Sustainability of Crop Production System in South East Dry Zone of Sri Lanka: With Special Reference to Groundnut, Green gram and Sugarcane

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Research Report No: 219 January 2019

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First Published: January 2019

ISBN: 978-955-612-246-6

FOREWORD

Sustainable development of agriculture sector in Sri Lanka is the core objective of the National Agricultural Policy which is focused to meet the basic needs of the farming community in terms of food security, increasing employment opportunities and income through developing socially acceptable, economically viable and environmental friendly agricultural production systems. Consequently, the government has implemented various food production programmes in time to time. Though a huge amount of resources has been allocated on such programmes, the performance of the sector remains below expected level. The policymakers have only considered the economic aspect of such programmes despite the social and environmental factors. Therefore, this study attempted to make policymakers aware in order to pay their attention on social, economic and environmental aspects of farming systems in the process of decision making.

The study findings show the relative level of sustainability of the cropping systems which are focused in the study. Level of overall sustainability or the sustainability with respect to either financial, social or environment aspects of different crops has found by the study. Accordingly, it could be used in informed decision making regarding different crop based systems.

I congratulate the research team for successfully complete this study. This report provides a lot of useful information related to measuring sustainability of crop production systems in Sri Lanka. I hope the findings and recommendations would be useful to policymakers in the agriculture sector.

K. Udage
Director/CEO

ACKNOWLEDGEMENTS

This study was conducted as a part of the collaborative project on Capacity Development of Agrarian Research-Policy-Technology Personnel in Sri Lanka on Global Change and Sustainability which was conducted by Asia-Pacific Network for Global Change (APN) and Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI) in 2016-2017.

We would like to extend gratitude to Mr. K. Udage, Director, HARTI for his support in publishing this report and to Mr. R.L.N. Jayatissa, Additional Director, HARTI for encouraging us to bring out this report as a HARTI publication. We would like to forward our gratitude to Ms. R. Weerakkody, Head of the Agricultural Resource Management Division (ARMD) and the coordinator of the collaborative project for encouraging and supervising us to complete this study successfully.

We appreciate the external reviewers namely Prof. L. M. Abeywickrama, Head, Department of Agricultural Economics, Faculty of Agriculture, University of Ruhuna and Dr P. Dunusinghe, Senior Lecturer, Department of Economics, Faculty of Arts, University of Colombo for the valuable comments provided on the final draft of the report to improve the quality. We thank Ms. S. K. Kumara and Mr. S. Epasinghe, Former Heads of the ARMD. We are also thankful to Ms. Suharshi Perera for the expert editorial assistance.

The research team highly appreciates to the farming communities in the study areas for sharing their experiences and dedicated valuable time to provide information during the field survey. We extend our appreciation to DDs and ADAs for providing information and supporting to coordinate relevant field and AIs, ARPAs of study areas in Ampara, Moneragala and Hambantota districts for their invaluable assistance to complete this study.

Mr. D. M. A. C. Dissanayaka, Former Statistical Assistants of HARTI and Investigators, Ms. J. P. C. Jayasinghe, Ms. D. D. I. Dhanushika, Ms. U. H. C. T. de Silva, Ms. M. W. B. Mayurasena, Ms. M. A. H. Manchanayake, Ms. I. S. S. Dissanayake and Ms. D. S. Muthugala should be also thanked for the support they extended during the survey. Various assistance by Ms. Deepthika Rupasinghe and Ms. Olu Indrachapa of the ARMD and the staff of Publication and Printing also mentioned with due gratitude of the valuable contribution rendered to publishing this report.

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Executive Summary

The National Agricultural Policy (2007) of Sri Lanka is mainly focused on achieving food security of the nation, sustainable development of agriculture in the country through developing economic opportunities for the farmers while maintaining environmental quality. In line with the objective of achieving food security, Food Production National Programme: 2016-2018 was implemented in 2015/2016 *Maha* season with an allocation of Rs. 2155 million and priority food crops, set production and productivity targets have been identified. Although the government has allocated a huge amount on several such programmes during the recent past, the performance of the sector fell below expected levels underscoring the importance of finding out the causal factors behind the poor performances of the sector. On the other hand, economic factors are considered key decision-making tools in the process of policy-making of the country underlying all three aspects; economic, social and environmental. Thus the ground reality and the actual reasons leading to poor achievement in the production and productivity of crops are not adequately understood and addressed. Therefore, this study attempted to address this issue by identifying social, economic and environmental conditions of prominent crop production systems with the objective of revealing the social, financial and environmental dimensions of the prominent food crop production systems in the South-East Dry Zone of Sri Lanka.

