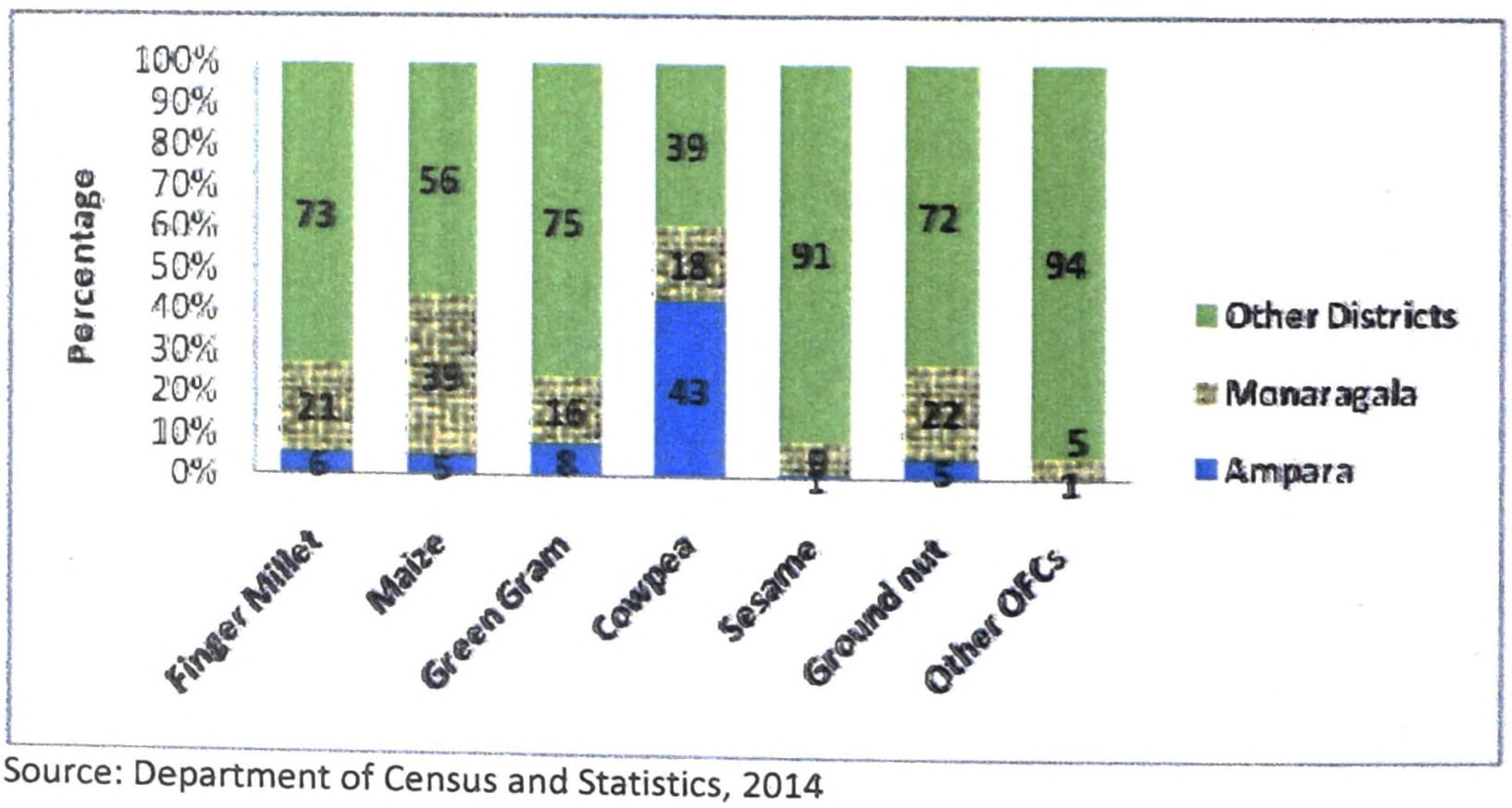
Source: Department of Census and Statistics, 2014

Figure 2.4: Percentage Contribution to Total Extent of OFCs from Study Locations - 2013

Data further shows that both districts provide a considerable contribution to national extent OFCs through occupying 49 percent of cowpea extent, 35 percent of maize extent, 26 percent of Groundnut extent, 23 percent of finger millet extent, 23 percent of green gram extent, and 12 percent of sesame extent. Therefore the data establishes that Ampara and Moneragala districts qualify as major OFCs growing areas that provide a considerable contribution to the national extent under OFCs.

2.3 OFCs Production in Study Locations in Comparison to National Level - 2012

Of the national production of 512,981 mt of OFCs produced in 2013 the two districts of Monergala and Ampara produce 23 percent of the national total. Crop wise distribution of OFCs show that of the national production of 209,042mt of maize produced in 2013 in Moneragala district produces 39 percent and Ampara district produces around 5 percent. In the Ampara district the highest production is for cowpea which produces 43 percent of the national production with Moneragala producing 18 percent. While production of OFCs in Ampara district with regard to other OFCs are below 10 percent of the national production Moneragala as a district has a higher percentage of OFCs produced. Table 2.2 and Figure 2.5 give one an overview of the production of the OFCs in the two study locations of Ampara and Moneragala. Accordingly Amapra and Moneragala districts qualify as major OFCs producing areas that provide a vast contribution to national production.



Source: Department of Census and Statistics, 2014

Figure 2.5: Percentage Contribution to Total Production of OFCs from Study Locations - 2013

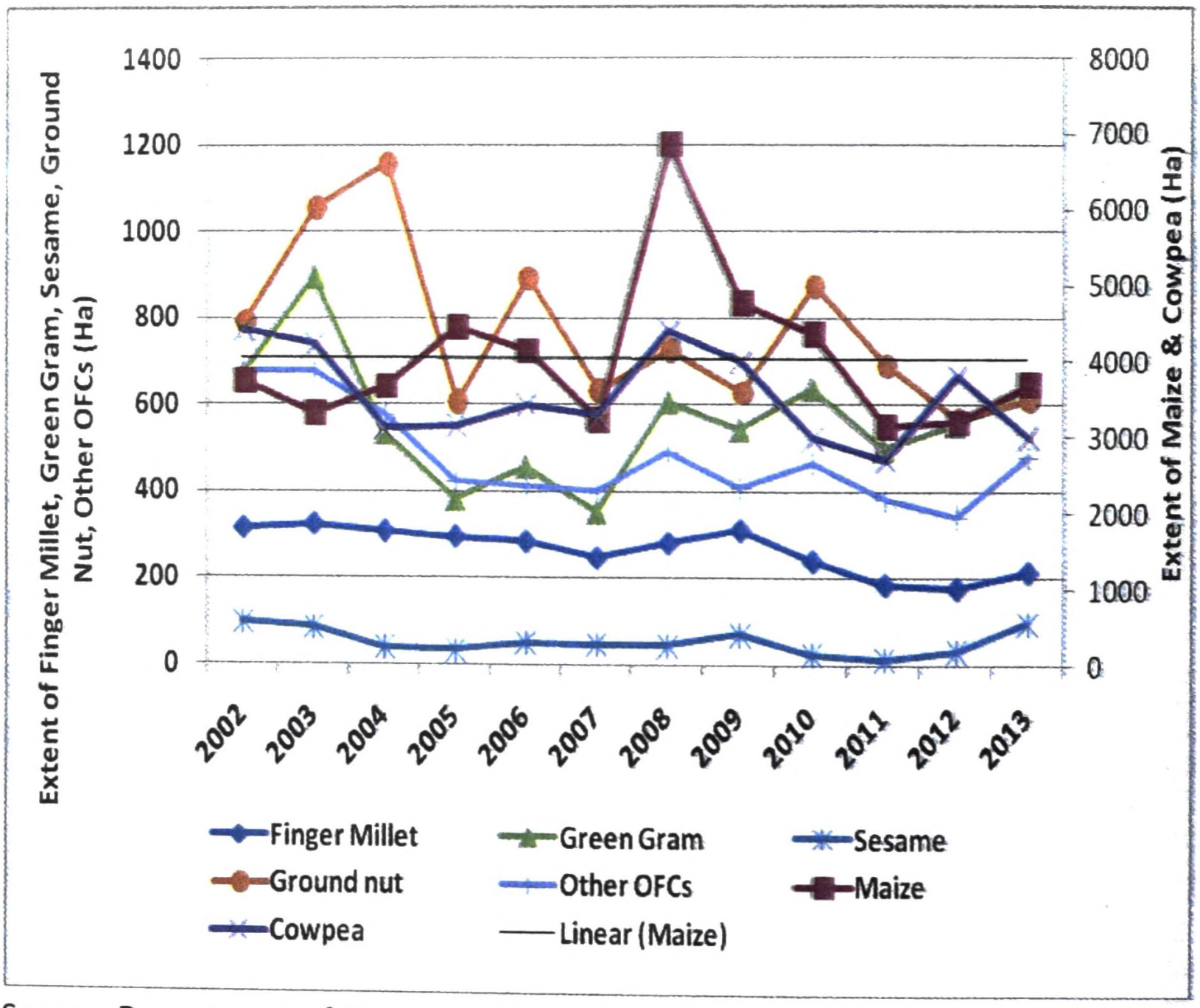
Table 2.2: Production of OFCs in Study Locations in Comparison to National Level - 2013

Crop	Sri Lanka		Ampara				Monaragala				Both Districts		
	mt	Island Rank	mt	%	District Rank	Island Rank	mt	%	District Rank	Island Rank	mt	%	Island Rank
Maize	209,042	1	10861	53	1	4	80752	84	1	1	91613	44	1
Finger Millet	7,011	11	416	2	5	6	1483	2	5	1	1899	27	1
Green Gram	14,252	6	1159	6	3	4	2348	2	4	2	3507	25	2
Cowpea	14,185	8	6090	30	2	1	2596	3	3	2	8686	61	1
Sesame	14,236	7	118	1	6	11	1228	1	6	2	1346	9	2
Groundnut	27,486	5	1477	7	4	5	6175	6	2	2	7652	28	2
Other OFCs	226,769	-	269	1	-	-	1889	2	-	-	2158	1	-
Total	512,981	-	20390	100	-	8	96471	100	-	2	116861	23	-

Source: Department of Census and Statistics, 2014

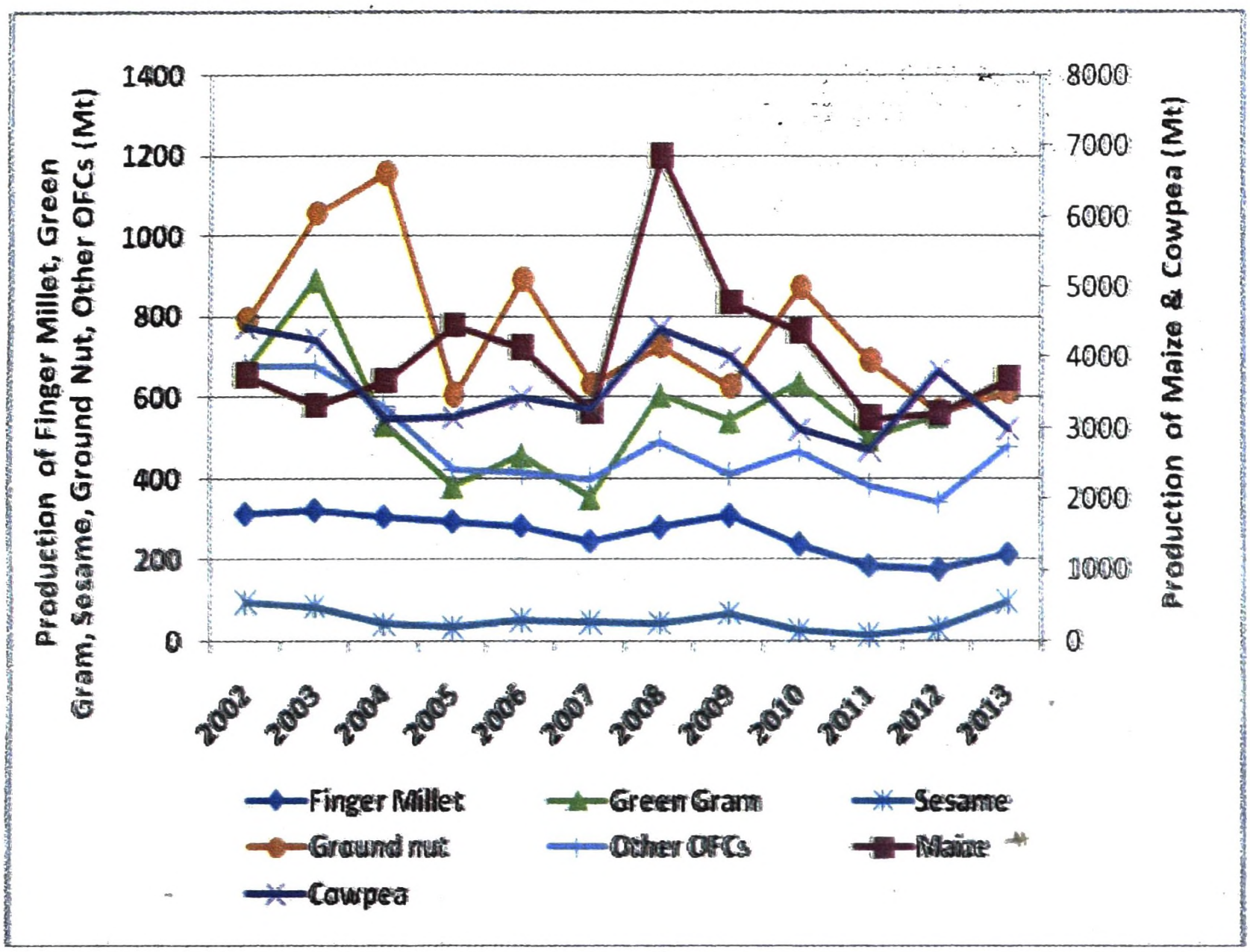
2.4 Extent and Production of OFCs in Ampara District (2002-2013)

Figure 2.6 and Figure 2.7 show the extents and production under OFCs in Ampara district. Throughout the period from 2002 to 2013 all the crops have shown an increasing acreage under cultivation. Cowpea and maize are the two crops with over 3000 ha under cultivation. The variations shown in the extents cultivated follow through in the lines of the ethnic conflict which affected this district prior to year 2007 due to which there was uncertainty over the daily existence which undoubtedly led to extents which were cultivated showing a variation. In the year 2011 (Appendix 2.3) there was floods which affected the Eastern province thus affecting the extents cultivated and thereby the production.



Source: Department of Census and Statistics, Various Years

Figure 2.6: Extent of OFCs in Ampara District (2002-2013)



Source: Department of Census and Statistics, Various Years

Figure 2.7: Production of OFCs in Ampara District (2002-2013)

Of the number of OFCs grown in the district the highest extent is under maize, cowpea, green gram and groundnut. As shown in the Table 2.3 and Table 2.4 the extents and production of these crops for the past five years from 2008 to 2013 show it is at the provincial level rather than at the interprovincial level that the crops of maize and cowpea have the largest extents. The extents cultivated at interprovincial level show a steady increase since 2009 for the maize crop while for cowpea there has been a decrease (Table 2.5 and Table 2.6). A reason being that the farmers preferred to cultivate maize due to the increase in the farm gate price received during harvest.

The extents of green gram are more or less similar both at the provincial and inter-provincial level while the extents of groundnut show a larger extent grown in the inter-provincial areas.

Table 2.3: Summary of Production of OFCs in Ampara District by Provincial and Inter-provincial Areas (2008-2013 Average in mt)

Crop	Pro.	Ave.	%	Inter.	Ave.	%	Total	Ave.
Maize	111880	22376	66	58866	11773	34	170746	34149
Cowpea	30720	6144	68	14195	2839	32	44915	8983
Green Gram	1900	380	49	1973	395	51	3873	775
Groundnut	1142	228	13	7411	1482	87	8553	1711

Note: Pro: Provincial Inter: Inter-provincial Ave: Average

Sources: Deputy Director's Office of Agriculture (Inter-provincial) Ampara
Deputy Director's Office of Agriculture (Provincial) Ampara

Table 2.4: Summary of Extent under OFCs in Ampara District by Provincial and Inter-provincial Areas (2008-2013 Average ha)

Crop	Pro.	Ave.	%	Inter.	Ave.	%	Total	Ave.
Maize	37292.5	7458.5	73	13995	2799.0	27	51287.5	10257.5
Cowpea	38399.7	7679.9	75	12786	2557.2	25	51185.7	10237.1
Green gram	2112.9	422.6	50	2128.95	425.8	50	4241.85	848.4
Groundnut	1042.4	208.5	16	5335	1067.0	84	6377.4	1275.5

Note: Pro: Provincial Inter: Inter-provincial Ave: Average

Sources: Deputy Director's Office of Agriculture (Inter-provincial) Ampara
Deputy Director's Office of Agriculture (Provincial) Ampara

A further breakdown of extents cultivated (Table 2.5) in the district during *Yala* and *Maha* at ASC levels that there are specific areas where a large extent of the crops are cultivated. Inter-provincial figures for maize show of the 32 percent grown 21 percent is grown in Pallanoya and only 4 percent grown in Tottama. Therefore major maize producing ASCs in Inter-provincial areas in Ampara district are Pallanoya, Tottama and Namalthalawa. At the provincial level where 67 percent of the maize crop is cultivated 33 percent is from Maha Oya and 25 percent is from Padiyathalawa. A considerable extent is grown with maize in Lahugala ASC in Ampara district.

With regard to cowpea a major percentage (96% in Mahaoya, Padiyathalawa and Lahugala) is cultivated at provincial areas with only 4 percent at the inter-provincial areas (Namalthalawa, Thambiluwil). Green gram is grown in equal proportions at the provincial (Maha oya, Padiyathalawa, Lahugala) and interprovincial areas (Central Camp and Namalthalawa). Groundnut is the most popular crop among the farmers from Thambiluwil (Inter-provincial) and Lahugala (provincial).

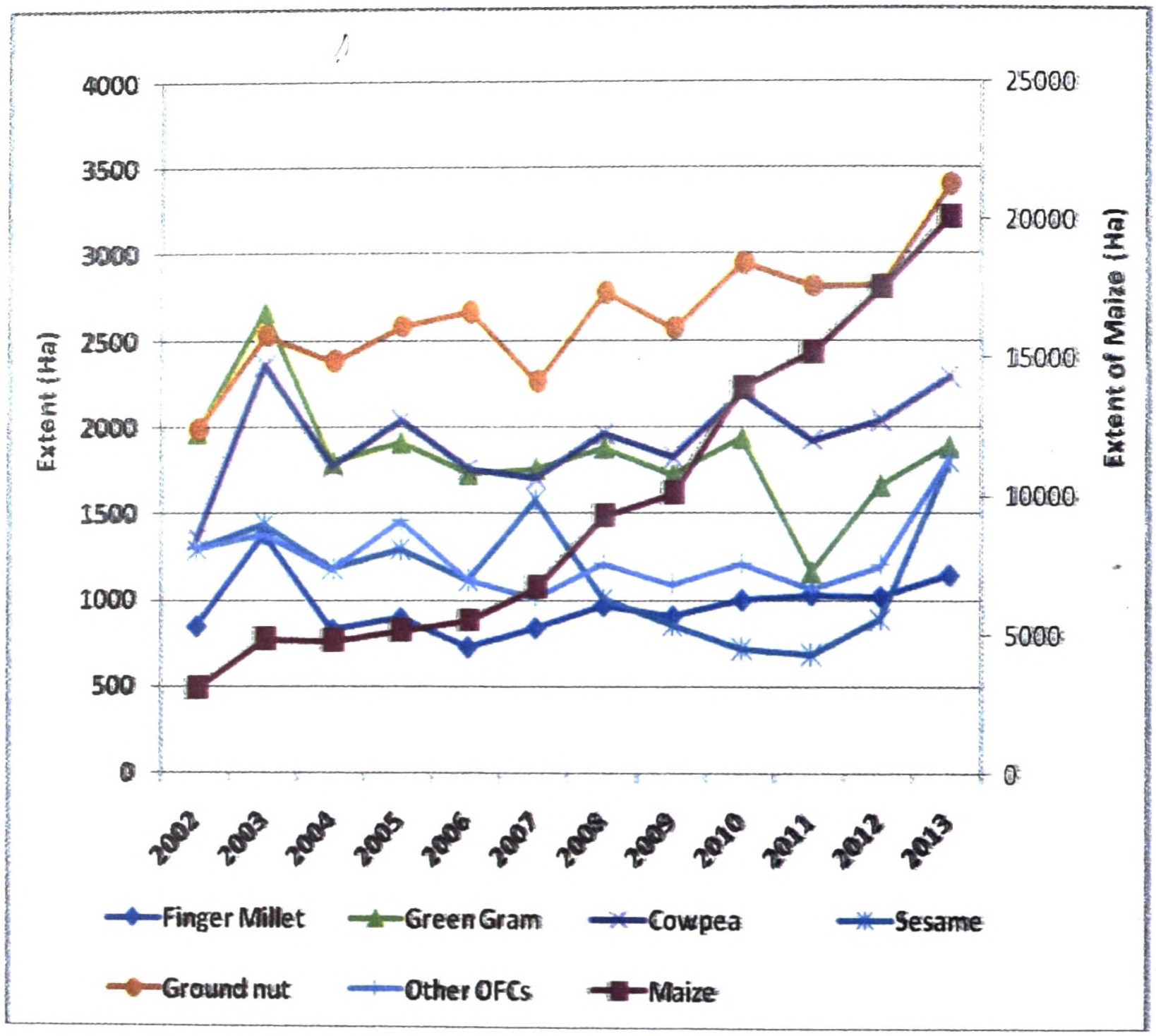
Table 2.5: Extents of OFCs in Ampara District in ASCs in Provincial and Inter-provincial Areas in 2014

Name of ASC	Maize	Cowpea	Green Gram	Groundnut	Total
Interprovincial Areas					
Irakkamam	4.5	2	4.5	2.25	13.25
Akkaraipattu West	0	2	20	0	22
Thambiluvil	3	11.5	4	252	270.5
Akkaraipattu East	38	1	3	26	68
Komari	2	0	0	125	127
Pothuvil	47	11	11	57.5	126.5
Palamunai	37	0	0	28	65
Ninthavur	3.25	0	6	65.75	75
Samanthurai	7.5	3	10	4.5	25
Malwatta	4	0	0	5	9
Neelavanai	1.7	1	0.5	1	4.2
Annamalai	10	5.5	16	5	36.5
Uhana	58	70	25	39	192
Mayadunna	49	33.1	10.95	20.6	113.65
Central Camp	45	10	135	13	203
Namalthalawa	388	40.2	115	56	599.2
Damana	8	2.5	1	23	34.5
Pallanoya	2058	20	64	59	2201
Tottama	823	29	21	20	893
SubTotal	3586.45	241.8	446.95	802.6	5077.8
Provincial Areas					
Mahaoya	3165.8	3658.7	106.6	43.2	6974.3
Padiyathalawa	2490.2	2771.2	133.3	57	5451.7
Lahugala	850.5	342.6	151.4	120.7	1465.2
Sub total	6506.5	6772.5	391.3	220.9	13891.2
Total	9692.95	7014.3	838.25	1023.5	18569

Sources: Deputy Director's Office of Agriculture (Inter-provincial) Ampara
Deputy Director's Office of Agriculture (Provincial) Ampara

2.5 Extent and Production of OFCs in Monaragala District

The major OFC cultivated in the Moneragala district as shown in Figure 2.8 and 2.9 is the maize crop. Appendix 2.4 shows the steady increase in cultivation of maize from the year 2002.