South East Dry Zone (SEDZ) of Sri Lanka comprises three districts; Ampara, Moneragala and Hambantota. Those areas were selected as the study area and green gram, groundnut and sugarcane were identified as major Food Crop Production Systems (FCPS) in the region. The study sample was derived using a multistage sampling technique and 362 farmers were interviewed in three FCPS. The data was gathered through a questionnaire survey, focus group discussions and key informant interviews. Among various techniques used in assessing sustainability, the index approach is widely used in empirical studies and applied for this study as well. Overall sustainability is computed via a composite index.

The study revealed that the highest social acceptance and economic viability were recorded in sugarcane, where groundnut was recorded as the most environmental friendly production system. Compared to other two pillars, social sustainability was the major contributory factor in generating the crop sustainability index where the major contribution for developing social sustainability index was provided by 'competitiveness' (mean difference between breakeven and actual price) in all three production systems. A major contribution for developing environmental sustainability index was provided by the 'chemical fertilizer application' (severity of chemical fertilizer application) while 'relative economic importance' (contribution to total family income from crop production) contributed mainly for developing economic sustainability.

In order to ensure better economic conditions for farming communities, it is vital to improve the overall sustainability of all three production systems in the region significantly. Economic sustainability of production systems could be improved by increasing productivity and thereby increasing the profitability of the crop through increasing availability of quality seeds and planting materials with higher yield. Similarly, social sustainability could be increased by increasing the net return to family labour by means of mechanization of most labour intensive operations and introducing varieties which are suitable for mechanized harvesting. At the same time, it is important to introduce and promote usage of crop varieties with high demanding characteristics and encourage value addition in order to achieve higher profitability.

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LIST OF ABBREVIATIONS

ADA	–	Assistant Director of Agriculture
AERs	–	Agro-Ecological Regions
AI	–	Agriculture Instructor
ANOVA	–	Analysis of Variations
ARPA	–	Agriculture Research & Development Assistants
ASC	–	Agrarian Service Centre
CSI	–	Crop Sustainability Index
DSD	–	Divisional Secretariat Division
DD	–	Deputy Director of Agriculture
ECSI	–	Economic Sustainability Index
ENSI	–	Environmental Sustainability Index
FCPS	–	Food Crop Production Systems
GND	–	Grama Niladari Division
LCDZ	–	Low Country Dry Zone
OFC	–	Other Field Crops
PCA	–	Principal Component Analysis
SEDZ	–	South East Dry Zone
SES	–	Socio-Economic Status
SOSI	–	Social Sustainability Index

CHAPTER ONE

Introduction

1.1 Background of the Study

A cornerstone of the agricultural policy of Sri Lanka is 'sustainable development' through developing economic opportunities for the farming communities whilst maintaining environmental quality (Ministry of Agriculture, 2015). In line with this policy, the national programme for food production 2016-2018 has begun to implement a strategy of increasing the production of Other Field Crops (OFCs) (Presidential Task Force on National Food Production, 2015). The programme envisions self-sufficiency in four OFCs - maize, groundnut, red onion and green gram by the year 2018 with substantial achievement in production and productivity of the rest of the OFCs comprising soya bean, big onion, chili, sesame, black gram, cowpea and finger millet (Presidential Task Force on National Food Production, 2015). The estimated allocation to realize the set targets during the period from 2016 to 2018 amounts to Rs. 2155 mn. There has been a concentrated effort to achieve the production and productivity targets through successful implementation of the programme.

With regard to the sugarcane, there has been a growing interest in increasing the extents of land, one of the foremost concerns of the government, as sugar has the second highest import bill among food and beverage which is a staggering 254 US$ mn in 2015 (Central Bank Annual Report, 2016). The government policy is to increase the present six percent produced for local consumption to 50 percent of the domestic need within the next five years. It is also foreseen by the government that while slashing the import cost on sugar cultivation in the country could trigger economic development in rural areas.