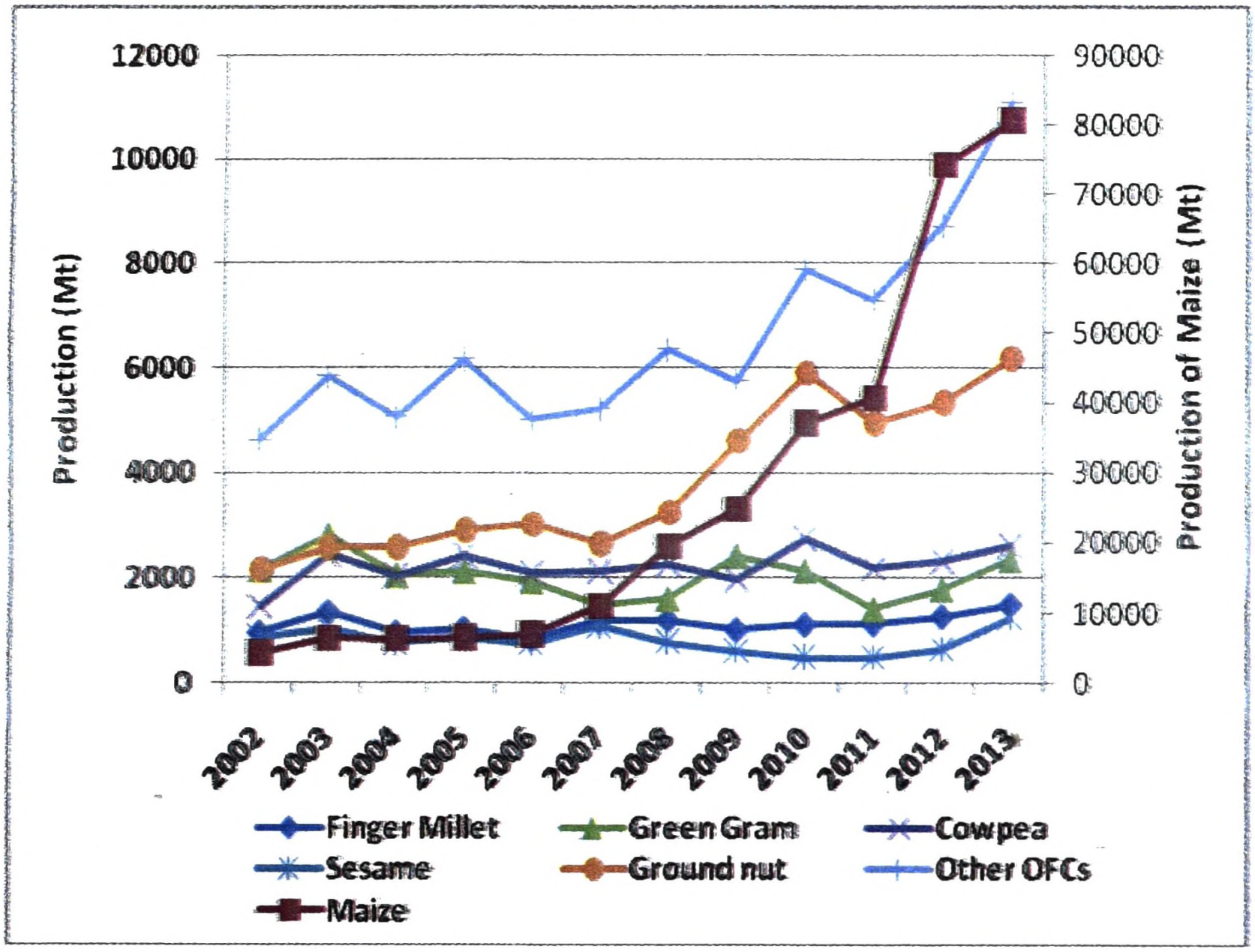


Source: Department of Census and Statistics, Multiple Years

Figure 2.8: Extent of OFCs in Monaragala District (2002-2013)

The emphasis of the government in reaching self-sufficiency in the cultivation of maize coupled with the subsidies provided to farmers led to the increase in extents cultivated in the Moneragala district where 20,092 ha are cultivated in 2013. The two inter-provincial ASCs of Ethimale and Siyabalanduwa in total cultivate 66 percent of the total production of maize in the district (Table 2.6). Of the provincial areas which cultivate 44 percent of the rest Dambagalla and Moneragala ASCs cultivate extents of nine percent and seven percent respectively. The other OFC cultivated in Moneragala district in large extents is groundnut 3,404 ha in 2013 where distributions of the extents cultivated of around 44 percent are found in

the area of Thelulla. The soil of this area has proved to be very fertile and large extents of OFCs are cultivated as shown in Table 2.6.



Source: Department of Census and Statistics, Various Years

Figure 2.9: Production of OFCs in Moneragala District (2002-2013)

Table 2.6: Breakdown of the OFCs Production by ASCs in Moneragala District -2014

Area	ASC	Maize	Cowpea	Green gram	Ground nut	Finger Millet	Sesame	Other OFCs	Total OFCs
Provincial	Kataragama	312	86.4	86	88	16	-	489	588.4
	Sewanagala	308	66	44	220	76	-	582	714
	Thanamalwila	432	206.4	183	334	150	-	354	1305.4
	Thelulla	312	190.8	127	1416	30	-	2078	2075.8
	Wellawaya	732	129.6	352	572	14	-	746	1799.6
	Aluthwewa	720	523.2	125	400	80	-	842	1848.2
	Kotagama	1780	24	17	0	0	-	126	1821
	Bibila	1600	102	30	6	10	-	186	1748
	Nannapurawa	2048	57.6	16	104	67.5	-	198	2293.1
	Nelliyadda	1624	63.6	34	48	15	-	30	1784.6
	Medagama	720	26.4	12	23	42	-	186	823.4
	Dambagalla	8368	111.6	24	300	26	-	156	8829.6
	Badalkumbura	712	81.6	47	0	59	-	234	899.6
	Hingurukatuwa	116	8.4	7	0	4.4	-	202.8	135.8
	Buttala	3008	328.8	520	0	30	-	1425	3886.8
Inter Provincial	Monaragala	6368	88.8	73	640	30.8	-	298	7200.6
	Siyabalanduwa	28012	162	27	288	131	5.6	240.8	28625.6
	Ethimale	34120	34.5	12.5	101	20	0.8	216	34288.8
	Okkampitiya	1352	54	74.5	54	22	12	413.2	1568.5
	Thelulla	1068	98.4	124	1330	10	95.2	448	2725.6
		93712	2444.1	1935	5924	833.7	113.6	9450.8	104962.4

Source: Deputy Director's Office of Agriculture (Inter-provincial) Monaragala
Deputy Director's Office of Agriculture (Provincial) Monaragala

2.6 Degree of Mechanization of OFC Production in Study Locations

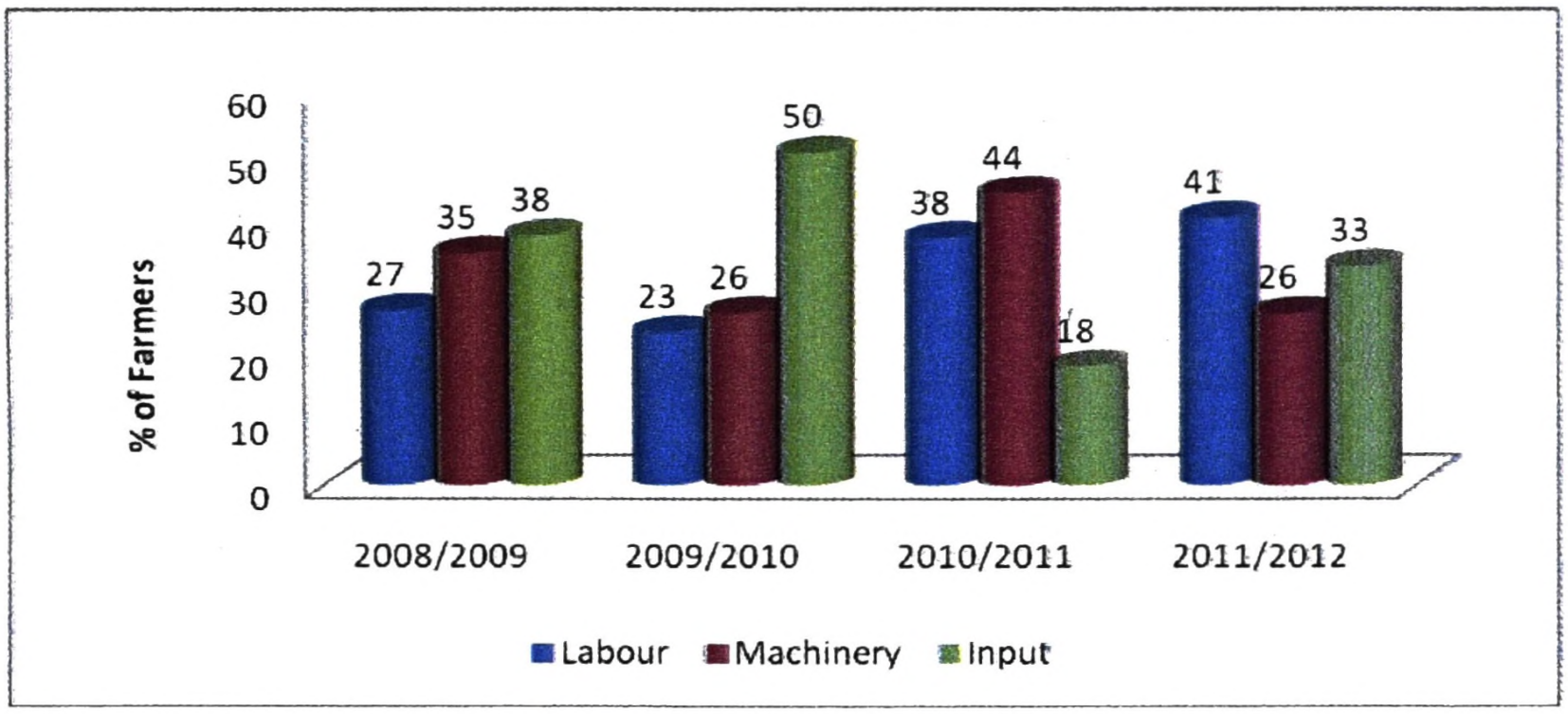
2.6.1 Maize Production

Table 2.7 shows the labour, machinery and input costs for the production of maize in Moneragala district. Mechanization of the OFC crop compared to the paddy crop is found for only a few operations in the cultivation cycle of the crop. There has been mechanization in the initial land preparation and latter stages during harvesting and threshing of the crop. As maize is one of the most commercialized OFCs in Moneragala the use of machinery in the crop cultivation cycle is more frequent than in other OFCs grown in the district. The data prove the fact that the cost items vary season to season while there cannot be seen a marked change (either increase or decrease) in the degree of mechanization.

Table 2.7: Imputed Cost of Cultivation per Acre for Maize in Monaragala District (Rs.)

Season	Costing Items & Cost in Rupees			Total Cost (Rs)
	Labour	Machinery	Inputs	
2008/2009 *Maha*	6083	8064	8662	22809
2009/2010 *Maha*	5209	5868	11285	22362
2010/2011 *Maha*	8691	10269	4190	23150
2011/2012 *Maha*	10928	7046	8971	26954

Source: Department of Agriculture, Multiple Years.



Source: Department of Agriculture, Multiple Years

Figure 2.10: Imputed Cost of Cultivation per Acre for Cowpea in Monaragala District (Rs)

The Table 2.8 presents a brief outline of the use of machinery by the farmers in selected activities in maize cultivation for four consecutive from 2008/09 *maha* season to 2010/11 *maha* season. The need for pre weedicide application and general land preparation differ from land to land largely depending on the degree of weed growth in each land. Over the years land preparation process has been done manually. Primary and secondary land preparation followed by preparation of ridges is done either by machines or with the use of draught power. Data shows a gradual replacement of draught power by mechanized operations over the years. Seed planting, harvesting and drawing of the harvest are entirely manual operations. Data reports a gradual shift from manual threshing and two wheel tractor operated threshing to four wheel tractor operated threshing of maize in the Monaragala district.

Table 2.8: Power Sources Used for Selected Operations in Maize Production in Monaragala District

Operation	Farmer % Using Labour/ Draught Power*				Farmer % Using Machinery			
	08/09	09/10	10/11	11/12	08/09	09/10	10/11	11/12
General land preparation	48	50	74	40				
1st& 2nd Plough					74**	80**	100***	94***
2nd Plough only	26*	20*		6*			54***	
Preparation of ridges		36*	36*		68	64	74	88
Digging holes & Seeding	100	100	100	100				
Weeding &Earthing up	100	100	100	100				
Fertilizer Application	98	100	100	100				
Harvesting & Drawing	100	100	100	100				
Threshing & Processing								
2W Thresher	22				64	70	46	58
4W Thresher					14	30	54	42

* Draught power
** - 2 wheel tractors
*** - 4 wheel tractors
Source: Department of Agriculture, Multiple Years

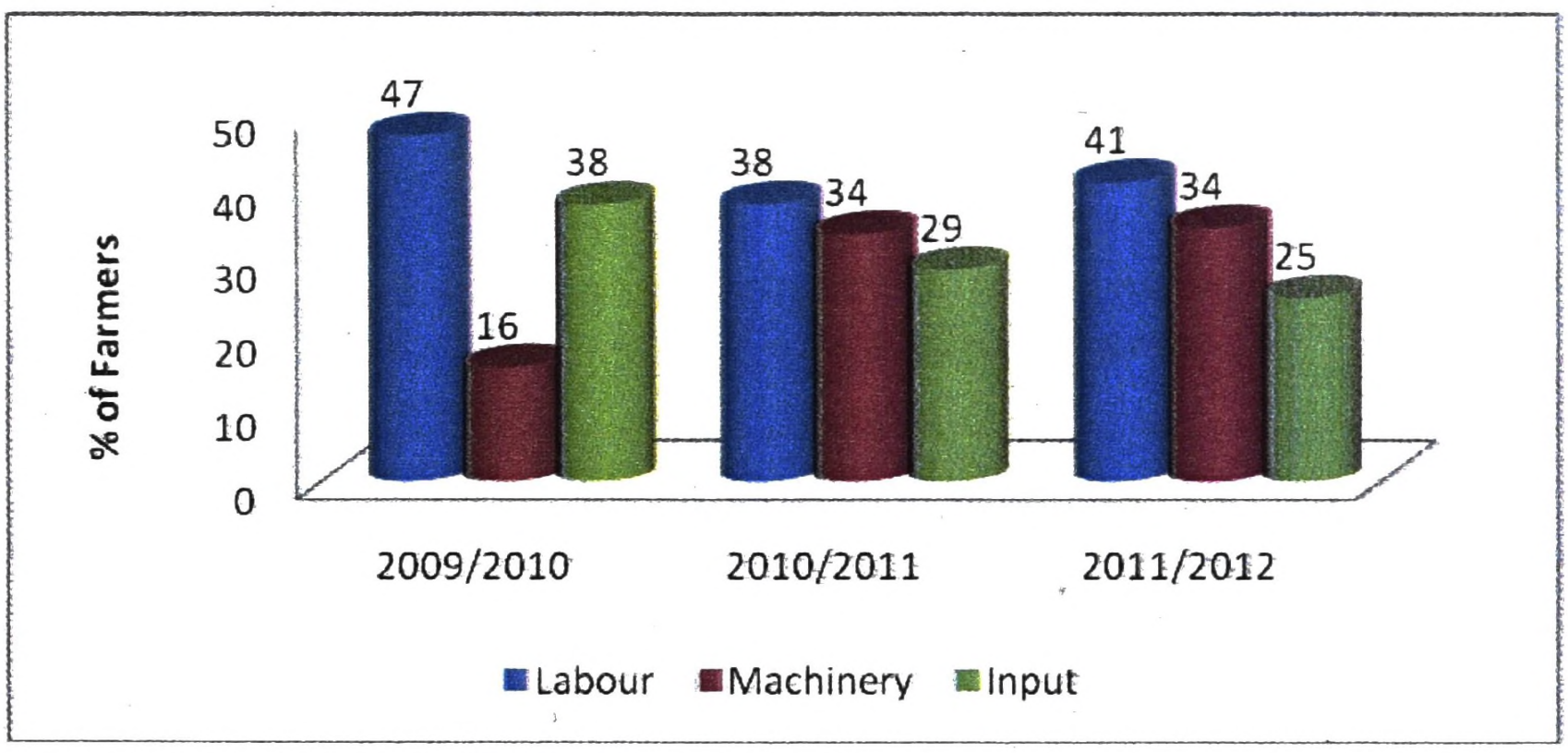
2.6.2 Cowpea Production

As depicted by Table 2.9 and Figure 2.11 there is an increasing trend of mechanization of cowpea production in Ampara district. Four wheel tractor operated land preparation has been the observable improvement in the cowpea cultivation in the Ampara district. There is a gradual shift from manual processing of cowpea towards mechanized processing.