At present, though there has been an increase in land extents of selected crops in the National Food Production Programme 2016-2018, there is an overriding problem or inability to reach the goals of sustainable development with respect to the previous state driven food production programmes. The reasons may be the problems of agriculture sector being multifaceted and governed by a multitude of social, economic and environmental factors stemming from the lack of agricultural technology, poor trade policies, food production issues, natural resource and environmental problems and national planning and government policies.

The social, economic and environmental factors besieging the farming communities could be seen main dilemmas. In addition, there has been only 'piecemeal solutions' leading to the lack of sustainability of the farming communities in social, economic and environmental terms. The dilemma of the sector has fallen short of policy goals while placing sustainability at a greater risk. The question remains whether policy formulation process has adequately placed the emphasis on the perspective of sustainable development and the resources that are mobilized for economically viable farming options while preserving environmental quality and ensuring the prosperity of farming communities.

The ground level social, economic and environmental circumstances of crop production relations/activities differ one from the other. Thus, any causality behind poor performances in OFC production is too often place-based. Without identifying this persevering heterogeneity at the grassroot level and addressing the related problems for production and productivity improvement in OFCs it is inevitable that production programme the same fate will befall on the new food as well.

On the other hand, a paradigm shift is required in the agriculture sector not only to feed the increasing population but, to face the challenges of climate change and food security while ensuring the well-being of the farming community and environmental resilience. This requires understanding wider circumstances under which each and every farming system is operated, direct and indirect benefit enjoyed by the farming communities and externalities generated in quantitative terms with options for improvement and overcoming the problems.

Hence, this study will attempt to address the above gap through identifying social, economic and environmental conditions of crop production at the grassroot level with causality behind the present level of performances in selected Food Crop Production Systems (FCPS). The findings will help; sensitize the policymakers on triple bottom lines of sustainability, social acceptability and economic viability of farming options with the quality of environment in the OFC sector of Sri Lanka; to provide a scientific input for informed decision-making through identification of desirable development strategies and agricultural programmes that ensure sustainable agriculture development in the country; to capacitate policymakers for science based-informed decision-making towards productivity improvement, crop zoning (regional identity versus diversification), youth attraction in agriculture, promoting good agricultural practices, address gender issues in framing operations, resource allocation for site-specific needy issues while

contributing to ecological resilience and prosperity among farming communities in the SEDZ. Since this analysis steps into site-specific analysis beyond the conventional generic assessment, it will also be a novel experience to researchers, decision-makers, local communities, labour force and value chain actors of the OFC production systems and the country as a whole.

1.2 Objectives of the Study

1.2.1 Main Objective

To assess the social, financial and environmental dimensions of the prominent food crop production systems in the South-East Dry Zone of Sri Lanka.

1.2.2 Specific Objectives

1. To elaborate on the socio-economic status of the farmers in selected crop production systems.
2. To assess the input utilization patterns of selected crop production systems.
3. To find the social, environmental and economic aspects of sustainability.
4. To assess the sustainability of selected crop production systems.

1.3 Organization of the Report

The first chapter presents the background and objectives. The second chapter provides the national level extent and production information of the selected crops. The methodology is discussed in chapter three including sampling, data collection and analysis. Socio-economic information of the sample is presented in chapter four. Next, descriptive statistics and input utilization of the selected crops is explained. Sustainability of selected crops is discussed in chapter six and the final chapter draws the conclusion and recommendations.

CHAPTER TWO

Overview of Selected Crop Production Systems in SEDZ

2.1 Brief Introduction of the Selected Crops

2.1.1 Green gram

Green gram is an important pulse crop grown under traditional farming systems, mainly in the dry and intermediate zones of Sri Lanka. It has been identified as one of the principal but cheap source of protein and its importance as a component of the Sri Lankan diet has grown over the years. Therefore, benefits of increasing the green gram production would be twofold: improving income levels of farmers while generating employment opportunities and diversifying farming systems for sustainable agricultural production on one hand and fulfilling the dietary needs of the people while reducing the prevalence of malnutrition among the people on the other. At the same time, green gram is considered a potential crop of assuring food security for local masses, diversifying agricultural production and sustaining agricultural productivity.

2.1.2 Groundnut

Groundnut, also known as peanut, is an important legume and also an oil crop grown mainly in dry and intermediate zones of Sri Lanka. It is native to tropical America and now widely distributed and cultivated in tropical and sub-tropical regions of America, Africa and Asia including India and Sri Lanka. Groundnut is cultivated in uplands under rain-fed conditions during *Maha* season and in paddy lands under irrigation during *Yala* season. Although groundnut is an oil crop, it is in demand as snack and confectionery items in Sri Lanka.

2.1.3 Sugarcane

The crop is native to the warm temperate to tropical regions of South Asia and used for sugar production. Sugarcane is the major sucrose extracting crop used in the sugar industry in Sri Lanka, grown mainly in dry and intermediate zones of the country as a plantation crop. Pelwatta, Sevanagala, Kantale and Hingurana could be identified as major areas where the sugarcane plantations are concentrated within the above-mentioned zones. There are two types of systems existing in sugarcane

plantations that are, out-grower system and settlement system where both systems could be seen in Pelwatta area. In Pelwatta area sugarcane is grown under rain-fed conditions while the crop in Sevanagala and Hingurana are almost grown under irrigation.

2.2 Economic Significance of the Crop

2.2.1 Employment Generation

Most of the cultivation practices of both green gram and groundnut are more labour intensive and land preparation is the only mechanized operation in both crops. Labour requirement of the cultivation of one acre ranges from 24-30 man days/ac in green gram and it is 37-51 man days/ac in groundnut. Although sugarcane differs from the above two crops since it is a plantation crop. Labour usage in different operations are much similar in all three crops. In sugarcane cultivation, harvesting is the most labour consuming operation while land preparation is mostly done using machinery. Therefore, the cultivation of these crops will generate more employment opportunities for farming and non-farming communities as well. Table 2.1 illustrates the estimated employment generation from green gram and groundnut cultivation.

Table: 2.1: Total Employment Generation of Selected Crops

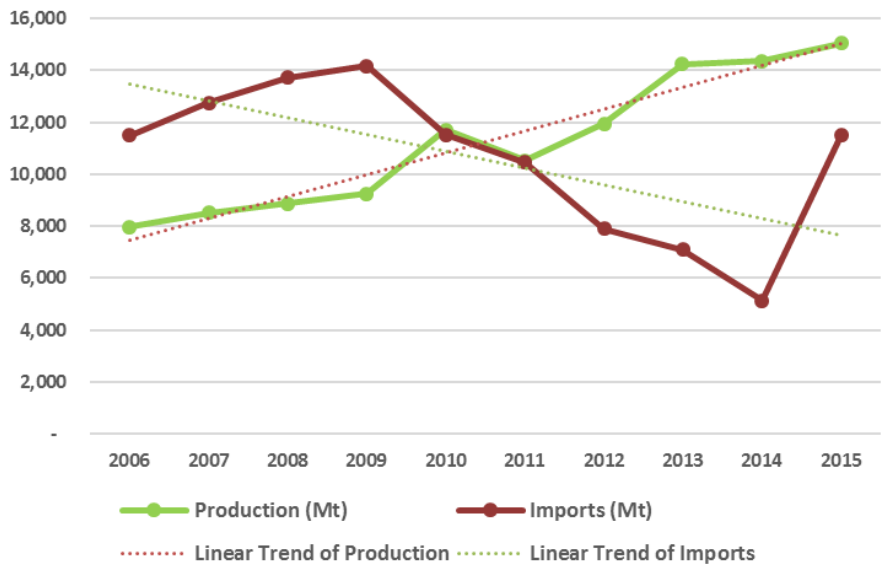
Year	Man days per acre	
	Green gram	Groundnut
2010	29	51
2011	29	49
2012	30	41
2013	27	50
2014	26	37
2015	24	38

Source: Department of Agriculture

2.2.2 External Trade (Foreign Exchange Saving)

The overall trends of both green gram and groundnut production have increased while the trend in imports has decreased over time. A sharp decline in imports and a growth of production in green gram after the year

2010 is observed due to the additional production from third season cultivation has reached to the market.