Table 2.9: Imputed Cost of Cultivation per Acre for Cowpea in Ampara District (Rs)

Season	Costing Items & Cost in Rupees			Total Cost (Rs)
	Labour	Machinery	Inputs	
2009/2010 *maha*	2510	830	2013	5353
2010/2011 *maha*	4170	3720	3182	11072
2011/2012 *maha*	4889	4147	3001	12037

Source: Department of Agriculture, Various Years



Source: Department of Agriculture, Various Years

Figure 2.11: Imputed Cost of Cultivation per Acre for Cowpea in Ampara District (Rs)

Table 2.10: Power Sources Used for Selected Operations in Cowpea Production in Ampara District

Operation	Farmer % Using Labour/ Draught Power*			Farmer % Using Machinery (2w*/4w**)		
	09/10	10/11	11/12	09/10	10/11	11/12
1st Plough	18 50*	38*	36*	32**	62***	64***
2nd Plough	48*	38*	36*	30**	62***	64***
Preparation of Beds & Ridges	52 48*					
Seeding	100	100	100			
Weeding & Earthing up	100	100	100			
Harvesting and Drawing	100	100	100			
Processing	84	100	84	16*		16*

* Draught power
** - 2 wheel tractors
*** - 4 wheel tractors
Source: Department of Agriculture, Various Years

2.6.3 Groundnut Production

Table 2.11: Imputed Cost of Cultivation per Acre for Groundnut in Moneragala District (Rs)

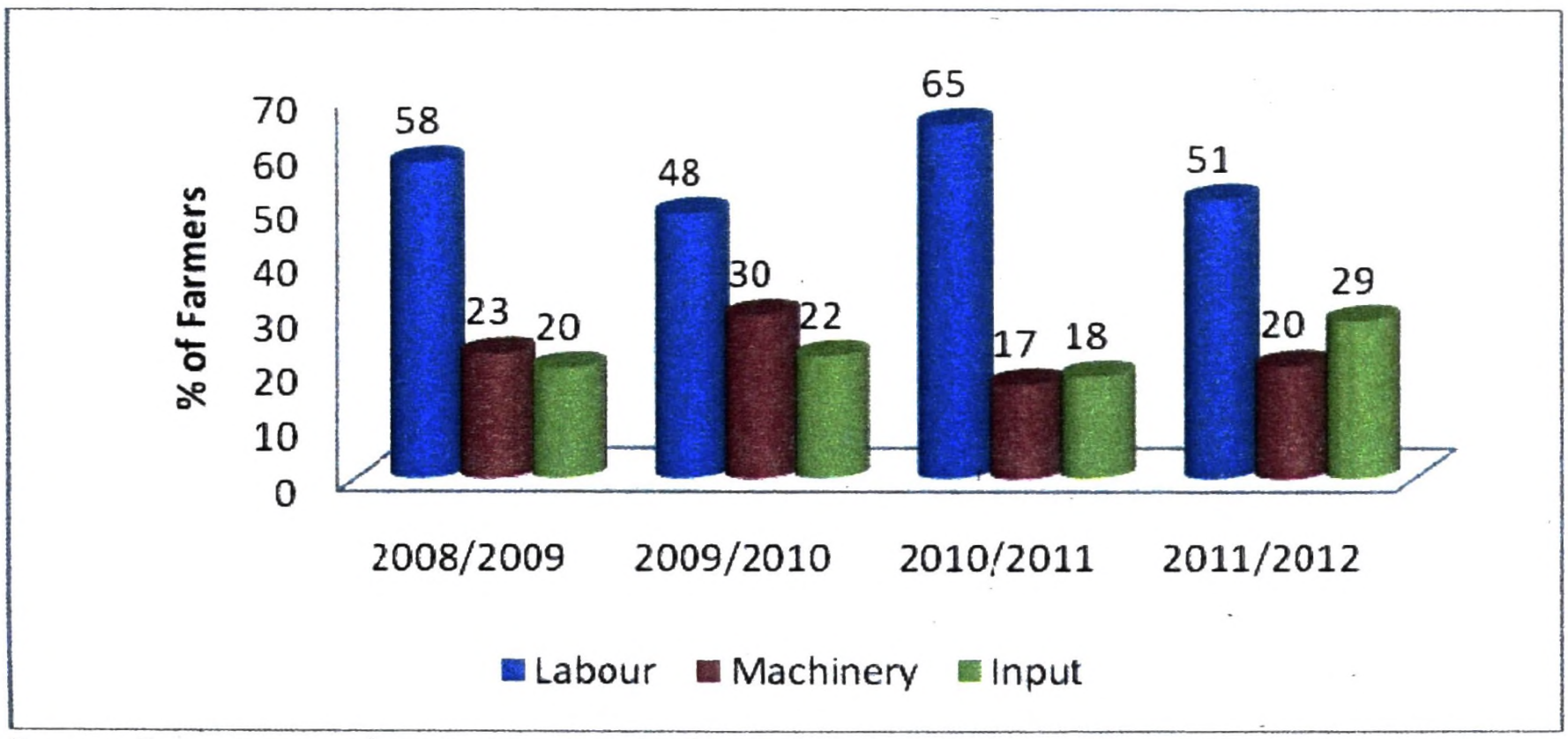
Season	Costing Items & Cost in Rupees			
	Labour	Machinery	Input	Total
2008/2009 *maha*	10381	4056	3569	18006
2009/2010 *maha*	7376	4527	3371	15274
2010/2011 *maha*	18643	4874	5275	28792
2011/2012 *maha*	12707	5085	7154	24946

Source: Department of Agriculture, Various Years

Table 2.12: Power Sources Used for Selected Operations in Groundnut Production in Moneragala District

Operation	Farmer % Using Labour/ Draught Power*				Farmer % Using Machinery (2w*/4w**)			
	08/09	09/10	10/11	11/12	08/09	09/10	10/11	11/12
1st & 2nd plough	36	46 10*	22*	-	64	44**	78**	100**
Seed Processing & Seeding	100	100	100	100	-	-	-	-
Weeding & earthing up	100	100	100	100	-	-	-	-
Harvesting and drawing	100	100	100	100	-	-	-	-
Processing	100	100	100	100	-	-	-	-

* Draught power
** - 2 wheel tractors
*** - 4 wheel tractors
Source: Department of Agriculture, Multiple Years



Source: Department of Agriculture, Multiple Years

Figure 2.12: Imputed Cost of Cultivation per Acre for Groundnut in Moneragala District (Rs)

Groundnut cultivation is still a labour intensive operation where the use of machinery is only for the operation of land preparation (Table 2.11, Figure 2.12 and Table 2.12).

2.7 Mechanization of OFCs in Indian Sub Continent

India ranks first in the world in terms of pulse production and is one of the largest consumer and processor of pulses in the world. India produced 14.66 Million tones (Mt) of pulses from 23.00 Million ha areas, with an average yield of 637 kg/ha (Ali and Gupta, 2012). However, the country is importing pulses of 2.5–3.5 Mt every year to meet the demand. Average farm size in India, recent year 1.21: ha (Chand et al, 2011).

Some of the major pulses grown in India are chickpea or Bengal gram (*Cicer arietinum*), pigeon pea or red gram (*Cajanus cajan*), lentil (*Lens culinaris*), uradbean or black gram (*Vigna mungo*), mungbean or green gram (*Vigna radiate)* cowpea (*Vigna unguiculata*). The major pulse-producing states are Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka and Andhra Pradesh which together account for about 80 percent of the total production.

The present machines which are available are the Tropicultor' by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, which is drawn either by animal or tractor. It is a multipurpose implement that executes land preparation, seed and fertilizer placement, weeding, bund formation and earthing up operations. The implement costs about Indian Rs.50, 000 which is designed and supplied by ICRISAT.

Source: ICRISAT, India

Tropicultor: Animal Drawn and Machine Operated

The currently available varieties of pulses in India are not suited for mechanical harvesting therefore pulses are harvested manually. The problem lies with the fact that plant height is not adequate and the branches are close to ground due to semi spreading growth of the plant. A study done by Jukanthi *et al* (2012) shows that with the development of chickpea cultivars with 30 percent to 40 percent taller than the existing cultivars would be more suited to mechanical harvesting. Availability of varieties with cultivars suited to mechanical harvesting will reduce production cost and attract farmers towards increased production of pulses. With the constantly escalating labor cost, farmers find manual harvesting of pulses very expensive and they would like to increasingly opt for mechanical harvesting. At present farmers in Tamil Nadu are using the same combine harvesters that are designed to harvest paddy as found in Sri Lanka for harvesting all types of pulses also by changing the mesh required for separation of grains depending upon the pulse variety that is to be harvested. This machine saves both time and expenditure for the pulse growers, where 20 laborers are needed to harvest an acre of land for a few hours; the machine can harvest an acre within an hour. Total cost to harvest one acre is around Indian Rs.1000 only.

Combine Pulse Harvester
Source: www.thehindu.com/ article568331.ece

In developed countries, such as Australia, Canada and USA, pulses like chickpea and lentils are harvested mechanically with very large harvesters. The combine harvesters are built specially for harvesting of pulses and they combine many operations from removing the plant from the ground, separating out the seeds from the rest of the foliage, distributing the residue across the field and transferring the resulting product to a storage

bin via a truck. As most of the pulse crops are one pick variety there is the use of combine harvesters.

Source: Aboutharvest.com, 2015

Grain Combined Harvester

2.8 Summary

The comparison of extent and production figures of OFCs between national level and district level for Ampara and Monaragala districts establishes that study locations are major OFCs producing districts that have provided a considerable contribution for the recent drive for accelerated food production in the country. Selection of ASCs as study sites mentioned in the chapter one is also justified with the data presented in this chapter as they are major OFCs producing representative sites to study on any aspects of OFCs production. Investigation into production data of a few selected OFCs from study districts provides an understanding of a slow shift from manual operations to mechanized operations in OFC production in the country, a common phenomenon in the neighboring countries too.

CHAPTER THREE

Availability of Farm Machinery for OFC Production

This chapter discusses the available farm machinery for OFC production in Sri Lanka under three sub sections based on the origin and invention of farm machinery; (a)Designed and invented by FMRC, (b). Imported and distributed by private agri-business firms and (c) Manufactured and sold by local manufactures.

3.1 Farm Implements Designed and Invented by FMRC

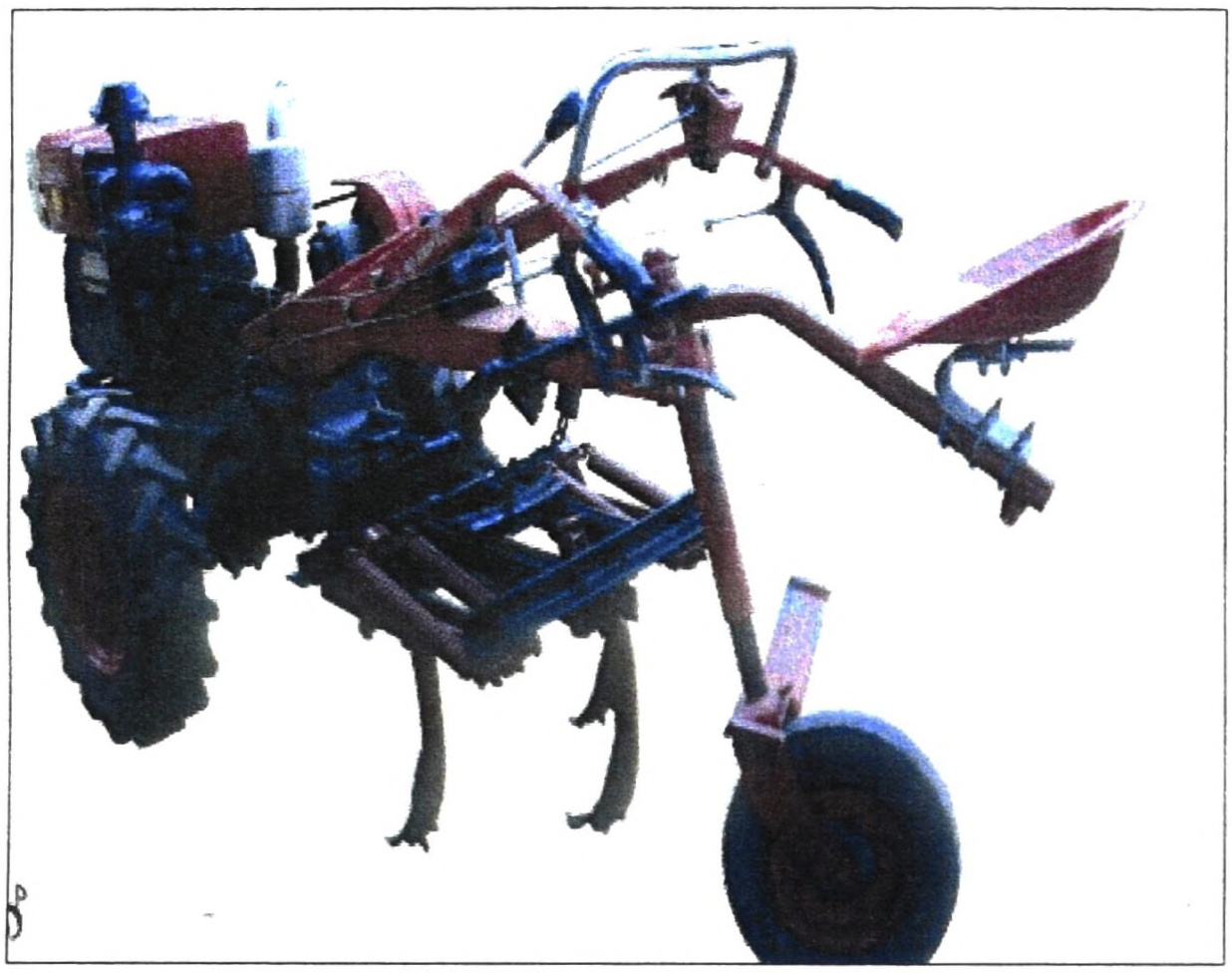
The Farm Mechanization and Research Centre (FMRC) task lies in the introducing of effective agricultural mechanization technologies for the crops grown which are compatible with the socio-economic and field conditions prevailing in various regions of the country. The FMRC tests, designs and develops appropriate technologies to suit local conditions. The commercial production of farm machinery is not mandatory to FMRC and therefore the private sector machinery manufactures who are registered at the DOA produce these machines in accordance with the FMRC designs followed by the tender procedures of the DOA.

Table 3.1 illustrates the contact details of manufactures who produce various machinery for OFC production from different locations of the country with the machinery they produce. Appendix 3.1 provides further details on the distribution of such machinery by the said manufacturers with locations, number of units sold with unit prices. As per the details in Appendix 3.1, groundnut decorticator is the fast moving farm implement which has been sold to farmers in various parts of the country. Given below is a list of farm implements which have been designed and developed by FMRC. None of these machines have additional consumption of fuel for their operation.

Table 3.1: Machinery Manufacturers Registered at FMRC

Company & Contact Details	Machinery
K.G.R Perera, Rangana Motors, Anuradhapura Rd, Daladagama, Ullalapola, Maho.	Manual Seeder for maize, Green gram, Black gram & Soybean
	Maize Thresher
	Groundnut Decorticator (electrical)
	Swiss Hoe (manual)
M.H.M Gaws, Atlas Metal Engineering (pvt)Ltd, 571,Kandy Rd, Kegalle.	Manual seeder for finger millet & gingerly
	Two wheel tractor operated seeder
	Multiple Crop Thresher (maize & Sunflower)
	Peddle pump
	Swiss Hoe (manual)
	Groundnut Decorticator (electrical)
Jinasena (pvt)Ltd, 176/1, Thimbirigasyaya Rd, Colombo 05	Maize Thresher
B.M. Hemachandra, Hansa Industries, NO:400,Pahala Imbulgoda,Imbulgoda.	Two wheel tractor operated 3 tine plough
	Manual seeder for maize, ,green gram, black gram & soybean
	Groundnut Decorticator (manual)
	Two wheel tractor operated pump
	Swiss Hoe weeder
R.M Wijerathne Banda, Indika Motors, Jayamawatha, Bulnewa, Galnewa.	Two wheel tractor operated seeder
	Injector Planter
	Maize Thresher
	Groundnut Decorticator (electrical)
	Swiss Hoe (manual)
T.M Ismahun, Mahaweli Agromec, Technical place, Thambuththegama.	Maize Thresher
	Multiple Crop Thresher with Cleaner
W.M Jayawardhana , Jayawardhana Engineering, No.04,Dewalahinda, Ampara.	Seed Master (4 w tractor) For maize and other OFCs
	Earther (Disc Plough for earthing up maize fields)

Source: HARTI Survey data, 2014



Source: HARTI Survey Data, 2014.

Two Wheel Tractor Operated 3 Tine Plough/Tiller
Photo Credit: FMRC

3.1.1 Two Wheel Tractor Operated 3 Tine Plough/Tiller

The 12 hp tine tiller was originally produced for secondary land preparation to be attached to the four wheel tractor. This was later modified to fit the two wheel tractor and was used for primary tillage as it loosens the soil and removes/uproots weeds. In addition the tine tiller can be used during the crop establishment stage as a weeder between the rows of crops. This machine is appropriate for crops which do not require fine land preparation. The machine is suitable for both lowlands and uplands.

Tine Tiller	Specifications/Remarks
Capacity/Efficiency	1.5 ac/day
Labour Replacement (for maize)*	12 man days/day; 8 man days/ac
Cost per unit	Rs. 30000/=.
Crops	Maize
Manufacturers	Hansa Industries
No. of units sold	1/ Athurugiriya for ginger farming

*Authors' calculation based on DOA data

Source: Department of Agriculture and HARTI Survey Data, 2014

The key constraint associated with the tiller is the high cost of the implement. Farmers at present refrain from purchasing the implement as on the purchase of a two wheel tractor rotavators which are used for secondary tillage are given free of charge by the dealers. As there are no other two wheel tractor operated implements which have been produced for primary tillage there are still rare occasions when these tine tillers are purchased.

b. Ridger

Designed for maize cultivation ridger had been mainly used in Monaragala, Puttalam and Kurunegala areas. Machine with the working efficiency of 2-2 ½ ac/day was introduced at a cost of around Rs. 5000/= after the year 2000. Ridges can be made with this 2 wheel tractor operated machine and there is a provision of adding fertilizer too.

Ridger
Photo Credit: FMRC

3.1.2 Seeders

The FMRC has introduced three types of seeders for OFC production. Machines have been manufactured by adjusting the spacing recommended by the DOA where the distance between plants are reduced while increasing the distance between rows. Accordingly the plant density is kept constant while the increased row distance ensures the use of inter-cultivators after the crop establishment.

a. Manual Seeder for Maize, Green gram, Black Gram and Soybean

The manual seeder can be used by a single person and is more suitable for lands where primary and secondary land preparation is completed. While the machine is drawn on the ground seeds are buried and covered with soil in a shallow furrow dug on the ground by this method. It is designed to complete two rows at a time. Even though the recommended spacing for maize is 30cm x 60cm as per DOA, the FMRC machine has been designed as per 23cm x 80cm in order to use inter- cultivators for weed control and earthling up. According to manufacturers this has been mainly purchased by farmers from the Anuradhapura and Ampara areas.

Manual Seeder (Maize)	Specifications/Remarks
Capacity /Efficiency	2ac/day
Labour Replacement (for maize)*	10 man days/day; 5 man days/ac
Cost per unit	Rs. 25000/=.
Crops	green gram, black gram, maize, cowpea and soya
Manufacturers	Rangana Motors and Hansa industries
No. of units sold	100 & 5 respectively by above manufacturers

*Authors' calculation based on DOA data

Source: Department of Agriculture and HARTI Survey Data, 2014

Manual Seeder for maize, green gram, black gram and soybean
Photo Credit: FMRC

b. Manual Seeder for Finger Millet and Sesame

This machine with 7hp has been developed to encourage row seeding and with this seeder three rows of seeds can be established at once. Pure seeds need to be mixed with sand to maintain the recommended seed rate. The sizes of the sand particles need also to be neither smaller nor larger than the seed so as to facilitate a better seed rate. Forty units had been sold to a non-governmental organization distributing implements in the Moneragala district.

Manual Seeder for finger millet and sesame
Photo Credit: FMRC

Manual Seeder (Finger Millet)	Specifications/Remarks
Capacity/ Efficiency	1.5 ac/day
Labour Replacement (for finger millet)*	25 man days/day; 8 man days/ac
Cost per unit	Rs. 10,000/=
Crops	maize, soya bean, black gram, green gram and cowpea and finger millet
Manufacturers	Atlas Metal Engineering (pvt.) Ltd
No. of units sold	40 units to an NGO

*Authors' calculation based on DOA data

Source: Department of Agriculture and HARTI Survey Data, 2014

This implement can be attached to any power source but mainly used with two wheel tractors. This walk behind type seeder is used in highland where secondary land preparation has been completed. During the use of this machine a furrow is dug, seeds are buried and covered with soil. Performance of the machine depends on the degree of land preparation. According to FMRC this has been used by farmers in Monaragala, Ampara, Puttalam and Kurunegala districts.

c. Rotavator Seeder

- Rotavator seeder is a dual function tractor operated machine (both walk behind type or riding) with a rotavator and the seeder. This was introduced so that prior land preparation is not necessary as the rotavator will accomplish the function while seeding takes place. Introduced recently the implement is mainly used for maize where the distance is fixed at two rows not as the recommended distance of 80 cm but rather 60 cm distance which is mainly due to the rotation difference and the low width of the rotavator.

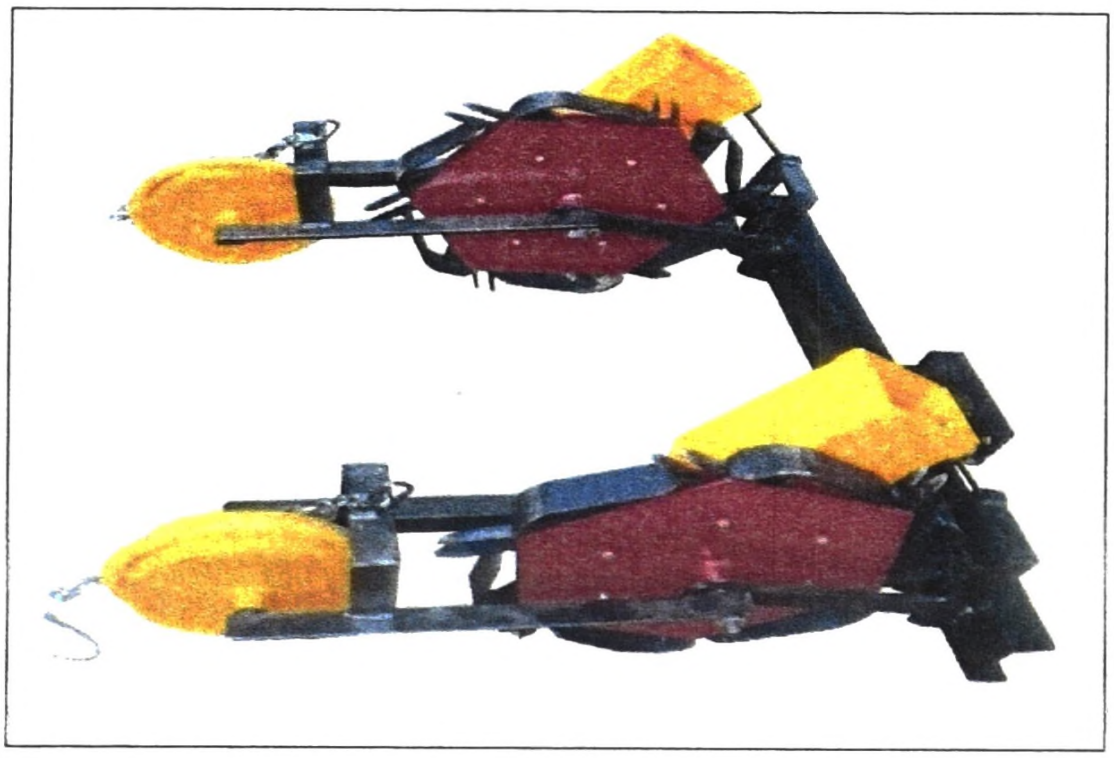
Rotavator Seeder
Photo Credit: FMRC

A proto type of this machine has been tested by Hayleys Agro Company. The company intend to manufacture and selling these machines in the future and to promote this machine through the extension service of the DOA. At present there is a plan to first manufacture 40 of these units and sell them to farmers of the Northern Province. According to FMRC the implement is mainly used by farmers from Kurunegala, Anuradhapura and Ampara areas.

Rotavater Seeder	Specifications/Remarks
Capacity / Efficiency	5 ac/day
Labour Replacement (for maize)*	25 man days; 5 man days/ac
Cost per unit	Rs.48,000/= -Rs.50,000/=.
Crops	maize, green gram, black gram, cowpea and soya bean
Manufacturers	Hayleys Agro Company Agreed to produce

* Authors' calculation based on DOA data
Source: Department of Agriculture and HARTI Survey Data, 2014

d. Two Wheel Tractor Operated Injector Planter (Walk behind type)



Two Wheel Tractor Operated Injector Planter (Walk behind type)
Photo Credit: FMRC

Initially this was designed as a one injector manual seeder by The Jinasena Company in collaboration with Mr. Ray Wijewardena as early as in 1980. Only in the year 2000 this was further developed by the FMRC with more injectors which could be coupled with a tractor. The 7 hp walk behind type machine has been designed as per 23 cm x 80 cm only for maize cultivation.

Injector Planter	Specifications/Remarks
Capacity /Efficiency	2-2.5 ac/day
Labour Replacement (for maize)*	10-13 man days/day; 5 man days/ac
Cost per unit	Rs.45,000/= - Rs.125,000/=
Crops	Maize
Manufacturers	Indika Motors
No. of units sold	4 units to farmers in Vavuniya

*Authors' calculation based on DOA data
Source: Department of Agriculture and HARTI Survey Data, 2014

This was designed as a seeder for planting legumes in stubble soon after harvesting where there has been no land preparation carried out. This is mainly for intermediate crop grown in highland (Chena farming) used in Monaragala, Anuradhapura and Kurunegala (especially Anamaduwa and Galgamuwa areas), according to FMRC. At present this is not commercially produced.

e. Four Wheel Tractor Attached Tine Tiller Seeder (Spring Loaded Tine Tiller)

This 7hp walk behind type implement is a modification of the Chinese implement developed to suit local conditions with spring loaded tine technology. This four wheel tractor operated seeder is designed to complete four rows at once. Work efficiency is lower in smaller fields as turning circle is more in this case. Tested performance is good and FMRC is developing this machine for groundnut.

Spring Loaded Tine Tiller
Photo Credit: FMRC

Spring Loaded Tine Tiller	Specifications/Remarks
Capacity/ Efficiency	4 ac/day (large fields), 2-2.5ac/day (small fields)
Labour Replacement (for maize)*	20 man days/day; 5 man days/ac
Cost per unit	Rs.45,000/=
Crops	maize, green gram, black gram, soya, cowpea and groundnut
Manufacturers	Hayley's Agro company has agreed to produce

*Authors' calculation based on DOA data
Source: Department of Agriculture and HARTI Survey Data, 2014

3.1.3 Threshers

There are two machines available for threshing; Maize threshers and multiple crop thresher.

a. Multiple Crop Thresher

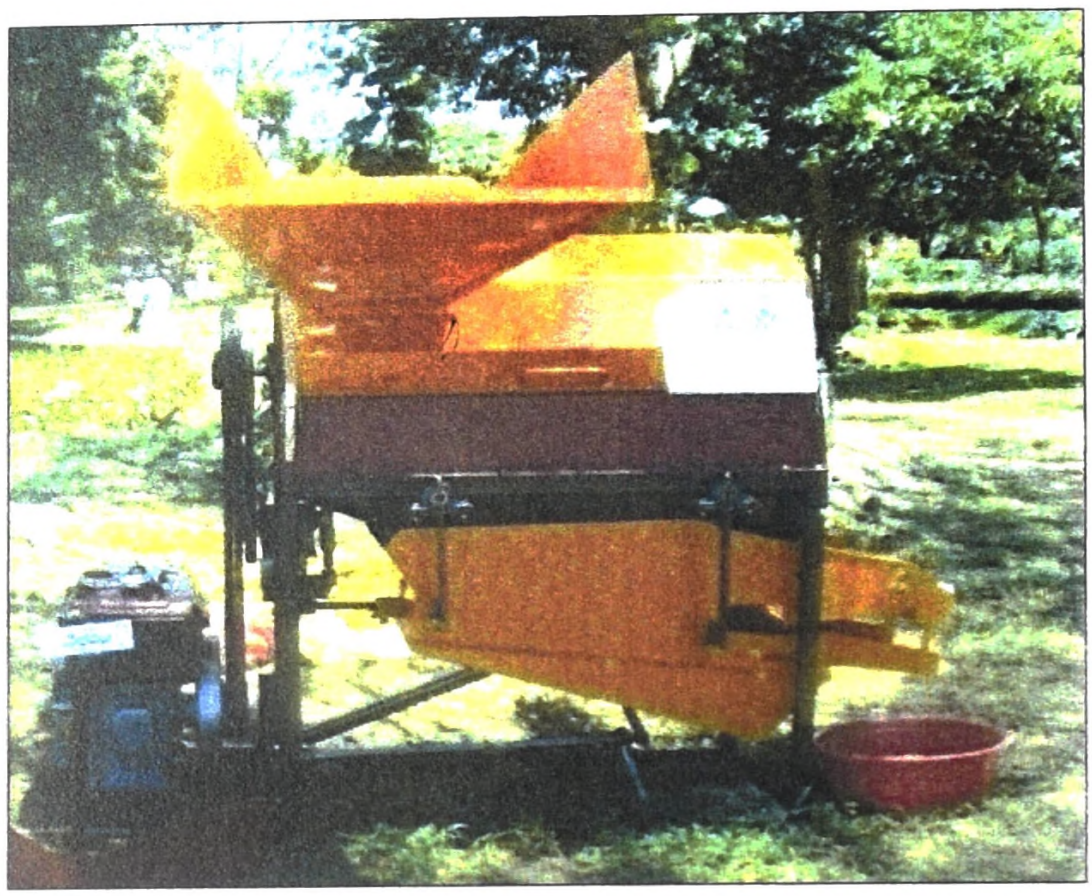
Multiple Crop Thresher
Photo Credit: FMRC

Multiple Crop Thresher	Specifications/Remarks
Capacity/Efficiency	1000kg/hr for maize, 900kg/hr for sunflower and 700kg/hr for soya bean
Cost per unit	Rs.110,000/=
Crops	black gram, green gram, maize, sunflower, soya bean
Manufacturers	Atlas Metal Engineering
No. of units sold	100

*Authors' calculation based on DOA data
Source: Department of Agriculture and HARTI Survey Data, 2014

b. Two Wheel Tractor Operated Maize Thresher

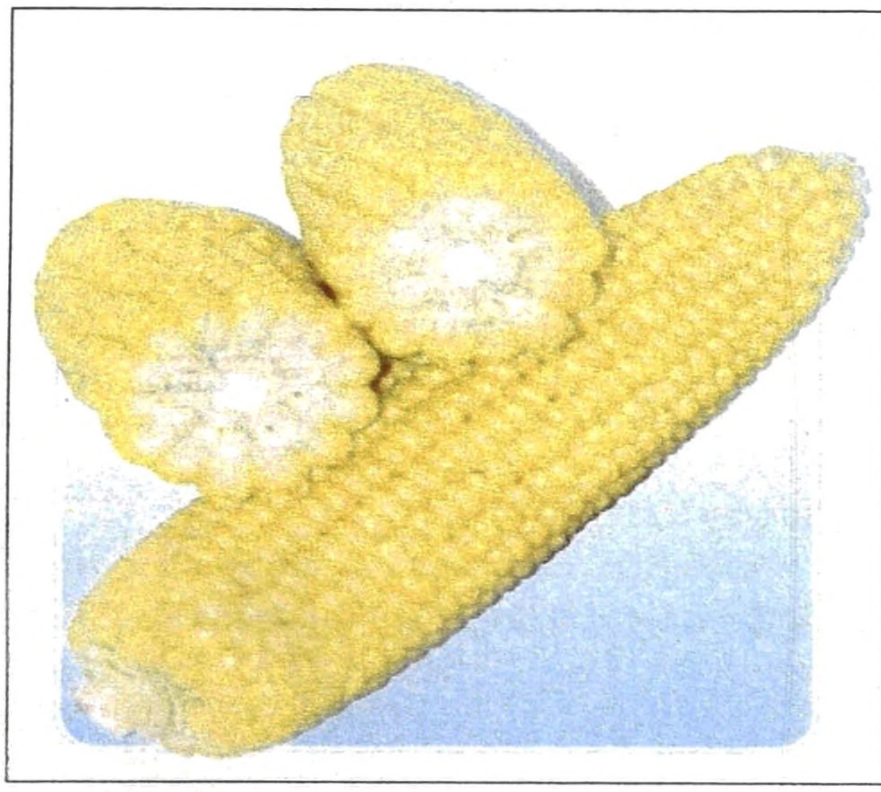
This machine was designed in 2004. Prior to the designing and manufacturing of this thresher, farmers used manual methods. It was an arduous task to remove maize from the cob. The paddy thresher was modified as a higher damage percentage was recorded for maize in these machines. The thresher is powered by two wheel tractor.



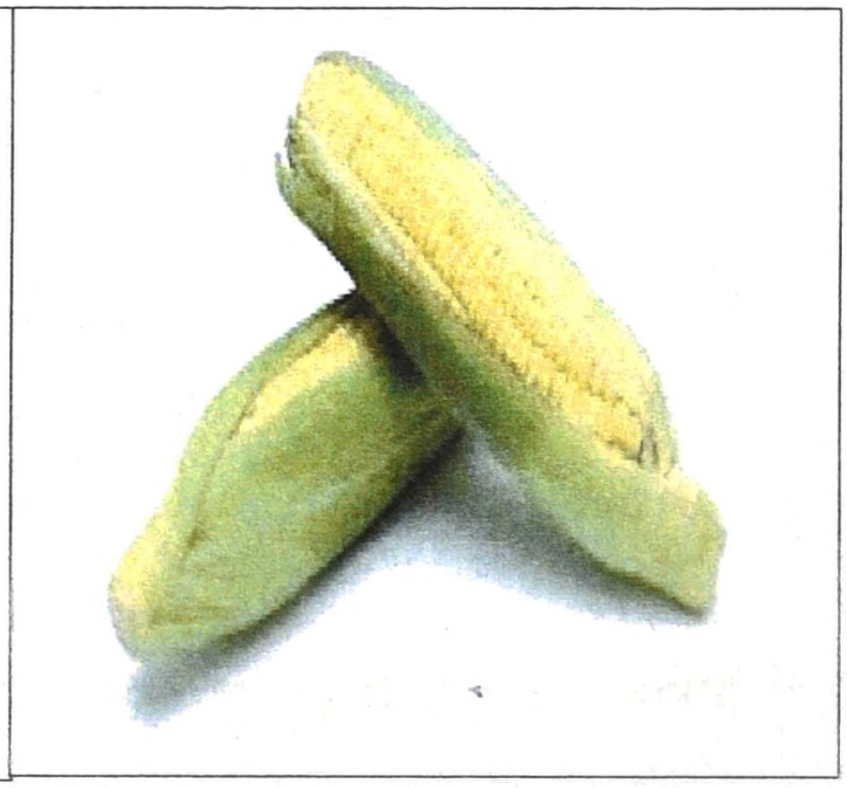
Two Wheel Tractor Operated Maize Thresher
Photo Credit: FMRC

Two Wheel Tractor Operated Maize Thresher	Specifications/Remarks
Capacity / Efficiency	2500kg/hr (without cover) 1500kg/hr (with cover) -1.5 tones/hour
Cost per unit	Rs 145000/= and Rs 148000/=
Crops	maize
Additional fuel consumption	No
Manufacturers	Indika Motors and Rangana Motors
No. of units sold	25 units to farmers in Anuradhapura and Ampara by Indika Motors and 30 units to farmers in Anuradhapura, Ampara and Monaragala by Rangana Motors.

*Authors' calculation based on DOA data
Source: Department of Agriculture and HARTI Survey Data, 2014



Cobs without cover
Photo Credit: www.google.lk, 2014



Cobs with cover
Photo Credit:www.google.lk, 2014

c. Four Wheel Tractor Operated Maize Thresher

Four Wheel Tractor Operated Maize Thresher
Photo Credit: FMRC

This has been designed to replace the use of paddy threshers among the maize farmers. The need for this machine was due to insufficient capacity of two wheel tractor operated maize thresher for medium and large scale maize farmers. The Nawaloka Group plans to design a multi-crop thresher.

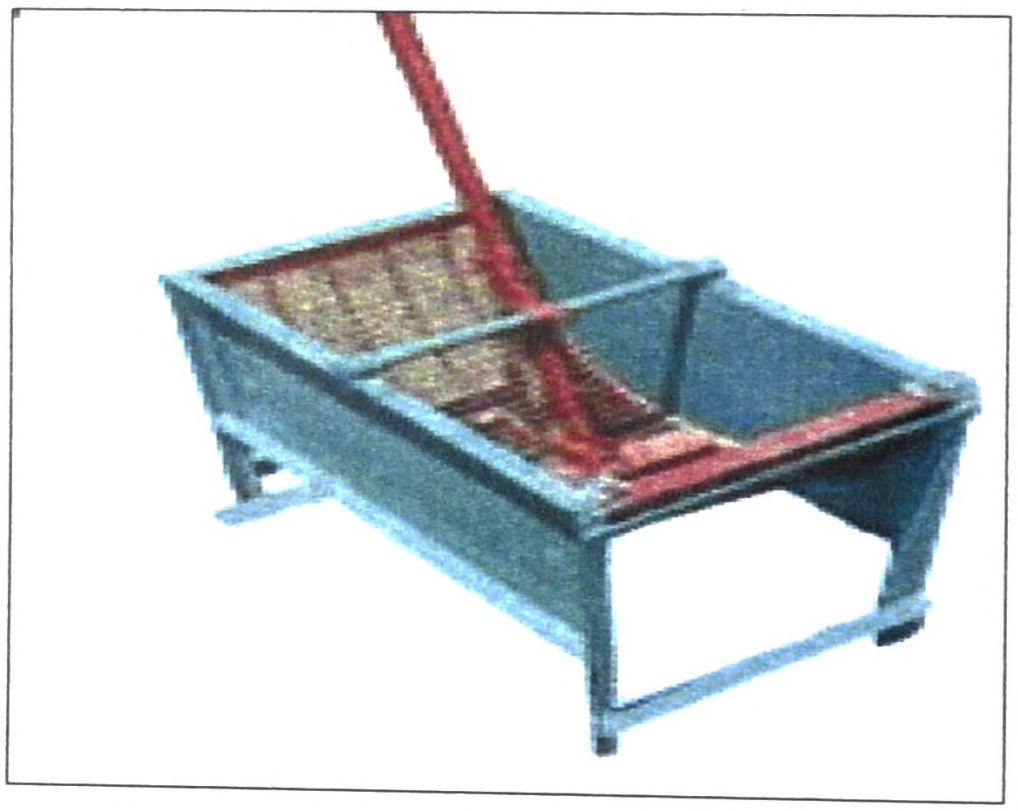
Four Wheel Tractor Operated Maize Thresher	Specifications/Remarks
Capacity / Efficiency	5-6 tones /hr, 95%.
Cost per unit	Rs 285,000/=.
Crops	Maize
Manufacturers	Mahaweli Agromec
No. of units sold	Not sold

*Authors' calculation based on DOA data

Source: Department of Agriculture and HARTI Survey Data, 2014

d. Manual Groundnut Decorticator

The manual Groundnut decorticator was introduced around the year 2000. It is mainly used for groundnut shelling and used by individuals who sell gram. The seeds have to be cleaned manually by winnowing.



Manual Groundnut Decorticator
Photo Credit: FMRC

Manual Groundnut Decorticator	Specifications/Remarks
Capacity / Efficiency	15kg/hr
Labour Replacement	5 times
Cost per unit	Rs. 12,000 -15,000
Crops	Groundnut
Manufacturers	Hansa industries
No. of units sold	200 units to farmers in Vavuniya, Batticaloa, Ampara

*Authors' calculation based on DOA data

Source: Department of Agriculture and HARTI Survey Data, 2014

e. Electrical Groundnut Decorticator

These are electrical motor driven machines using 5 k watt of power. There are three different capacities of these machines which are used for shelling and cleaning of groundnut. The groundnut in its shell is fed to the machine and the end product which is given is the de-shelled clean groundnut. Initially the machine had a capacity of 50-60 kg/hour and later it was further improved to 100, 200 and 400 kg /hour with a shelling efficiency of 70%. The selling records by different manufacturers are as follows.

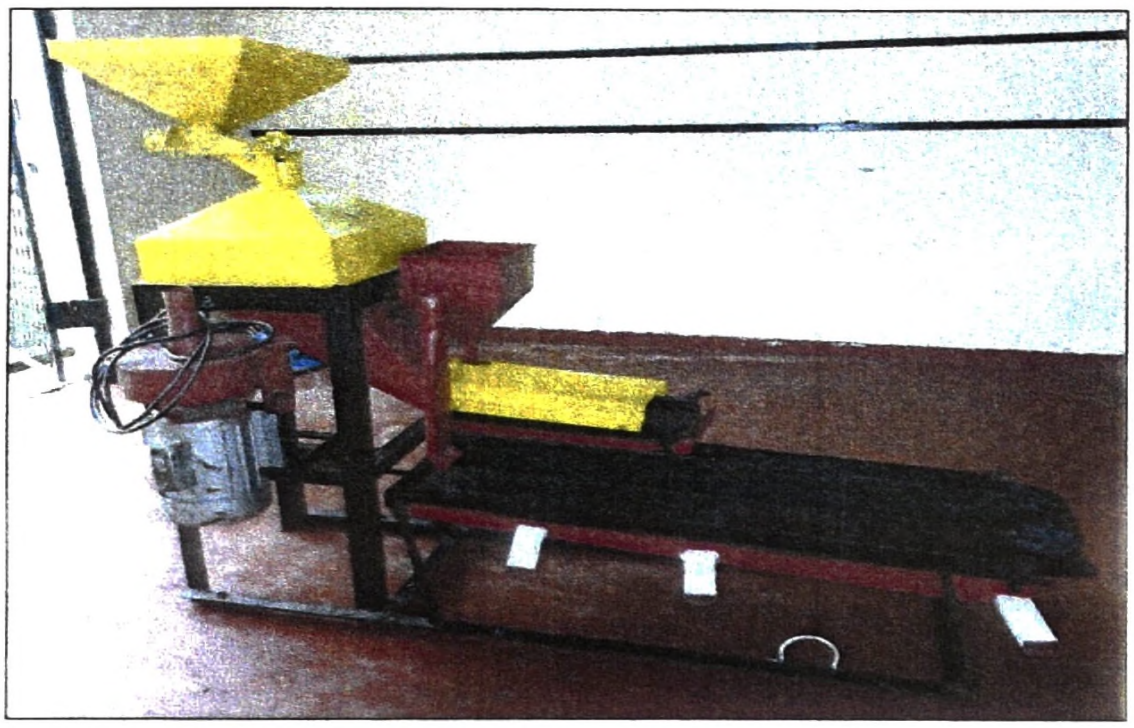
Electrical Groundnut Decorticators
Photo Credit: FMRC

Rangana Motors – 25 units at Rs.145,000/= to the farmers in Mannar, Madawachchi and Maho and to FAO.