Source: Department of Census and Statistics, Department of Customs

Figure 2.1: Production and Imports of Green gram

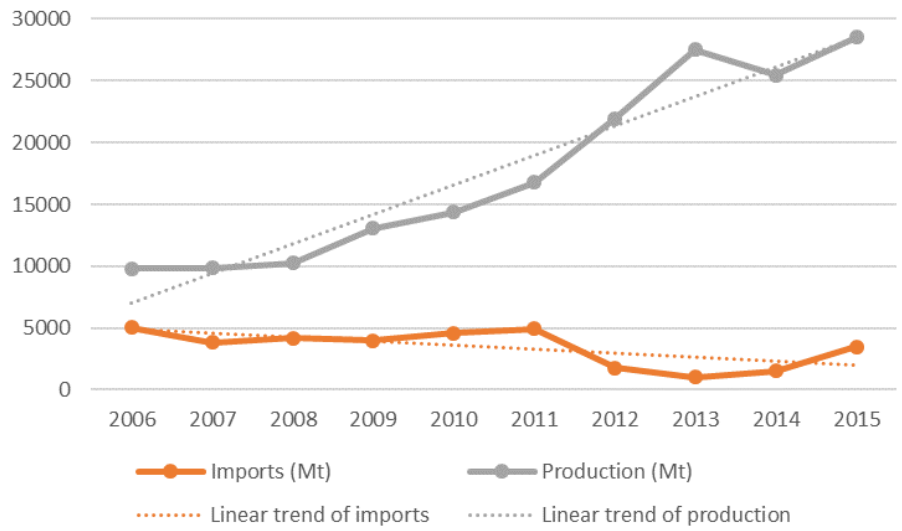
Contribution of imports to the total green gram requirement of the country was around 57 percent in 2006 and it has gradually declined to 30 percent in 2014. The percentage share of the total requirement in 2015 has suddenly increased to 50 percent due to low production recovered during that year mainly owing to the drought condition that prevailed.

Table 2.2: Contribution of Imports to the Total Consumption Requirement of the Country

Year	Imports (%)		
	Green gram	Groundnut	Sugarcane
2006	59.04	33.84	90.36
2007	59.99	28.13	94.18
2008	60.73	28.94	93.55
2009	60.51	23.45	93.54
2010	49.59	24.29	94.59
2011	49.79	22.69	94.56
2012	39.82	7.55	94.10
2013	33.21	3.59	91.17
2014	26.30	5.63	90.86
2015	43.28	10.88	91.77

Source: Department of Customs

A sharp increase could be observed in the production of groundnut after 2011 and the share of imports to the total requirement has decreased from 34 percent in 2006 to 11 percent in 2015.

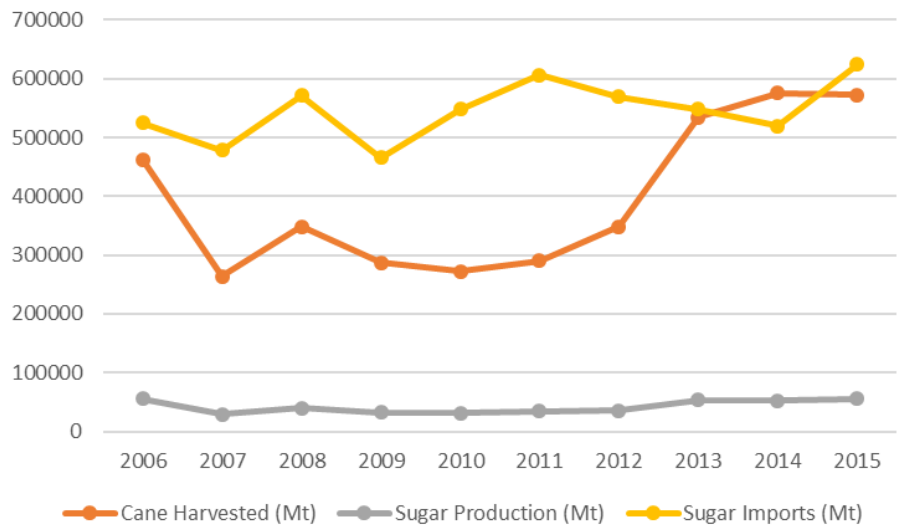


Source: Department of Census and Statistics, Department of Customs

Figure 2.2: Production and Imports of Groundnut

Green gram was imported from various countries mainly Australia, Myanmar, Thailand and Malaysia. Of the total imports in 2013, 46 percent came from Australia and 40 percent from Myanmar while the total groundnut imports have come from India.

In contrast to these two crops, sugarcane production fluctuated over time and showed slight increment after 2013 while sugar production remained almost constant over the years. Data shows that the overall domestic sugar production was sufficient to meet less than ten percent of the total sugar requirement of the country and the country expend more than 30 million rupees annually for sugar imports. It indicates that there is a huge potential for the expansion of sugarcane cultivation in the existing plantations. The national policy on the Sri Lanka sugar sector development was approved by the cabinet of ministers in 2005 which recognizes that domestic sugar industry has the potential to produce at least 50% of the domestic requirement of sugar and other value-added products of sugarcane within the next nine years (Sirimanna, 2011) and it will reduce a large component of the foreign exchange expenditure to import sugar which could enhance economic developments in rural areas. Sri Lanka imports sugar mainly from Brazil and India. Imports from Brazil contribute around 40 percent of total sugar imports while around 30 percent was imported from India.

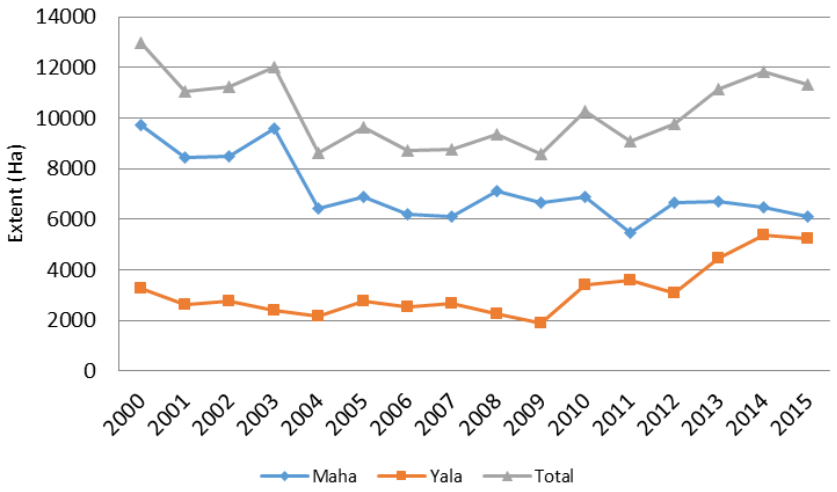


Source: Annual Report, Central Bank of Sri Lanka

Figure 2.3: Cane Production, Sugar Production and Sugar Imports

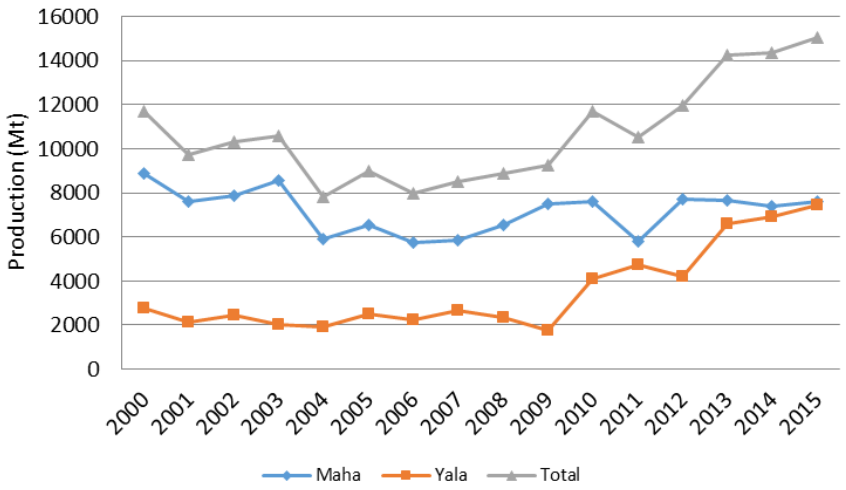
2.3 Production, Extent and Productivity

The trend in the area, production and yield of green gram for the period of 2000 to 2015 for Sri Lanka is illustrated in Figure 2.4, Figure 2.5 and Figure 2.6 respectively. As shown in the figures, both production and cultivated extent of green gram has fluctuated until the year 2003 and thereafter a sudden decline could be observed in 2004. The main reason for that was a failure of the crop during the *Maha* season due to heavy rains which led to the flood condition throughout the country. After 2004 there was a slight increment both in production and cultivated extent until the year 2009 and afterwards, and a rapid growth due to the introduction of third season cultivation was observed. The extent under green gram has dropped from 12,969 ha to 11,346 ha during 2000 to 2015 which is a 12 percent decline while the total annual green gram production has increased from 11,695 Mt in 2000 to 15,005 Mt in 2015, a 29 percent increase reflecting the improvement of the average yield of the crop.