Indika Motors - 60 units at Rs.135,000/=, Rs.185,000/=, Rs.275,000/=, to the farmers in Tissamaharama, Hambantota, Elahera, Maho and Kurunegala. Atlas Metal Engineering had undertaken orders from farmers in Northern Province especially from Jaffna.

The key disadvantage of this machine is insufficient shelling efficiency which is around 70% of the groundnut gets decorticated. There is a rubber drum which has to be replaced every three months even if the machine is used at minimum capacity. Therefore Indika Motors developed this with a steel drum which is now promoted by them. But at commercial level there is still no great demand for this machine.

f. Legume Crops Processing Machine



Legume Crops Processing Machine
Photo Credit: FMRC

Legume Crops Processor	Specifications/Remarks
Efficiency (for cowpea)	30-40 Kg/hour
Cost per unit	Rs 200,000/=
Crops	cowpea, green gram, black gram and soya bean
Manufacturers	Not produced at present

*Authors' calculation based on DOA data
Source: Department of Agriculture and HARTI Survey Data, 2014

This was used for purposes of threshing, grading and processing. It requires 1kw/hr. Machine was introduced prior to year 2000. One main disadvantage of the machine is that the first and second processing is normal where the crop is sent through the machine but before the third clean the seeds have to be soaked in water and dried and then sent through the machine. Therefore it is not commercially produced at present.

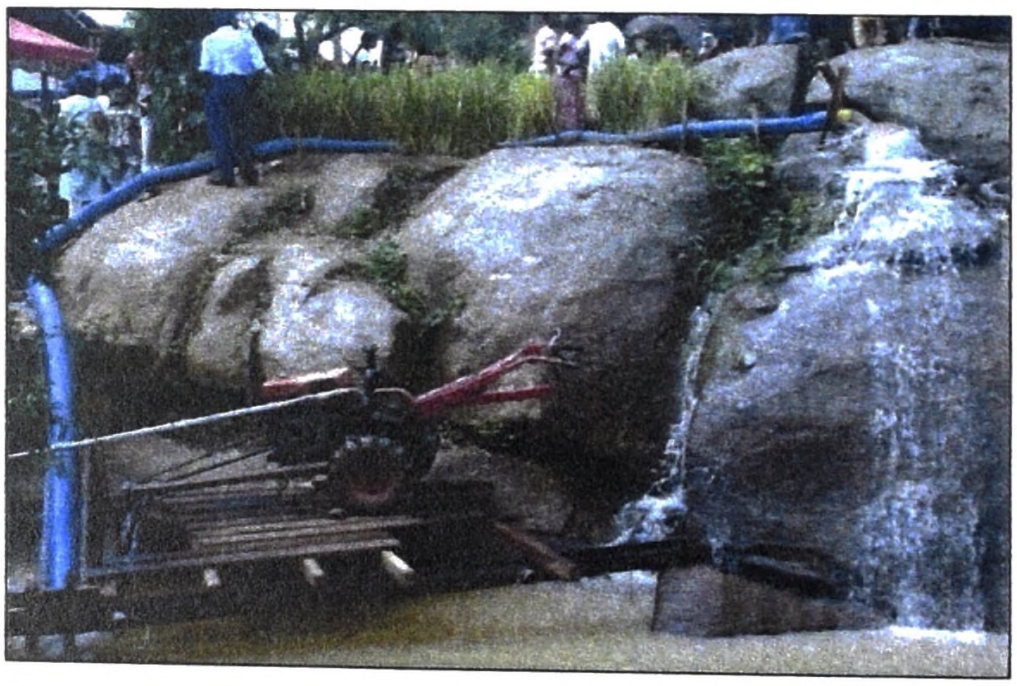
g. Finger Millet Thresher

Finger Millet Thresher
Photo Credit: FMRC

There are two machines with two capacities; 50-60 kg/hr 2 and 300kg/hr. The machine with less capacity was designed since threshing of finger millet was a time consuming task. It has been designed both for threshing and de-husking of this crop. The millet sent through the machine has to be completely dry. Currently this machine is not produced due to lack of demand. Cost per unit was Rs.100,000. The other machine had a capacity of 300 kg /hr can be operated by two wheel tractor or electric motor. This has been tested in Mahailluppallama but yet to be commercially produced.

3.1.4 Water Pumps

a. Two Wheel Tractor operated Axial Flow Pump



Two Wheel Tractor Operated Axial Flow Pump
Photo Credit: FMRC

This water pump has been designed by FMRC with a fuel efficiency of 1.2 l/hr and powered by a two wheel tractor. Capacity is 5000 l/min and a 25 feet head only at 4.5 meter height otherwise flow rate decreases. The water lift is 7m and cost Rs 60,000/=. Submerge pump has only delivery head and no foot valve. This pump cannot be used in agro wells. It is only used in places where the water level does not reduce such as large reservoirs, tanks and irrigation canals. Large areas can be irrigated in a short time from a shallow water source. These water pumps are mainly used in Puttalam, Batticoloa and Kurunegala districts.

b. Four Wheel Tractor operated Axial Flow pump

This has been designed by FMRC with a fuel efficiency of 1.2 l /hr and the capacity is 20,000 l/min. The water lift is 10 m and the cost is Rs 110000/=. Advantages are similar to the 25 feet head pump but with a larger flow of water.

Four Wheel Tractor Operated Axial Flow Pump
Photo Credit: FMRC

3.1.5 Inter Cultivator

a. Manual Swiss Hoe

Manual Swiss Hoe
Photo Credit: FMRC

Swiss hoe inter cultivator or manual weeder is used for weeding in uplands with a capacity of 1 ac/day and cost is Rs. 1500 /=. However this is not popular as many farmers do not purchase this weeder since they have designed one of its own. Atlas Metal Engineering had sold two units for Rs. 1500/= each to the farmers in Kurunegala.

c. Inter-cultivators

Inter-cultivators used to control weeds have 30 cm distance between cultivated plants. The cost is around Rs. 20000 - 30000/=. The capacity is 1 ac/ day. The machine was introduced to Kurunegala and Puttalam areas and at present is mostly seen in the Monaragala and Ampara area.

3.2 Farm Implements Imported and Distributed by Private Agri-Business Firms

3.2.1 Rotavator

Rotavator is used for secondary tillage by attaching to two wheel tractor and the main purpose of using this machine is to pulverize the soil.

Rotavator
Photo Credit: FMRC

3.2.2 Motorized Weeder

This is a motorized weeder which has been imported from China by Hansa industries (Pvt) Ltd. Mainly used for maize grown in small plots of land less than an acre. Mainly machines had been sold in the Vavuniya district.

Weeder
Photo Credit: FMRC

3.2.3 Four Wheel Tractor

This is one of the machines used by a large majority of farmers during land preparation. The four wheel tractor was originally produced to get more power out of the tractor. Increasing engine, wheel and tire size added traction and reduces the soil compaction. The four wheel drive tractor has greater pulling power allowing for the use of a larger combination of implements that can be operated at a greater width and speeds. The result is faster cultivation and quicker planting times, with the seeds being planted in the best conditions in the narrow planting window. It saves time by reducing the number of times (passes) made in a field with large equipment. This in turn lessens soil compaction which means increased yields and profits. One of the greatest benefits of 4 w drive powers is reduced labor and capital costs on the farm. A range of four wheel tractors are imported to Sri Lanka from Massey Ferguson at the cost of Rs.4,440,000/, Tafe 45DI between Rs.1,642,223 to 1,663,890, Mahindra at Rs.1,399,000/, John Deere at Rs.1,750,000 to Rs.2,700,000. This range of costs shown here is with regard to different types and horsepower of the machine.

Four Wheel Tractor
Captured during HARTI Field Survey, 2014.

3.2.4 Seeder

A seeder which was imported from China, has not been commercially viable as the implement is not suited for Sri Lankan terrain. For clayey and muddy soils plus undulating lands the implement which is mainly made of plastic is not durable as there is a greater tendency for breakage.

Seeder
Captured during HARTI Field Survey, 2014.

3.2.5 Views of the local Importers of Machinery

According to the view of the local importers farm machinery when imported is cheaper in cost than machinery produced in Sri Lanka. For example the cost of a seeder (shown above) can be imported at Rs.250,000 – Rs.300,000/ from China inclusive of all the taxes and duties. According to the importers in addition the machines can be purchased more easily and as required as when it is manufactured locally due to delays by manufactures under local circumstances. They are also of the view that the imported machines are durable.

The importers complain that they are faced with a multitude of constraints such as that the government does not help them to sell machine by popularizing the machines among the farmers. As most of the importers do not have extra cash and the facilities to advertise the machines they are faced with the burden of popularize the new machine. Importers explained that it is the responsibility of the DOA to popularize the machines among the farmers through the extension programmes. The present

advertisement avenue was the agricultural exhibitions such as 'Deyata Kirula' which is an inadequate means of popularization. According to importers the one machine which has had sales is the four wheel tractor. With aggressive promotions a few of the machines such as seeder and tiller have been sold to farmers.

3.3 Farm Machinery Developed and Sold by Local Manufacturers

The Table 3.2 provides the details of local machinery innovators who are both farmers and machinery manufacturers.

Table 3.2: Machinery Manufactures in Study Locations

Name	Address	Contact No.	Machine Description
Mr.Anura Dissanayaka	Kongashandiya, Mahakalugolla, Siyambalanduwa	0779896196	Two wheel tractor operated disc plough
			Combined Paddy Harvester altered for Harvesting of Maize Four wheel tractor operated Seeder
Mr. H.B.M. Sampath	Gamunupura Ethimale	0774528070	Rotovater altered for earthing-up
Mr.Chamara Priyantha	Podagama, Thanamalwila	0716225017	Paddy agri-mec altered for threshing of finger millet Modified FMRC maize thresher
Mr.W.M Jayawardhana	No.04, Dewalahinda, Ampara	0774512480	Seed planter for several OFCs including Maize, Cowpea, Green Gram
			Furrow opener for weeding and earthing-up
Mr. Chandrasiri	Devalaya, Lahulgala	0715525420	Combined Paddy Harvester altered for Harvesting of Maize

Source: HARTI Survey Data, 2014

The Case studies of the above machinery manufacturers is given below.

3.3.1 Two Wheel Tractor Operated Disc Plough

Mr. Anura Disanayake was first involved in the machinery manufacturing industry at the age of 20. The four/two wheel tractor operated disc ploughs produced at his own workshop are popular especially among the farmers who opened up new lands in war affected areas such as Kotiyagala, Ethimale, Buddama, Dambagalla, Bibila and Maha oya in Ampara districts. The machinery is displayed at the selling point in Siyambalanduwa town. He has never visited FMRC but had participated in exhibitions held in Colombo and surrounding areas. Around ten people are employed at his machinery manufacturing plant. The cost of disc plough was Rs.130, 000/= during 2013/14 *Maha* season.

Disc Plough
Captured during HARTI Field Survey, 2014.

During the months from November to January the plant is closed for operations due to lack of demand for machinary. During that period the workers are involved in farming activities. More than 1500 four wheel tractor operated trailers were produced and sold at Rs.340,000/= in 2014. He has not acquired any patents and according to him the MOA or any other government organization is not aware of his involvement in the manufacturing of farm machinery. He has not obtained any credit facilities for his industry however he seeks assistance for such services for the expansion of the industry. He also states: "there are no places for my customers to get credit. Therefore they take machines on credit basis and

at the end of the season after six months they do payments at once. I do not retain a big margin. Of them around 80 percent do payments accurately as most of them are large scale farmers who cultivate more than 10 ac". The plough is largely used in sugar cane and maize cultivation.

3.3.2 Four Wheel Tractor Operated Seeder

The seeder produced by him is one that is adjustable and used for maize cultivation. As it has springs it does not break when it is used in an uneven earth. Machine specifications are: Spacing 10 inches ×27 inches. It requires only 6-7kg of seeds per acre. With this spacing thinning out of plants is not necessary so that 10% of seeds wasted through thinning out are saved. The machine was used only in 2013/14 *Maha* season for seeding of around 40ac of his own land.

Seeder
Captured during HARTI Field Survey, 2014.

Farmers prefer to rent his machine as they are available on credit basis. He is also a good extension worker as he takes the time to explain to the farmers on the working of the machines produced by him and is involved in after sales services for a period of one year. According to Mr. Anura Disanayake, farmers lack knowledge on the use of machinery and therefore they need to be enlightened. Due to their lack of knowledge on machinery farmers face many problems; (a) use of more than the recommended quantity of seeds per acre incurring an additional cost (b) high cost of machines (c) problems faced when machines are bought on lease such as difficult to find parts for some machinery and companies.

For instance one farmer who used a Chinese machine stated that it breaks easily due to the use of plastic rather than metal in manufacturing.

3.3.3 Altered Combine Harvester for Maize Threshing

The John Deere combine harvester is used for paddy harvesting which was modified by Mr. Anura Disanayake to harvest maize. The alteration has been made in the teeth of the cutter bar for maize harvesting and processing of maize. He had harvested his own field in 2012/13 *Maha* season. According to Mr Dissananyake the machine is most appropriate for flat terrain.

However, according to him the crop was harvested at 4.5 months so that the crop is thoroughly dry otherwise the wet seeds block the huller causing reduction in efficiency of the machine. Well dried maize seeds are not broken with the use of machine. Once maize crop is harvested the machine is once again altered for harvesting of the paddy crop. The cost of harvesting in 2013/14 *Maha* season was Rs.8000 to 10,000/ac and the process takes two hours.

Altered Combine Harvester for Maize Threshing Captured during HARTI Field Survey, 2014.

3.3.4 Paddy Agrimec Altered for Threshing of Finger Millet

Finger millet was traditionally threshed with the use of mortar and pestle, a time consuming operation mainly done by women. One farmer in Thanamalwilla altered the Agrimec machine to suit the requirements of threshing finger millet. This has been done by covering the huller with a sheet made of iron so that the harvested crop when fed into the machine

is pressurized to separate seeds. The machine has a capacity to process 1000kg/hr. During 2013/14 *Maha* season the threshing cost has been Rs.8/kg. The owner had taken this machine to the *'chena'* where finger millet is grown and the farmers had benefited from mechanical processing of finger millet both in terms of time and cost reduction.

Paddy Agrimec Altered for Threshing of Finger Millet
Captured during HARTI Field Survey, 2014.

One of the disadvantages of this machine is that the seeds mixed with crushed plant parts should be separated by putting an extra effort. The machine operator does this operation with the help of his two wheel tractor. Or else seeds should be separated by winnowing. Safety of the operator is a serious issue due to manual feeding of plants into the machine where there is a risk of the operator's hand getting crushed. Attaching a fan for seed separation and a bucket for feeding of plants are among the possible improvements needed.

3.3.5 'Seed Master'

This implement was designed by a farmer cum machine producer in Ampara district. Realizing the problems faced by the Sri Lankan farmers in OFC production which is mainly the scarcity of a trained labor force this individual set about designing the 'Seed master'. Many labour days are required for seed planting and fertilizer application for which this implement was produced.

The Seed Master *SL* is a Multi-crop seeder cum fertilizer drill. It is a tractor drawn implement which has been designed for planting maize, groundnut, black gram, soybean, green pea, bean seeds and sunflower seeds. With the aid of this 'Seed master' proper spacing can be maintained for each crop with a controllable required depth. The distance within and between rows and plants are adjustable. It has two separate chambers, one is for seeds and the other is for fertilizer. The chamber inserts fertilizer and seeds separately at the same time. Therefore, this machine while being efficient reduces the labor cost drastically.

Seeder
Captured during HARTI Field Survey, 2014

In addition to the Seed Master developed for OFC crops he has also developed a seed planter for highland rice farming and a Seed Master *SL* Hole digger for coconut, banana and other plants that require deep holes dug in the ground.

Field preparation using Seed Master Maize crop after use of Seed Master

Source: seedmastersl.blogspot.lk (access date: 2014.11.05)

3.3.6 Rotavator Altered for Earthing Up

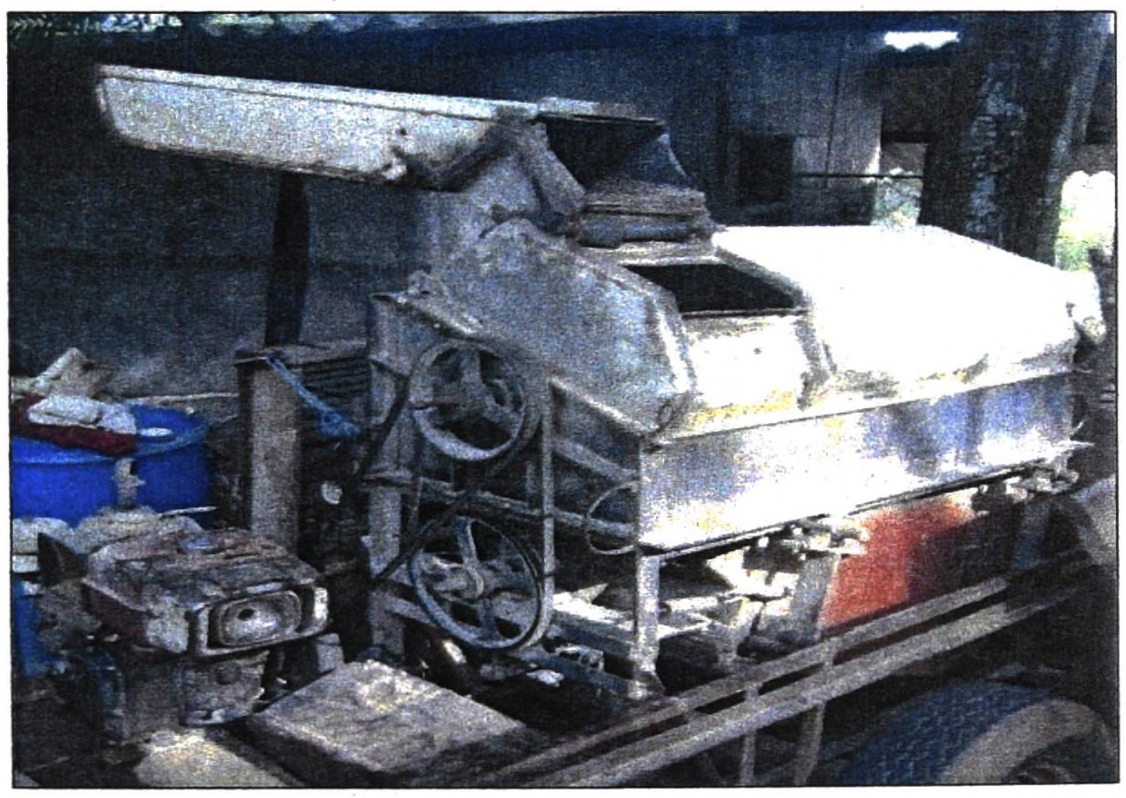
Mr. Sampath is a young and innovative farmer who has experimented on farm machinery to try and find ways to adjust machinery to suit the Sri Lankan agricultural fields. He has changed the structure of the rotovator to an earthing up implement. This implement was used for earthing up process in maize cultivation. His adjustments proved to be successful, but the implement at present is not used as the material used being of low quality and after a couple of seasons it has become defunct. He has plans to rebuild another implement in the near future.

The capacity of the implement is between 1 and 1.5 ac per day and it consumes 5l of diesel which cost Rs.600/ac. When the implement was used he spent around Rs. 6000/for earthing up per 1 ac of land. He could save a lot both in cash and time by using this technique in 2013/2014 *Maha* season.

Rotovator Converted to Earthing up Implement
Captured during HARTI Field Survey, 2014.

3.3.7 Modified FMRC Maize Thresher

The same farmer has modified the FMRC maize thresher which when in operation had a number of errors. Belt of the huller skipped always due to unmatchable placement and fixing, due to which, it cannot be operated continuously for more than few minutes. He has renovated the machine by making necessary changes. Now the machine can be used continuously for a long time without the machine becoming inoperable.



Maize Thresher
Captured during HARTI Field Survey, 2014.

3.3.8 Altered Combine Harvester for Maize Threshing

Combined Harvester (Bar)

Converted Cutter

Captured during HARTI Field Survey, 2014.

A large scale farmer had altered his combine harvester by replacing the huller and teeth on the cutter bar with newly manufactured parts that are appropriate for maize harvesting and processing of maize. The crop is harvested around six inches above the ground. He had harvested around 80ac in 2102/13 *Maha* season and 45ac in 2013/14 *Maha* season. To be more effective the land should be of plane terrain.

In general the farmers need to harvest their crop in 3.5 months for various needs. However, according to him the crop should be in the field for more than 4.5 months so that the crop is thoroughly dry otherwise the wet seeds block the huller causing reduction in efficiency of the machine. Well dried maize seeds are not broken with the use of machine. The wastage is 3-25%. Once maize crop is harvested the machine is adjusted for harvesting of the paddy crop. The cost of harvesting in 2013/14 Maha season was Rs. 10,000/ac and it takes two hours.

3.3.9 Views of Local Manufacturers

Some of the manufacturers of machinery in Sri Lanka are innovative and progressive farmers who have mechanical knowledge. They are generally small to medium scale entrepreneurs who have set up small workshops either by obtaining credit or with their own finances. Production of machines and implements by these manufacturers are based on orders which they receive from farmers. They purchase raw material and recruit temporary employees after having a confirmed order. One disadvantage of this is that they can hardly maintain permanent staff or stores of raw materials because there is no continual demand meanwhile most manufactures themselves are employees within their own premises.

According to the manufacturers there are several constraints for the successful operation of machinery industry; scarcity of skilled labour, high cost of labour and raw materials and less demand from the local market.

1. Scarcity of Skilled Labour: Machinery manufacturers have to recruit employees on a temporary basis because of the lack of a continual demand from the market for which skilled workers cannot be recruited.

2. High Cost of Labour: The 'labour cost' in the local machinery industry is high as operations are labour intensive as a large number of operations are done manually from metal cutting and curving to welding. Therefore the number of labour days required to manufacture an implement is high which in turn increases the labour cost.

   According to certain manufacturers the other impact of the labour is directly related with the market size. For example, countries such as India and China have huge local demand in their local markets, which means they produce on large scale. This in turn increases productivity and efficiency, enhances expertise and overall improvements in the machinery industry. These countries have low production cost where small scale local manufacturers thus find difficult to compete.

3. High Cost of Raw Materials: Local manufacturers request tax deductions in raw materials for manufacturers producing agro-implements. According to manufacturers demand of the local market is very complicated since our local market is small therefore there is

only a very small potential for the manufacturer. Therefore what is required is that there should be a policy to either promote local manufacturers to manufacture locally or import machines by providing necessary requirements. According to one manufacturer he was discouraged by a state authority procedural details and government red tape in the past which had necessitated him to pay bribes to get tenders passed by various boards. As he said, public mechanism and institutional framework in this sector have to be re-evaluated and re- constructed.

4. Less Demand from the Local Market: Unfavorable attitudes of farmers towards machinery usage, unwillingness to change the present method of cultivation and fear to deal with new technology are some points raised by concerned manufactures. Farmers do not like to risk their hard earned money on machinery. A remedy which the manufacturer suggested was the provision of credit facilities. In addition manufacturers suggested that there should be a stronger linkage between the officers from the agriculture sector with farmers and manufacturers by which farmers will be made aware of the new technology available in the market.

CHAPTER FOUR

Awareness and Use of Farm Machinery for OFC Production

4.1 Introduction

This chapter presents a discussion on farm mechanization in OFC production in study locations. It describes the level of farmer awareness and the degree of utilization of farm implements available for OFC production. The discussion is organized under sub headings allocated for major OFCs grown in study locations namely maize, green gram, cowpea, groundnut and finger millet.

4.2 Maize Production

4.2.1 Pre-land Preparation

As revealed from the literature survey there was no marked shift towards mechanization of maize production until 2011/12 *maha* season, however, the HARTI survey reveals a gradual shift towards mechanized processing of maize in study locations by 2013/14 *maha* season. The commercial farmers from provincial areas operate maize cultivation at larger scale in uplands during *maha* season. These uplands are kept fallow during the *yala* season due to lack of rainfall and therefore are occupied by shrubs and grasses like *mana*. Thus intensive pre-land preparation is a must. Since mid-August farmers begin to remove shrubs and grass with the mammoty and other traditional farm implements which consumes 10-15 mandays per acre. Deviating from these conventional means of pre-land preparation a farmer from Pallanoya area in Ampara district had begun to use a bush cutter for cutting weeds particularly to stop the use of weedicides and to reduce the cost of other manual methods of pre land preparation. When new lands are opened for maize cultivation the traditional *chena* cultivation system is practiced. The cultivation begins with pre-land preparation through destruction of and setting fire to shrubs and undergrowth. As these lands are highly undulating the most of the operations are done manually.

4.2.2 Land Preparation and Crop Establishment

In most cases in sloped lands land preparation by disc plough is done ignoring contours which lead to increased erosion. With the onset of rains

the lands are ploughed once or twice depending on the soil condition with the disc plough. Almost all the farmers know about disc plough however the affordability is not applicable not only due to the cost of the plough (Rs.125,000) but also farmers do not own tractors to operate ploughs. Therefore disc ploughs are used on hired basis and accordingly the majority of the farming community from both districts (74 percent farmers from Ampara district and 82 percent farmers from Monaragala district) participated in group discussions had used disc ploughs for land preparation. The data also shows that a higher number of farmers than those who actually used the disc plough prefer disc ploughing (84% from Ampara and 88% from Monaragala). Since lands are occupied with grasses and shrubs farmers are used to disc ploughing. Sometimes tine tiller is also used followed by disc ploughing and some others do disc ploughing regardless of their lands being occupied with grass and shrubs or not. All these actions lead to severe erosion of land.

Table 4.1: Awareness, Affordability and Use of Farm Implements for Land Preparation in Maize Production in Study Locations

Farm Implement	% of Farmers in Ampara District				% of Farmers in Monaragala District			
	Aware of	Affordable	Used	Willing to use	Aware of	Affordable	Used	Willing to use
Disc Plough	100	NR	74	84	100	NR	82	88
Tine Tiller	100	NR	46	36	100	NR	58	32

Source: HARTI Survey Data, 2014

Land preparation is followed by application of a weedicide before or soon after planting of seeds to suppress weed growth. When the bush cutter is used the land is ploughed once before planting of seeds.

A couple of year's back draught power was the main source of power used for the opening up of furrows for planting of seeds. This is still practiced to a certain extent. In addition since late 2010 the tine plough is been used. It is altered to suit the cultivation of maize by removing five out of nine tines to maintain 1.5 feet spacing between the rows. The entire farming community is aware of the tine plough, however affordability is still less as per disc plough due to high cost which is around Rs.30,000/=. The choice

between the tine plough and the disc plough depends on the condition of the land and weed growth and the availability of farm implements in the area. Accordingly there has been more or less equal demand for the disc plough and tine tiller from the farmers in both areas however data shows that disc plough is much preferred.

Seed Establishment

Manual seed planting predominates in both areas though it is both costly and time consuming. There were five types of machines available for the planting of maize seeds namely, manual seeder, rotavator seeder, injector planter, 'seeder' and 'seed master'.

Table 4.2: Awareness, Affordability and Use of Farm Implements for Seed Establishment in Maize Production in Study Locations

Farm Implement	% of Farmers in Ampara District				% of Farmers in Monaragala District			
	Aware of	Affordable	Used	Willing to use	Aware of	Affordable	Used	Willing to use
Manual Seeder	100	23	34	38	100	32	24	28
Rotavator Seeder	30	10	0	21	10	4	0	26
Injector Planter	100	NR	8	0	53	NR	10	0
'Seed Master'	28	1	11	52	40	1	14	48

Source: HARTI Survey Data, 2014

Out of these five machines 'Seeder' manufactured by a local farmer was only for his own use but was not commercially produced. The entire farming community was aware of the manual seeder manufactured by FMRC in both locations and a certain percentage of farmers were affordable too from both locations. As evident from the data the number of farmers who are willing to use this machine is higher than the number who had already used.

FMRC has introduced two wheel tractor operated rotavator seeder for seed planting for many OFCs including maize. This machine was demonstrated both in provincial and inter-provincial areas in Ampara district. Accordingly a certain percentage of farmers from both areas were

aware of rotavator seeder however none of them had used it. Affordability is also less but some farmers had shown an interest to use this machine. Experienced farmers who had previously used machines stated that though it consumes less labour and time, there are several constraints i.e. the number of seeds per planting hole unable to stop seeding whenever required and poor control of plant spacing and waste of seeds at the turning points. Some farmers felt that the machinery is not needed and those who wish to use them are lethargic. They believed that manual operations are the most efficient thus investing in farm machinery is a waste of resources. Though women in this area were extensively involved in OFC farming activities, they were hardly aware of mechanized operations for OFC cultivation.

Though injector planter is well known to the farming community it is presently out of demand.

'Seed Master' by an innovative machine fabricator from Pallanoya in Ampara district (Mr. Jayawardene) is a recent intervention for the planting of maize seeds. It is largely used in provincial areas where large tracts of thousands of acres are under maize cultivation. Currently the machine has an enormous demand and during 2013/14 *maha* season around 400 ac have been cultivated with the 'seed Master' in Ampara and Batticaloa districts including large farms of private sector in Welikanda and Punani areas in Polonnaruwa district. The manufacturer had hired out three machines for planting of seeds at a cost of Rs.3,500/ac. Four machines have been sold to Batticaloa, Ampara and Trincomalee areas at the cost of Rs.275000/.

Ethimale is a predominant maize producing area in the Monaragala district and a provincial extension service has recently been extended to this area. The farmers have not been introduced to any machinery for mechanization of maize production though most farmers operate on larger scale. According to the Agriculture Instructor of the area (Mr. Lakmal Ranweera) the 'seed master' had been used by 5 farmers in the area in 2011/12 *maha* season. Fairly flat and smoothly prepared lands are necessary for the successful operation of this machine otherwise seeds cannot be buried deep into the soil. Except for this weakness 'Seed Master' is a good intervention for large scale crop establishment. Currently, 'Seed Master' is becoming popular among the farmers for seed establishment in both areas. Certain farmers had already used the 'Seed Master' and more farmers are willing to use this in the future.

A machine, introduced by another manufacturer from Mahakalugolla in Ampara district (Mr. Anura Dissanayake), had been used in 2013/14 *maha* season for seeding of around 40ac of his own lands. In the following year the same machine was used for planting of seeds in around 40 ac. An earther was also produced by Mr. Dissanayake where around 150 units was sold in 2012/2013 *maha* season and 2013/2014 *maha* season but in 2014/2015 *maha* season the number he was able to sell decreased to 100 units. The main reason for this as understood by him was that the units sold were exchanged among the farmers and therefore there was no necessity for any additional new units to be purchased.

Crop establishment has been mechanized by another farmer using a locally manufactured two wheel tractor operated 'furrow digger/opener'. The manufacturer is the same person who introduced the 'Seed Master'. Fabrication of this machine has been to circumvent the weaknesses of 'Seed Master'. This farmer had experienced that the seeds had not been buried when he used seed master on his land which had an undulating terrain and where the land had not also been prepared smoothly. The expectation of this farmer is that the machine needs to be upgraded to seed planting and covering of seeds with soil.

4.2.3 Inter-cultivation Practices

Earthing up in maize cultivation is also a manual operation as irregular spacing of the crop does not permit the use of machinery. Inter-cultivators can be used when the crop is established using the 'Seed Master' as regular spacing is maintained. It was found that a furrow opener had been used for weeding and earthing up operations but only for the crops grown with regular spacing. None of the farmers had used this machine except for the manufacturer.

The common inter-cultivation practices in maize production are earthing up and fertilizer application. A large scale farmer (Mr. Anura Disanayaka) had harvested around 2500kg/ac of maize on average by applying fertilizer but with no earthing up. Instead he had used a herbicide called 'Clio', which kills all the weeds by disintegrating the chlorophyll in the plant. This reduces competition and makes it unnecessary for earthing up. The herbicide is termed as an impact herbicide which interferes with plant photosynthesis, membrane structure and carotenoid pigment formation. "Bleaching" of weeds is an evident effect and exposure to sunlight kills target broadleaf weeds and grasses (www.impactherbicide.com/features.

html). According to him this herbicide comes in 300ml bottles. He had used 25 bottles at a cost of Rs.5050/bottle spending Rs.100 per tank for spraying for 30ac of land. As a large scale farmer he had always experienced scarcity of labour for maize cultivation and therefore delayed cultivations both due to ever increasing number of farmers growing maize and thereby the increasing acreage. Other than this most of the farmers practice inter-cultivation practices as they do traditionally.

4.2.4 Harvesting and Processing

Conventionally maize was harvested manually which takes around 10 man days/ac. While some farmers harvest young corn cobs (green cobs)for boiling purposes others harvest when the corns are completely dried. Corn so harvested are further sun-dried and then processed in different ways. In the most traditional maize processing method such as in Panama in Ampara district corn is packed in a polythene bag or gunny bag and beaten with a baton.

Table 4.3: Awareness, Affordability and Use of Farm Implements for Harvesting and Processing in Maize Production in Study Locations

Farm Implement	% of Farmers in Ampara District				% of Farmers in Monaragala District			
	Aware of	Affordable	Used	Willing to use	Aware of	Affordable	Used	Willing to use
Combine Harvester	4	NR	2	14	11	NR	1	10
Multiple Crop Thresher	67	5	31	43	92	2	22	39
Maize Thresher (2wheel)	100	2	14	48	100	3	0	5
Maize Thresher (4 wheel)	13	1	0	8	8	1	0	5
Paddy Thresher (Tsunami)	100	NR	72	98	100	NR	78	96

Source: HARTI Survey Data, 2014

Some farmers process corn by spreading them on the floor and then moving a tractor over the corn similar to the threshing of paddy. Damage is minimal in this method. However gradually farmers have turned to harvest and process corn in a newer method.

As revealed from group discussions at Bodagama, Thanamalwila in Monaragala District (Mr. M. G. Gunasena and the group) farmers had tried to use combine harvester for maize without much alterations in the machine except for changing only the spacing, however this had proved to be unsuccessful. Farmers had experienced that seeds were mixed with crushed plant residue resulting in high wastage.

Altered combine harvester is a new intervention by two large scale farmers in study locations. A machinery owner from Lahugala in Ampara district (Mr. M. Chandrasiri Devala Asala, Lahugala) had altered his combine harvester for both harvesting and processing of maize. The cost of operation of this machine for one acre of land is Rs.11000/ac in 2012/13 *maha* season and it has been reduced to Rs.10,000/ in 2013/14 *Maha* season. This method has replaced the number of labour days which required for harvesting and processing of maize cultivated in an acre of land. The limited use of this method was found only among two owners of combine harvesters who had altered their machines for the purpose.

A farmer from Wedikumbura in Monaragala district (Mr. Ajith Priyananda Ariyarathna from Vihara Mawatha, Aluth Waththa,) had hired the above machine for harvesting of his maize crop during 2012/13 *maha* season spending Rs.11000/ac with additional two labour days/ac. The crop was grown in his fairly flat land of 6 acres. According to Mr. A. P Ariyaratne the capacity of the machine varies with different land types: 6 ac/day on flat lands and 3 ac/day on lands where there are boulders and rocks. The machine could be used in most of the lands in the area except in highly steep lands in Monaragala district. For successful operation of the machine corn should be well dried otherwise during threshing, around half of a polybag of husks gets mixed with the seeds when an acre of maize is processed. The wastage amounts to 25-30 kg/ac which is higher than that of paddy thresher. Another disadvantage of using combine harvester is that it fails to pick the plants which were fallen on the ground while harvesting. Plants grown upright are only cut at 1.5 feet above the ground level. The best time for harvesting of corn with this machine is at the age of 4.5 months when they are sufficiently dried. If the corn is not adequately dried the wastage is higher.

Another large scale farmer (Mr. Anura Disanayake) had also used an altered John Deer combine harvester for harvesting of his maize crop. The machine efficiency was reported as 8 ac/day. He had hired out the machine at Rs.8000/ac. The key advantage is saving of labour though around 10% of corn are left on the field which thus requires additional labour for the collection. Mixing of crushed husks with the seeds is the other disadvantage. According to him the machine can be improved to avoid these weaknesses. The activities in maize production process by this person involve primary ploughing with the disc plough, secondary ploughing with the tine plough, seed planting with the seeder made by himself, application of weedicide instead of earthing up, fertilization and harvesting and processing with the altered John Deer combine harvester. Accordingly over 90% of maize production activities are mechanized.

The FMRC introduced Agrimec machine for the processing of maize in 2010. A farmer from Siyambalanduwa in Monaragala district (Mr. K.A. Lakshman Priyantha) had received an Agrimec machine in 2012/13 *Maha* season. He had at that time grown 10 ac of maize and the entire harvest had been processed with this machine. According to him the threshed seeds are very clean with no impurities but one disadvantage is that machine is very heavy and requires four persons to move it from one place to the other. For efficient operation of this machine it requires eight persons, one to pack the corns into bags, one to load corn into the machine, one to insert the corn into the machine, two to remove seeds, two to separate seeds (hulling), one to remove husks from the hull (part of the machine) as it is difficult to hull at a high speed with husks. Farmers today expect to complete any activity within the shortest time period for which they seek machines with the highest efficiency. When compared with paddy thresher (tsunami) the Agirmec is highly inefficient (communication with farmer groups, 2014) therefore it has been rejected by the farming community in the areas with large scale cultivation. In inter-provincial areas these were not found among the farming community nor were the farmers aware of the same. This shows that for farmers to use machines and to mechanize operations machines need to be up to farmers' expectation.

Use of paddy thresher (Tsunami) for the processing of manually harvested corns is the most prevalent method for maize processing in study locations. This method is used irrespective of scale of cultivation in both provincial and interprovincial areas. With the intervention of combine harvesters these machines were gradually displaced from the paddy

sector. The current trend towards mechanization in maize cultivation has opened up an opportunity for increased use of these underutilized machines (Communication with farmer groups, 2014). During 2013/14 *maha* season the cost of processing amounted to Rs.3000/hr to Rs.4000/hr. It is true that only half an hour is adequate for the processing of corns harvested from one acre of land thus processing cost per acre amounts to Rs.1500/ac to Rs.2000/ac. Cost reduction due to use of paddy thresher for processing of maize grown in one acre of land in 2012/13 *maha* season amounts to Rs.1500/ac but the most important aspect is ability to complete the operation within a shorter period of time with a considerable saving of labour. However some farmers believe that the wastage is higher when paddy thresher is used though the harvest of one acre can be processed within 30-40 minutes.

Table 4.4: A Comparison between Agrimec Machine and Paddy Thresher for Maize Processing

Machine	Agrimec	Paddy Thresher
Labour Days	4 persons (at least)	5 persons
Time consumption	Four hours/ac	½ hours/ac
Labour Cost (Rs)	Rs. 4000/ac	Exchange labour
Machine cost (Rs)	-	Rs. 2500/ac
Total cost	Rs. 4000/ac	Rs. 2500/ac
Wastage	11%	12%
Cleanliness	high	low

Source: HARTI Survey Data, 2014

Two main constraints in using paddy threshers for processing of maize are;

(a) Lack of experience for the farmers to use paddy threshers owing to lack of owning machinery and therefore they need to hire them with trained operators, and

(b) Limited availability of threshing machines leading to farmers to wait for a longer period for their harvest gets processed. When it reaches the processing stage most of the small farmers are eagerly waiting to sell the harvest as they want to utilize the cash to repay debts and utilize cash to purchase other items. As revealed from the group discussions, this includes settling cultivation loans and other loans, redeeming pawned items, purchasing domestic items, farm implements, lands and vehicles and construction and renovation of houses. In contrast those who still depend on exchange labour do not wish to add machinery into their traditional way of farming.

Table 4.5: Comparison of Cost for Harvesting and Processing of Maize with Different Machines

Cost (Rs)/ac	Rate	Combine Harvester	Tsunami with Manual Harvesting	Agrimec with Manual Harvesting
Machine cost	4000/hr	11,000	Rs.4000/hr →1/2hr/ac →2,500	Rs.1200/hr
Labour cost	Rs.1000/day	2mds →2,000	12 mds→ 12,000	12 mds→ 12,000
Total cost	5000	13000	14500	13200
Wastage	kg	Around 2% cobs un-harvested	25-30 (2% - 3%)	25
Husk with seeds	-	25-30kg/ac	20-25kg/ac	Not at all as very clean
Quality	-	good	Seeds are broken	Seeds are not broken but no high price

Source: HARTI Survey Data, 2014

4.2.5 Issues and Suggestions for Mechanization of Maize Production

As revealed from the group discussion held in Ethimale area, maize cultivation is a highly labour consuming activity. In most of the cases lands used for maize production are occupied by high grown weeds so that mechanized land preparation is a must. Therefore land preparation is almost a mechanized operation. Except for recent interventions for processing of maize, most of the other activities in maize production including earthing up, fertilization and harvesting are entirely manual operations. Given this situation farmers in maize producing areas have felt the necessity for mechanization of maize production particularly due to labour shortage they experience during cultivation season.