Source: Department of Census and Statistics

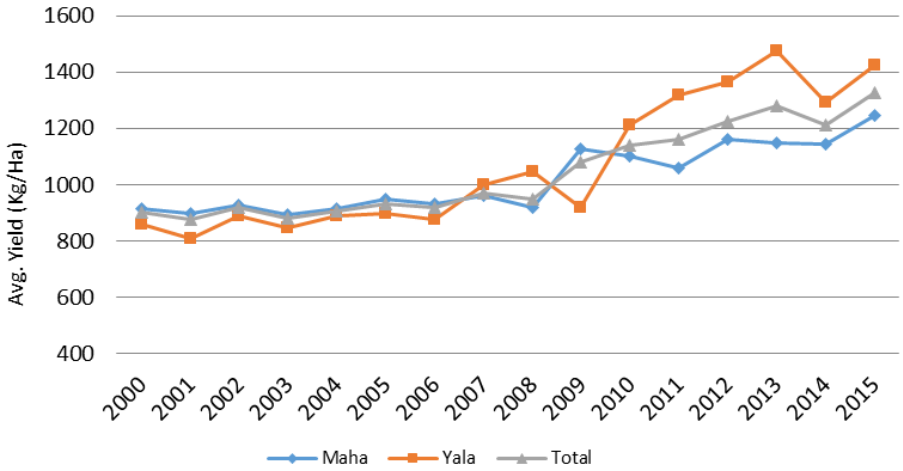
Figure 2.4: Cultivated Extent of Green gram



Source: Department of Census and Statistics

Figure 2.5: Production of Green gram

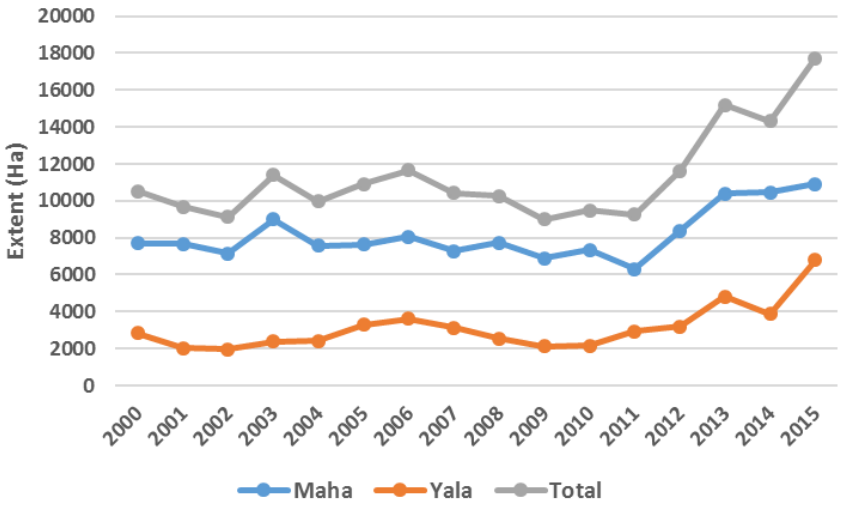
As illustrated in Figure 2.6, the average yield of green gram indicates stagnation until the year 2008 and then there was an improvement of the yield mainly due to the improvement of the yield of *Yala*. The average yield of the *Maha* season does not show a marked improvement when compared to the average yield of the *Yala* season.



Source: Department of Census and Statistics

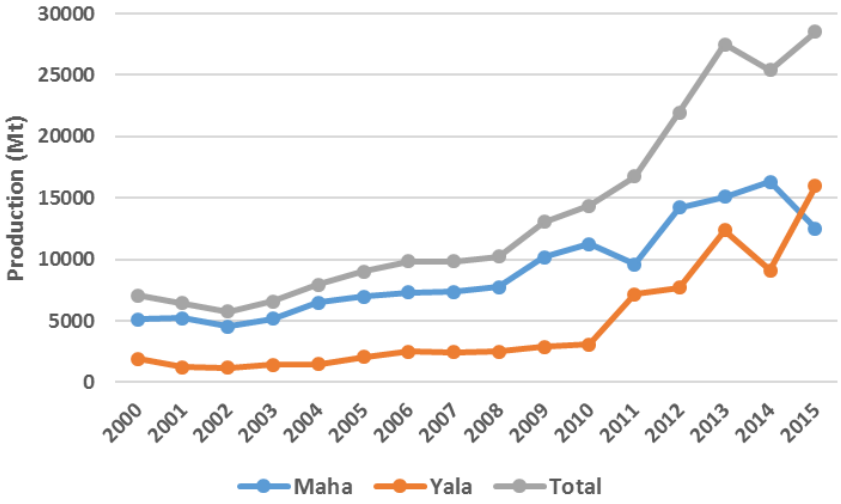
Figure 2.6: The Average Yield of Green gram