Both key informants and farmer groups were of the opinion that shortage of labour during land preparation and harvesting of maize crop acts as a key constraint for the allocation of more lands into cultivation. Farmer

groups are also aware of other disadvantages they experience during maize cultivation due to shortage of labour. For instance, during the time for earthing up they mostly depend on family labour where the availability is less and inadequate to complete the earthing up within a shorter time period. According to their own words the farming fields where earthing up was initially done have begun flowering when they begin at the other end of the field. Severe shortage of labour delays the completion of earthing up operation. This causes crop losses both directly and indirectly as farmers have not been provided with better alternatives to circumvent the said issue.

Crop losses occurs directly due to bending of or falling of maize plants when they are affected by wind and rains when the earthing up is not done at the required time. Earthing up followed by fertilization enhances flowering of crops and fruit setting. To the extent this operation delays the said physiological functions. With this delay the plants could miss the most favorable weather period for physiological reproductive functions such as flowering and fruit setting. Delayed flowering and fruit setting may lead to delay in maturity of the maize subject to forthcoming dry period, wild animal attacks and pest and disease infestations.

Farmers see the necessity for completing land preparation and crop establishment as well as earthing up within a shorter time period. Mechanization of more labor demanding operations is seen as a solution for the problem of labour scarcity. Maize producing farmers are willing to go for mechanization of crop establishment, harvesting and processing however their knowledge on the available machinery varies. They are also largely dissatisfied with the performance of available machinery.

Pallanoya in Ampara district is a fast moving area for maize production industry. Farmers in this area are comparatively aware of the farm machinery available and used for maize production. As per their experience the productivity is high when certain cultivation practices are mechanized. They have an understanding that mechanization is convenient and it saves time. They are also in the opinion that the 'seed master' is efficient and successful in comparison with manual seeding.

According to many officials labour is scarce during cultivation season and mechanization is essential to achieve both the production and productivity targets of the OFC sector. The maximum yield reported in Ethimale area was around 2700 kg/ac with severe yield fluctuations. Today's prime need

is to ensure both convenience and high yield through mechanized operations to retain farmers in maize production as fertilizer use is very high and costly which thereby increases the cost of production. Otherwise these farmers would start cultivating other cash crops such as sugar cane. From the experience they have gathered through farming for a long period of time farmers are in the opinion that mechanization of maize production should be a well-planned activity at the onset of cultivation. They stated that there are improved machines in the world even for land preparation but both awareness and use by local farmers is limited to rotavators and tine tillers. Even with manual operations there are farmers who obtained high yield of 3000kg/ac from the cultivation of maize therefore there is a huge potential for reaching production and productivity targets by employing mechanized operations with timely inter-cultivation practices in maize production.

4.3 Finger Millet Production

Land Preparation and Cultivation Practices

Of the OFC crops the extents cultivated for finger millet amounts to only around 6000 ha in the country. While Moneragala district has a larger extent under the crop Ampara district has a mere 500 ha (Table 2.2). Production of finger millet is commonly found in Mahaoya and Padiyathalawa in Ampara district and Thanamalwila in Monaragala district.

Finger millet was traditionally grown on newly cleared chenas during *maha* season and was usually planted without land preparation. However in the present day the land is tilled manually with the use of mammoties in most of the areas while in the Moneragala district the farmers who own disc ploughs utilize them for tilling land as a means of land preparation.

Table 4.6: Awareness, Affordability and Use of Farm Implements for Land Preparation in Finger Millet Production in Study Locations

Farm Implement	% of Farmers in Ampara District				% of Farmers in Monaragala District			
	Aware of	Affordable	Used	Willing to use	Aware of	Affordable	Used	Willing to use
Disc Plough	100	NR	-	50	100	NR	15	60
Tine Tiller	100	NR	-	54	100	NR	18	70
Altered paddy Agrimec	18	NR	-	-	100	NR	18	18

Source: HARTI Survey Data, 2014

Seeds are broadcast with the onset of the rains. There are no inter-cultivation practices followed for this crop. There is no fertilizer application nor weed control and pest and disease control. Since the seeds are broadcast weed control is not practiced but a higher yield can be obtained if there is a weed free environment.

Processing was entirely a manual operation traditionally done with the use of motar and pestle, which proved to be time consuming and difficult operation largely carried out by women. In Ampara millet is mainly produced for home consumption and therefore processing is still done in the traditional method. In Moneragala district cultivation is on commercial basis which has led to innovation of pre existing machines to process the harvest.

A processing machine has been designed and produced by FMRC (Chapter 3) specifically for finger millet but it has not been commercially manufactured, instead the only machine available for processing is the altered paddy agrimec. The alterations made to the machines vary depending on the need and knowledge of the farmer.

During the field survey it was seen that one farmer from Ethimale in Moneragala district had used paddy agrimec machine for processing of finger millet by altering it as appropriate for the purpose. According to this farmer processing with this machine is both efficient and profitable.

Farmers in Thanamalwila area are also using an altered paddy agri-mec machine for processing of finger millet. This alteration has been invented by a young farmer in the area, Mr. Chamara Priyantha. The agrimec machine has been altered by covering the huller with a sheet made of iron so that the harvested material when placed inside the machine is pressurized. Millet plants with sun-dried fingers are inserted to the machine by hand. Since the plants are dried they are crushed finely and mixed with seeds. The machine has a capacity of processing 1000kg/hr. During 2013/14 *Maha* season the threshing cost has been Rs. 8/kg. Chamara had taken his machine to the 'chena' where finger millet is grown and the farmers had benefited from mechanical processing of finger millet both in terms of time and cost.

One of the disadvantages of this machine is that the seeds are mixed with crushed plant residue and therefore one needs to separate the seeds by putting in an extra effort. The machine is powered by the two wheel tractor. Otherwise seeds should be separated from husks by winnowing. It was also observed that this operation is not safe as the operator has to feed the plants to machine by hand and there is the danger of the fingers/hand been injured in the machine. Since the plants are crushed finely inside the machine the dust emanating while the seeds being processed makes it difficult for the operator to breathe. Therefore while designing an appropriate machine for finger millet processing, these weaknesses should be avoided. Possible improvements for this machine: attaching a fan for seed separation while processing and a bucket for feeding of plants to the machine.

With the changing climatic conditions and the lack of rains when required farmers of Wilambaya farmer organization of Ethimale area stated that water scarcity is the key constraint for the production of finger millet and therefore they emphasized the need for water pumps. In general many farmers are not aware of machinery available for the production of other field crops. It was evident that as a result of using sub-standard machines farmers are reluctant to shift to mechanized operations. Therefore perfection of machinery is a prerequisite for mechanization of other field crop production.

4.4 Groundnut Production

Farmers in Hulannuge and Panama in Provincial Areas in Ampara District grow groundnut in uplands during *maha* season. 'Tissa' variety which matures in 3 to 3.5 months and was purchased from the DOA for Rs. 200/kg is used for the cultivation of Groundnut by these farmers. Except for land preparation almost all the activities in groundnut production are done manually. Matured Groundnut plants are removed from the field for pod separation is done manually. It is more time consuming as the quantity of pods which are small in size is high in this variety. It is a long felt need to mechanize groundnut cultivation as pod separation is a labour consuming difficult task (Deputy Director - Provincial Extension, Ampara District, 2013).

According to farmers, for timely commencement of the cultivation practices they should receive seeds during the month of August. In Hulannuge area the land preparation in groundnut cultivation is done followed by ploughing with four wheel tractor operated disc ploughs and then mix fertilizer into the holes dug manually at 1´ x 2´ spacing. Whilst seed planting is done by another person the entire crop establishment activity takes around 10 man days/ac. In Panama area land preparation is done in three ways. Most of the farmers do pre-land preparation where by removing weeds with mammoties, some farmers do entire weed control with weedicides and then the field is ploughed with the disc plough. Some others directly do disc ploughing the field as in Hulannuge area without pre-land preparation.

As reveled through group discussions at Thanamalwila area in Moneragala District (M.G. Gunasena and the farmer group,) land preparation for groundnut production begins in dry period in September by setting fire to the lands covered with dried weeds. Knowing that the delayed cultivation makes it difficult for harvesting of the crop in dried lands at the time of harvesting, farmers give priority to timely planting. If the lands are free from roots and other barriers land preparation is mostly done by ploughing 2-3 times with tractor operated ploughs. Seeds are planted at the spacing for Red Spanish 1.5´ x 0.5´. Farmers used both red and white varieties; Red Spanish called *rathu kadju* and *Walawa* and *Tikiri* called *sudu kadju* in the local use. The farmers in general obtain a harvest of around 750 kg/ac from red varieties which bear around 40-50 large pods per plant with 3-4 seeds per pod. White varieties bear around 75 to 100 pods per plant which are two seeded small pods that give around 1000 kg/ac.

Harvesting is done after about 75 days in the dry season in February and three days are kept for drying. Pod separation is done manually. The large seeds from the harvest are reserved as planting material. The attack of thrips locally termed as *lati* was reported as the main problem in groundnut cultivation. These farmers had not received new seeds from the DOA for the past 15 years. This emphasizes the necessity for refreshment of seed stocks used for ground cultivation.

Groundnut is the main OFC grown in Thanamalwila, Kowulara area in Monaragala district. Both seed production and commercial cultivations are carried out by farmer organizations for both men and women. All the cultivation practices in groundnut production are done manually. The most labor intensive activity which needs to be mechanized in this crop is pod separation from plants. It is also a must that decortications should be done carefully for the seeds to be used as planting material. This time consuming operation has been a disincentive for farmers to involve in the production of groundnut and thereby expand the area under cultivation. The key mechanization interest of groundnut farmers is an efficient machine for pod separation.

Table 4.7: Cost of Cultivation of Groundnut in Thanamalwila Area

Activity	Rate	Cost (Rs/ac)
Ploughing	Per ac	5000
Planting of Seeds	75 kg*Rs.175/ac	13125
Earthing up	2 md*Rs.800	1600
Harvesting	20 md*Rs.900	18000
Drawing and compiling for drying	4 md	2700
Pod separation	6 md	5400
Pod Yield (Red Spanish)	800 kg/ac *Rs.130	104000
Pod Yield (Walawa/Tikiri)	1000 kg/ac*Rs.110	110000

Source: HARTI Survey Data, 2013

Mechanization in Central camp in the Ampara District is low as farmers are of the opinion that the availability of skilled labour is a must for OFC production despite the issue of scarcity and the high cost. Among the other reasons for poor mechanization is farmers increased willingness to sell young pods which fetch higher prices at the market and therefore earn higher incomes to the farmer.

There is a distinctive area for groundnut cultivation in Sevanagala in Monaragala district. This area is not popular for OFCs like maize due to presence of Udawalawa major irrigation scheme that ensures irrigation needs for the cultivation of paddy during both seasons. Farmers are encouraged to grow OFCs only if there is a scarcity of water for paddy cultivation. In addition, windy weather prevailing in this area discourages growing of tall crops like maize even under water scarce situations. Under such windy dry conditions only short term short crops can tolerate. Therefore Sevenagala area is more suitable for groundnut cultivation. This has perpetuated subsistence nature of OFC production in this area thus leading to poor interest towards mechanization OFC production. As revealed through group discussions almost all farm operations from land preparation to harvesting of groundnut production in Sevanagala area is done manually.

Pod separation is the most tiring and time consuming operation in groundnut cultivation however, it is still done manually. Thus the most labour demanding operation in groundnut cultivation is yet to be mechanized. Processing of Groundnut is mechanized to a certain extent with the use of agrimec machine found mainly in Ethimale. However di-cortication is really found in this area as the large part of the harvest is sold as pods due to small extent of harvest obtained from the cultivations operated at smaller scale. Farmers are also incapable of demanding high prices with a small quantity of harvest they have to sell.

FMRC is currently developing a pod remover for groundnut. It was reported from Ethimale area that one farmer had used an agrimec machine with curved shaped hooks for pod removing in groundnut. The machine is still in the testing stage, harvest should be dried around six hours before using the machine. After this laborious task of pod separation farmers sell the harvest without value addition though there is huge potential for adding a value to this product through decortication. There are two machines introduced by the FMRC for groundnut de-cortication; manual and electrical groundnut decorticators, for de-shelling of pods and the Table 4.7 shows the awareness, affordability and use of them in groundnut processing in study locations.

Table 4.8: Awareness, Affordability and Use of Groundnut Decorticators in Study Locations

Machine	% of Farmers in Ampara District				% of Farmers in Monaragala District			
	Aware of	Affordable	Used	Willing to use	Aware of	Affordable	Used	Willing to use
Decorticator (manual)	100	89	14	14	92	49	15	10
Decorticator (electrical)	100	7	7	71	100	5	5	87

Source: HARTI Survey Data, 2014

Farmers' overall awareness of ground nut de-corticators is highly satisfactory. A higher number of farmers had used the manual type than the electrical type of the machine. More farmers find the manual machine affordable as it costs around Rs. 12000/= however the most demanding has been the electrical type with varying work efficiencies (50kg/hr, 60kg/hr, 100kg/hr, 200kg/hr, 400kg/hr) than the manual type with the efficiency of 15kg/hr. More farmers from both locations had used manual type than the electrical type which is costly and used by only owners of machines.

An experienced woman farmer in the area is of the view that the decorticator machine introduced by FMRC is a failure due to excessive need of labour for seed separation as seeds are mixed with husks during processing. A farmer who used an imported decorticator from India stated that it is efficient and the groundnut harvest purchased from the farmers is processed with this machine. The machine owner is an entrepreneur involved in selling of groundnut.

4.5 Cowpea and Green Gram Production

4.5.1 Land Preparation

The main subsidiary food crops grown by the farmers in Sevanagala, Kirilbbanara area in the Monaragala district are green gram and cowpea. In

Ampara farmers in Namalthalawa and Mayadunna the main crop is cowpea and while central camp farmers grow green gram.

Except for primary land preparation none of the other cultivation practices of these crops are mechanized nor are the farmers aware of the available farm machinery for the production of these crops. Most farmers cultivate around ¼ ac to ½ ac. The small scale operation that enables managing cultivation practices with family members or exchange labour has become disincentive for farm mechanization in cowpea and green gram cultivation.

Table 4.9: Awareness, Affordability and Use of Farm Implements for Land Preparation in Green gram Production in Study Locations

Farm Implement	% of Farmers in Ampara District				% of Farmers in Monaragala District			
	Aware of	Affordable	Used	Willing to use	Aware of	Affordable	Used	Willing to use
Disc Plough	100	NR	56	56	100	NR	66	72
Tine Tiller	100	NR	-	-	100	NR	0	0

Source: HARTI Survey Data, 2014.

Most of the farmers grow these crops during the *Maha* season. These lands are kept uncultivated during the *Yala* season. Similarly in the production of other OFCs pre land preparation and land preparation are both common and done in the same manner. Traditional farm implements including mammoties and sharp knives made for the purpose are used for pre land preparation. This is one of the labour intensive practices in cowpea and green gram cultivation. Pre land preparation is not necessary when four wheel tractor operated disc ploughing is carried out. Green gram is grown in the *Mada Kanna* (Mid-season) between *Maha* and *Yala* in the irrigated areas as farmers prefer to grow paddy when sufficient water is available. There are certain seasons when water is not adequate for other crops during *Yala* season thus green gram is cultivated. However the yield of green gram is dependent on availability of water.

Table 4.10: Awareness, Affordability and Use of Farm Implements for Land Preparation in Cowpea Production in Study Locations

Farm Implement	% of Farmers in Ampara District				% of Farmers in Monaragala District			
	Aware of	Affordable	Used	Willing to use	Aware of	Affordable	Used	Willing to use
Disc Plough	100	NR	68	-	100	NR	56	67
Tine Tiller	88	NR	0	0	78	NR	22	22

Source: HARTI Survey Data, 2014

Methods of land preparation and varied use of draught power (buffaloes) is popular among the farmers in study locations. In addition land preparation with four wheel tractor operated disc plough or use of two wheel tractor operated harrow are also seen at the field level. No secondary ploughing was reported in green gram cultivation in comparison with DOA data for Hambantota. This area has both primary and secondary ploughing. The decision to mechanize or not and the degree of mechanization depends on the nature of land and the growth of weeds. Accordingly the cost of land preparation varies from Rs. 540/ac to Rs. 9600/ac (HARTI study data, 2014).

Farmers from inter-provincial areas, for instance, Namaloya farmers use high land for cowpea and green gram cultivation in *Yala* season. Draught power is used for land preparation whereas farmers in Central camp area use two wheel tractors for land preparation.

4.5.2 Seed Planting

Seed planting is entirely a manual operation in the production of both crops. Row seeding is the most popular method and one or two seeds are planted half to one 'cupped hand' (*wiyatha*) apart on the furrows prepared with the use of tractor operated plough or draught power. Some farmers' plant seeds by digging holes with mammoty thus they fail to maintain proper spacing.

Table 4.11: Awareness, Affordability and Use of Farm Implements for Seed Establishment and Inter Cultivation Practices in Green Gram Production in Study Locations

Farm Implement	% of Farmers in Ampara District				% of Farmers in Monaragala District			
	Aware of	Affordable	Used	Willing to use	Aware of	Affordable	Used	Willing to use
Manual Seeder	37	30	0	4	39	26	0	3
Rotavator Seeder	22	7	0	4	20	13	0	7
Swiss Hoe	36	37	0	0	66	53	0	0

Source: HARTI Survey Data, 2014

Accordingly the cost of seed planting both cowpea and green gram cultivation vary. Whenever farmers grow these crops during 'Mid-season' no land preparation is done as seeds are sown before or soon after harvesting of paddy.

Table 4.12: Awareness, Affordability and Use of Farm Implements for Seed Establishment and Inter Cultivation Practices in Cowpea Production in Study Locations

Farm Implement	% of Farmers in Ampara District				% of Farmers in Monaragala District			
	Aware of	Affordable	Used	Willing to use	Aware of	Affordable	Used	Willing to use
Manual Seeder	37	7	-	0	33	7	0	0
Rotavator Seeder	7	4	-	17	18	4	0	9

Source: HARTI Survey Data, 2014

4.5.3 Inter-cultivation Practices

Weeding is done twice i.e, at the growing stage and flowering stage. In both instances farmers do both weeding and earthing up with the use of mammoty. The most labour demanding activity in the cultivation of these

crops is earthing up. No evidence was found on the application of weedicides, but ever increasing labour scarcity may encourage farmers to do so. Fertilization and pest control are not commonly found.

4.5.4 Harvesting and Processing

At present the variety of green gram cultivated in Sri Lanka requires harvesting with 4-5 picks which means that harvesting consumes more labour. This requires introduction of varieties that ensure harvesting of at least 80% of the harvest during the first pick or two.

A variety of green gram which has been undergoing trial runs in Sri Lankan fields requires only one pick and is called MIMD938 introduced from Korea. Tests carried out show that the variety is prone to the yellow mosaic virus but the yield when harvested has proven to be high in comparison to the present cultivated variety. This has been further tested with the farming community for the coming season. Hence farmers are highly enthusiastic to mechanize harvesting of these crops. Processing of green gram and cowpea is also a labour intensive operation in which seeds are separated from sun-dried pods by hand or threshing by foot.

Table 4.13: Awareness, Affordability and Use of Farm Implements for Harvesting and Processing in Green Gram and Cowpea Production in Study Locations

Farm Implement	% of Farmers in Ampara District				% of Farmers in Monaragala District			
	Aware of	Affordable	Used	Willing to use	Aware of	Affordable	Used	Willing to use
Multiple Crop thresher	89	3	30	44	79	1	33	4
Legume crop thresher	Machine was available only at the manufacturer							

Source: HARTI Survey Data, 2014

Most of the farmers in Sevanagala, Nugawela area in Monaragala district practice traditional methods and hardly use any mechanized operations. It was reported that an innovative farmer had altered the paddy agrimec threshing machine for the processing of green gram and cowpea. Farmers

accept it as an efficient method that can be operated with no damages to the seeds. It was also reported that farmers had reduced the area under cultivation due to severe shortage of labour during cultivation season. Therefore introduction of mechanized operations for green gram and cowpea production is very essential.

4.5.5 Issues and Suggestions for Mechanization of Green Gram and Cowpea Production

Mechanization of cowpea and green gram production is minimal attributing to unavailability of machinery as well as suitable varieties. Earthing up, harvesting and threshing are the most labour demanding activities in the production of cowpea and green gram. The key constraints that affect timely completion of these activities are labour scarcity. Sometimes farmers have to pay an extra amount of money for the labour. This leads to high cost of production and less profit, and the young generation is deviating from the production of these crops. This has perpetuated small scale nature of production systems limiting both production and productivity of the two important OFCS. Therefore the introduction of both appropriate varieties with synchronizing maturity and machinery are urgent to expand the production and to improve the productivity of these two crops. Similarly it is important to make aware of the advantages of shifting to mechanized operations through training and demonstration as well as providing credit facilities small scale producers for purchasing of machinery to shift from the present subsistence nature of production.

The majority of farmers in Thambiluwil area had heard about new machinery such as seeders however they had never seen the machinery while the rest have seen the machines but never used the machines. Therefore it is necessary for farmers to be made aware of the machinery. They also see some constraints in available machineries such as difficulty in adjusting the spacing. Due to inadequate spacing among plants there would be a reduction in the yield due to high density of plants and increase in the seed rate. They also proposed 9 inches as the most appropriate spacing. Damage to seeds of green gram and groundnut seems to be another constraint.

Green gram and cowpea producers in Amapara district too operate small scale cultivations of ¼ to ½ ac. Therefore pre land preparation is not a big task. In most cases farmers in Namaloya use drought power for land

preparation. In central camp area, farmers do land preparation with two wheel tractor operated ploughs for green gram and cowpea cultivation. Many farmers use the required machinery for this. Most of the other activities are not mechanized. Seeds are planted in holes or furrows dug with mammoties along rows. When green gram is cultivated in paddy lands, farmers sow seeds before harvesting of paddy and the sown seeds are buried when the use of heavy machinery for paddy harvesting. Some others sow seeds on the stubble and the seeds germinate in a few days.

Both weeding and earthing up in both green gram and cowpea production are done manually. This is done once or twice depending on the intensity of weed growth. Some use fertilizer but others do not. Harvesting is done several times but entirely as - manual operations. Many farmers harvest the crop 4-5 times /picks.

Processing is also done manually. The harvested pods are sun-dried and then seeds are separated by threshing with foot. Both due to small scale operation and less amount of harvest farmers are not interested in using machinery for processing. Many being full time farmers, the farm families have enough labour so that they do it leisurely with their own labour. This has made farmers less interested in using machinery in cowpea and green gram production.

CHAPTER FIVE

Conclusions and Recommendations

5.1 Introduction

Self-sufficiency in selected OFCs is a medium-term objective in the path to achieve long-run objective of greening agriculture in the country. Though farm mechanization is one among other several options which could substantially contribute to achieve both medium and long term objectives, poor level of mechanization is characteristic of the OFC sector in the country. This study is aimed at investigating the causality behind poor level of mechanization in OFC production both from supply and demand perspectives. The study found that poor adoption of farm machinery in the OFC sector is a result of several constraints. Looking into this from the supply and demand of machinery the main constraint from the supply side is the unavailability of suitable farm machinery for a variety of operations while it has been found that most of the available machines have technical defects since most of these are manufactured for other crops. From the demand side incompatibility of machinery to the local farm environment coupled with attitudes of farming community to the use of new technology is a primary constraint in mechanization of OFC production. Other factors which compound this issue is the poor awareness of available machinery, affordability of good machines due to high cost and poor farmer income. These constraints both singly and collectively have contributed to perpetuate a poor level of mechanization in the OFC sector.

5.2 Farming Circumstances and Attitudinal Constraints

The decision on farm mechanization and the degree of mechanization in OFC sector is primarily governed by prominent characteristics of farming systems. The study found two broad categories of farming systems relating to OFC production especially in maize cultivation as characterized below.

1. Village based OFC production system: This farming system is characterized by semi commercialized produce for both consumption and commercial purposes, diversified or a less degree of specialization, small or medium scale farming oriented towards value addition. Production process is largely based on family and exchange labour with less mechanization with limited interest towards mechanized operations.

2. Chena based OFC production system: This is an entirely commercialized system with a high degree of specialization large scale farming providing the key livelihood for farm households. The production process is dependent both on machinery and hired labour showing more interest towards mechanized operations.

The study found that the decision of farm mechanization and the degree to which mechanized operations are practiced in OFC cultivation is primarily governed by above differences.

The traditional upland farming system in OFC producing areas in the dry zone comprised of many crops. Diversified cropping coupled with diverse cropping patterns such as mixed cropping and relay cropping also discourage mechanization. The given diversity in the farming systems makes it difficult to use tractor operated large machinery such as ploughs and seeders. These structural differences too discourage farm mechanization to a certain extent especially due to subsistence nature of farming therefore shift towards commercial farming appears to be an incentive for farm mechanization.

Negative attitudes of farmers act as a constraint in changing the traditional way of farming. This is common with regard to employing mechanized operations in OFC production too. Those who cultivate at subsistence level have no motivation to use machinery as OFC production is a means of using family and exchange labour effectively for increasing profit margins from OFC production.

5.3 Unavailability of Farm Machinery

The FMRC as the responsible state sector institution for the research development of farm mechanization is already involved in its formal duties however whether it has adequately addressed the mechanization needs of the farmers producing OFCs is still in question. One important issue is that though it is mandatory for FMRC to develop new machinery it is not permitted to carry out commercial production. Once the technology is developed the patents are sold to the private sector manufactures for commercial production and distribution. The FMTC is responsible for the technology dissemination. The two institutes are headed by two deputy directors and also two directors and thus the agenda of one institution differs from one other. Thus farm machinery development, technology dissemination, commercial production and distribution which are essential

parts of the mechanization process are in conflict with each other. The distraction between the given responsibilities has resulted in low availability of and thereby unawareness of farm machinery among the farming community prevails, leading to poor level of farm mechanization in OFC production.

Increased demand for the limited number of machines available in a particular location is another factor contributing to less use of machinery by the farmers as they are not willing to stay for a long period of time to plant seeds to prevent any damages to the crops due to seasonal variations and processing of the harvest for financial needs.

Private sector involvement in machinery industry is found from two quarters – local manufacturers and importers of machinery. There are several constraints including less demand for machinery, availability of low cost imported machines in the market, importing constraints (tax), unavailability of skilled labour, and high cost of production due to high cost of labour and raw materials, high basic investment. Granting of tax concessions and educating farmers on the advantages of mechanization are the options available to encourage private sector involvements in this sector.

5.4 Unawareness of Farmers about Farm Machinery

The common response of many farmers participating in group discussions was their poor exposure to farm machinery for the production of OFCs. Though farmers representing major OFC producing locations had received a limited exposure to farm machinery introduced by the FMRC and local manufacturers, a large majority of other farmers have not been exposed to or were not aware of already mechanized operations in OFC production.

Except for mechanized land preparation and processing, all other activities in OFC production are done manually. However, farmers in provincial areas are more knowledgeable due to horizontal diffusion of knowledge on farm machinery among the farmers due to large scale production of OFCs. Though many farmers had not heard about mechanized seed planting, the interest they have shown towards the same is a proof that the formal training conducted by FMTC should be farmer driven as at the moment farmers show less interest towards training on farm machinery.

5.5 Unaffordability to Farm Machinery

Almost all the farm households in the study locations are involved in the production of one or many OFCs during the *maha* season. Each and every farm household provides a substantial weight to OFC production putting in a massive effort as it is the key livelihood for most of them. As a result the scale of cultivation by each household is relatively larger than its socio-economic circumstances. At a glance it conveys that OFC production has a considerable impact on poverty reduction at household level. However a large part of the OFC production process is linked to credit facilities provided by large agri-business agencies. The profit gained by the farmer at the end of the season after all deductions to such agencies is insignificant. The reality is that farmers are trapped in a vicious cycle and the flow of wealth generating from OFC production has failed to create the household economy which is more conducive for investing in farm machinery.

Moreover, most of the machinery cannot be operated in isolation. They require tractors which demand a huge investment. In particular, large and costly machines such as seeders and paddy threshers are not affordable to those who cultivate in small scale.

According to FMRC the high cost of machinery is due to small scale production. This has made it unaffordable even for large scale farmers who are also trapped in a vicious cycle of farming characterized by use of high external inputs and less sustainability. Countries such as India best derive advantages from economies of scale in the farm machinery industry. They produce more and thereby the cost is low. Therefore importation becomes cheaper than local production. This happens only with regard to tractors. The high cost of farm machinery has therefore become another constraining factor that has hindered the mechanization process in the country.

5.6 Inappropriate Farm Machinery

OFCs in study locations are commonly produced during *Maha* season under rain-fed conditions. Due to undulating/uneven nature of lands, farm fields need to be separated into small plots even if the cultivation is large scale. Irregular shape of land plots too is a disincentive for the efficient use of farm machinery. Whilst the allocation of land varies by crop each OFC demonstrates a particular mode on farm size. Mechanized operations in

both small and large scale domains are largely limited to land preparation and processing. Almost all other operations are done manually. The responsible authorities have failed to introduce machinery appropriate for diverse conditions. Instead they make blanket recommendations which are unsuitable for diverse circumstances. Due to one season cultivation of OFCs under rain-fed conditions mechanized land preparation in weed grown lands has become essential creating a huge demand for tractor operated ploughs. Other than to using draught power, mammoty is in use as the most efficient farm implement for generations as it supports many a cultivation and inter-cultivation practices. Any machine that is developed for inter-cultivation practices should therefore be more efficient than the mammoty.

As per the above discussion, unfavorable land characteristics in the OFC producing areas provide little incentives for the promotion of mechanized operations. As a result, OFC sector has failed to acquire potential advancement that would arise from farm mechanization. Seemingly there are two options to overcome the said issue; (a). By promoting small farm machinery that suits land characteristics and small scale farming (b). By regularizing the farm size and shape of the plot of land to suit the farm machinery.

Since labour scarcity is a key problem for OFC production farmers in several instances had tried to mechanize seed planting, harvesting and processing of OFCs with the use of machines introduced at grassroots level. Due to the use of sub standard machines introduced by various private agencies there are constraints to the mechanization process. This emphasizes the need to develop machines of good standards with zero defects and test them before introducing at grassroots level.

Therefore attention needs to be paid to improve machinery through practical use at the field season by season, however this does not happen as anticipated due to severe administrative delays associated with farm machinery development and testing procedure. Private sector has also shown less interest to the machinery sector. Few local manufacturers still try their best with lack of/little support from state agencies. Attention needs to be paid to the policymaking level and implementation of programs with regard to farm mechanization.

One of the main requirements is promoting awareness among farmers with regard to the available mechanization options in the OFC sector.

According to a large scale entrepreneur who owned and hired a number of machinery to farmer groups' for production and productivity gains indicated that farm mechanization could be achieved through various methods. Stating that the government needs to promote awareness among farmers with regard to mechanization it could help them work towards the development of agriculture sector in the country. Farmers at present lack knowledge on new technology and are trapped in traditional way of farming without any personal development. These farmers extensively depend on labour though farm mechanization generates more benefits. He has proven how farmers could achieve production and productivity gains through employing mechanized operations in OFC production. Ensuring rural road development by building access roads and proper ownership to lands are other incentives for them to mechanize their farm fields.

In line with achieving medium and long run objectives of the agricultural sector in the country, the above constraining process of farm mechanization needs to be seized at a certain point. Mechanization of OFC production should be a timely national interest. Steps should be taken to address the problem of poor mechanization of OFC production at a higher level and at a larger scale. It should be prioritized in the agrarian policies and development programmes from a holistic view point. Some disaggregated suggestions to address the issue of poor mechanization are discussed below.

In order to ensure increased availability of appropriate farm machinery, the trade-off between 'machine suits farm' versus 'farm suits machine' would be a better beginning for the government to make policy decisions and place investment priorities. Otherwise no individual farmer could be able to bear the huge costs involved in the machinery fabrication process.

With the choice of 'machine suits the farm', the proposed options are;

- Expedite the FMRC process in farm level adoptive research for the development of introduction of low cost, high tech, efficient and multi-purpose small farm machinery with zero defects and promoting them.
- Encourage students of Agricultural and Engineering faculties of the universities to innovate appropriate farm machinery of the same caliber.
- Encourage farmers and provide them incentives do innovations on farm machinery.

- Improve the staff strength of FMRC.
- Provision of tax concessions to import machines at low cost with high quality
- Sales promotion on farm machinery.

Development of small farm machinery will also be a solution to improve the affordability of farmers to a certain extent. In addition to this;

- The DOA should prioritize providing farm machinery through district and provincial agricultural offices to farmers/ farmer organizations at subsidized rates/under easy pay schemes.

In order to improve farmer awareness and use of farm machinery and the advantages of the same;

- Strengthening of technology transfer through machinery demonstrations by allocating more resources to district and provincial agricultural offices so as to ensure that farmers are better aware of low cost and efficient machinery and the productivity improvement due to farm mechanization.
- Farmers should be formally made aware of the use, maintenance and advantages of farm machinery at *kanna* meetings and through farmer organizations with the involvement of responsible SMOs (officials) appointed for each office by providing a new strength and adequate increased to the subject of farm mechanization in the extension service.
- Formal training programmes conducted by FMTC should be farmer driven programmes targeting farm mechanization.

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Appendix 1.1: Accelerated Other Field Crop Production Programme-2012

Crop	Districts	Financial Allocation (Rs.Mn.)	Expected Yield (Mt)
Dry Chilli	All districs	45.0	
Groundnut	Vavuniya,Mannar, Mullathivue, Kilinochchi, Trincomalee,Ampara,Puttalam,A'pura, Kurunagala,Monaragala,Hambanthota, Rathanapura	15.0	86
Black Gram	Anuradhapura,Monaragala, Kurunagala, Mulative, vavuniya	4.208	542.5
Maize	Hambanthota, Baticloae,Ampar,Trico, Kurunagala, A'pura, Pollonaruwa, Badulla, Monaragala, Ratnapura, Vavuniya, Mannar	5.0	26,304
Gingerly	Vavuniya,Jaffana,Mullathivue, A'pura, Monaragala, Hambanthota, DOA	3.026	
Cowpea	Ampara (province),Monaragala,	3.248	2,126
Soybean	A'Pura, (Inter prov. & province)Mahawali	5.0	10,800
Kurakkan	Vavuniya, A'pura,Monaragala, Hambanthota,DOA	5.0	
Green Gram	Kurunagala,Hambanthota,(P,IP), Anuradhapura(IP) Ampara(P, IP)	35.8567	925
Red Onion	Kilinochchi, Vavuniya,Jaffana,Trincomalee, Kurunagala,Puttalam,Matale,Rathnapura,Mahawali	9.5	
Big Onion	Babulla, Monaragala, Hambanthota(P & IP), Polonnaruwa(IP) Kurunagala, A'pura (P, IP)		
Potato	Nuwareliya, Badulla	28.3	

Source: Ministry of Agriculture

Appendix 1.2: National Extent under OFCs 2002-2015

Crop	Years and Extent (ha)											
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Finger Millet	5477	7358	5113	6207	5910	5408	6079	5902	6565	5282	5195	5951
Maize	23413	27060	23421	28401	32002	34184	51608	50857	57618	50591	59529	67722
Green Gram	11248	12016	8607	9643	8700	8765	9356	8569	10283	9068	9755	11147
Cowpea	11776	13836	9665	11360	10650	10634	12151	11439	10870	9278	11041	10815
Sesame	6582	8804	6983	9649	9337	9261	9512	10881	18397	14304	15558	17151
Groundnut	9115	11383	9980	10918	11662	10418	10272	9002	9481	9251	11609	15197
Other OFCs	24161	23585	21214	27650	27932	26679	23772	23133	22648	22947	26246	33182
Total	91772	104042	84983	103828	106193	105349	122750	119783	135862	120721	138933	161165

Source: Department of Census and Statistics, Various Years

Appendix 2.1: National Extent of OFCs 2002-2015

Crop	Years and Extent (ha)														% in 2015
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015 (Expec-ted)	
Finger Millet	5477	7358	5113	6207	5910	5408	6079	5902	6565	5282	5195	5951	7416	9729	3.6
Maize	23413	27060	23421	28401	32002	34184	51608	50857	57618	50591	59529	67722	67219	106904	39
Green Gram	11248	12016	8607	9643	8700	8765	9356	8569	10283	9068	9755	11147	11840	23404	8.5
Cowpea	11776	13836	9665	11360	10650	10634	12151	11439	10870	9278	11041	10815	11480	22455	8.2
Sesame	6582	8804	6983	9649	9337	9261	9512	10881	18397	14304	15558	17151	14524	22076	8.1
Ground nut	9115	11383	9980	10918	11662	10418	10272	9002	9481	9251	11609	15197	14326	20218	7.4
Other OFCs	24161	23585	21214	27650	27932	26679	23772	23133	22648	22947	26246	33182	21178	69159	25.2
Total	91772	104042	84983	103828	106193	105349	122750	119783	135862	120721	138933	161165	147983	273945	100

Source: Department of Census and Statistics, Various Years

Appendix 2.2: National Production of OFCs 2002-2015

Crop	Years and Production (mt)														
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015 (Expected)	% in 2015
Finger Millet	4071	5269	4669	6447	6296	5457	6506	6433	7307	5422	5984	7011	8852	10936.4	1.4
Maize	26417	29645	35201	41804	47521	56438	112287	129769	161694	135156	202315	209042	240588	300604.7	38.8
Green Gram	10324	10605	7808	8997	7975	8513	8878	9258	11703	10535	11956	14252	14352	27822.6	3.6
Cowpea	10436	12900	9157	11176	10114	10855	11952	13485	11609	10472	14812	14185	15119	24084.2	3.1
Sesame	4070	5486	4348	6161	5969	6304	6337	8525	16947	11270	12435	14236	14164	18885.1	2.4
Groundnut	5737	6587	7936	9034	9822	9831	10251	13077	14354	16763	21953	27486	25432	28466.5	3.7
Other OFCs	113243	114004	117435	162151	187267	197908	157664	174355	169744	174807	219072	226769	222655	363062.6	46.9
Total	174298	184496	186554	245770	274964	295306	313875	354902	393358	364425	488527	512981	541162	773862	100

Source: Department of Census and Statistics

Appendix 2.3: Production of OFCs in Ampara District 2002-2013

Crop	Year											
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Finger Millet	190	187	182	184	181	172	307	214	211	227	335	416
Maize	5891	5136	5457	6144	5663	462	14193	16701	17828	13150	9652	10861
Green Gram	513	708	416	290	355	299	593	572	546	727	1141	1159
Cowpea	3543	3362	2421	2383	2830	2799	4062	5613	3148	3693	7129	6090
Sesame	43	36	17	14	25	23	28	40	20	16	24	118
Groundnut	365	433	492	285	381	562	697	1344	1482	1546	1336	1477
Other OFCs	1490	1472	1195	856	877	1185	1489	1346	1129	855	923	269
Total	12035	11334	10180	10156	10312	5502	21369	25830	24364	20214	20540	20390

Source: Department of Census and Statistics

Appendix 2.4: Extent of OFCs in Monaragala District 2002-2013

Crop	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Finger Millet	846	1379	824	893	725	837	967	905	998	1029	1019	1144
Maize	3050	4838	4766	5140	5514	6708	9282	10092	13922	15205	17545	20092
Green Gram	1970	2669	1796	1913	1730	1760	1880	1724	1938	1162	1664	1893
Cowpea	1355	2359	1778	2042	1760	1704	1966	1827	2192	1924	2039	2291
Sesame	1290	1444	1182	1293	1113	1581	1004	849	714	680	886	1803
Groundnut	1984	2532	2381	2581	2666	2260	2778	2568	2948	2815	2823	3404
Other OFCs	1292	1385	1179	1461	1118	1012	1209	1093	1211	1064	1196	534
Total	11787	16606	13906	15323	14626	15862	19086	19058	23923	23879	27172	31161

Source: Department of Census and Statistics

Appendix 3.1 Machinery Manufacturers Registered at FMRC

Company & Contact Details	Machinery	Areas / Organizations sold	Units	Price
K.G.R. Perera, Rangana Motors, Anuradhapura Rd, Daladagama, Ullalapola, Maho	Manual Seeder for maize, Green gram, Black gram& Soybean	Anuradhapura, Ampara	100	25000
	Maize Thresher	Ampara, Anuradapura, monaragala	30	148 000
	Groundnut Decorticator (electrical)	Mannar, Madawachchi, Maho, WFO	25	145 000
	Swiss Hoe (manual)	Kurunegala	5	32 00
M.H.M. Gaws, Atlas Metal Engineering (pvt)Ltd, 571,Kandy Rd, Kegalle.	Manual seeder for finger millet & gingerly	Monaragala, NGO	5	10 000
	Two wheel tractor operated seeder	DOA, Badulla	4	45 000
	Multiple Crop Thresher (maize & Sunflower)	Kurunegala	100	35 000 110 000
	Peddle pump	Monaragala, Buttala	2	10 000
	Swiss Hoe (manual)	Kurunegala	2	1500
	Groundnut Dicorticater (electrical)	Jaffna, Northern Province	Under production	
Jinasena (pvt)Ltd, 176/1, Thimbirigasyaya Rd, Colombo 05	Maize Thresher			156 000
B.M. Hemachandra, Hansa Induatres,No:400,PahalaImbulgoda, Imbulgoda	Two wheel tractor operated 3 tine plough	Athurugiriya for Ginger	1	30 000
	Manual seeder for maize, green gram, black gram & soybean	Anuradapura	5	25 000
	Groundnut Dicorticater (manual)	Vavuniya, Batticola, Ampara	200	12 500
	Two wheel tractor operated pump a or b	Vavuniya	1	50 000
	Weeder	Batticola	200	60 000
R.M. Wijerathne Banda, Indika	Two wheel tractor operated seeder	DOA	4	35 000
	Injector Planter	Vavuniya	4	125 000

MECHANIZATION IN OTHER FIELD CROP SECTOR : A SITUATIONAL ANALYSIS

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