The trend in cultivated extent, production and average yield of groundnut for the period of 2000 to 2015 for Sri Lanka are depicted in Figure 2.7, Figure 2.8 and Figure 2.9. Fluctuation pattern could be observed in both cultivated extent and production of groundnut until the year 2010 and then there was an increasing trend in both attributes. At the same time, cultivated extent and production of groundnut in the *Yala* season showed an increasing trend after the year 2011 while those figures dropped in the *Maha* season. The extent under cultivation has increased from 10,534 ha to 17,716 ha during the period of 2000 to 2015 resulting in a 68 percent increase during that period while the production of groundnut has tripled during the same period from 7,065 Mt in 2000 to 28,502 Mt in 2015 indicating an improvement in crop productivity.



Source: Department of Census and Statistics

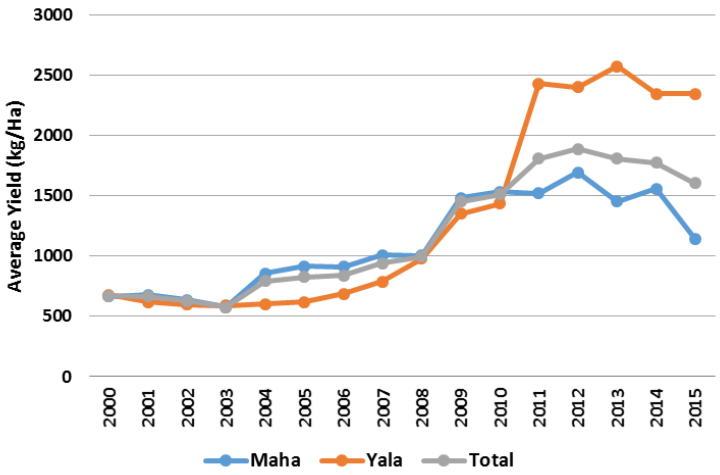
Figure 2.7: Cultivated Extent of Groundnut



Source: Department of Census and Statistics

Figure2.8: Production of Groundnut

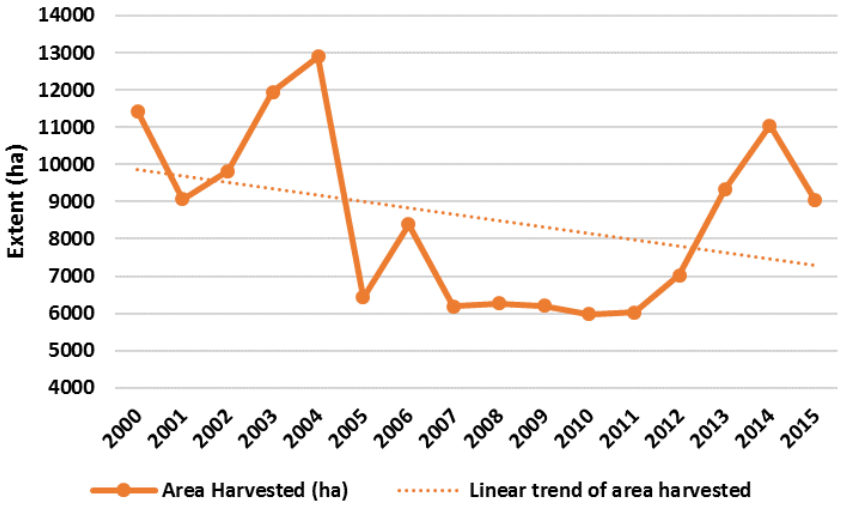
As shown in Figure 2.9, a sharp increment in average yield could be observed in 2011, especially in *Yala* season while the average yield of *Maha* season shows a fluctuation and does not show an increasing trend compared to the *Yala* season.



Source: Department of Census and Statistics

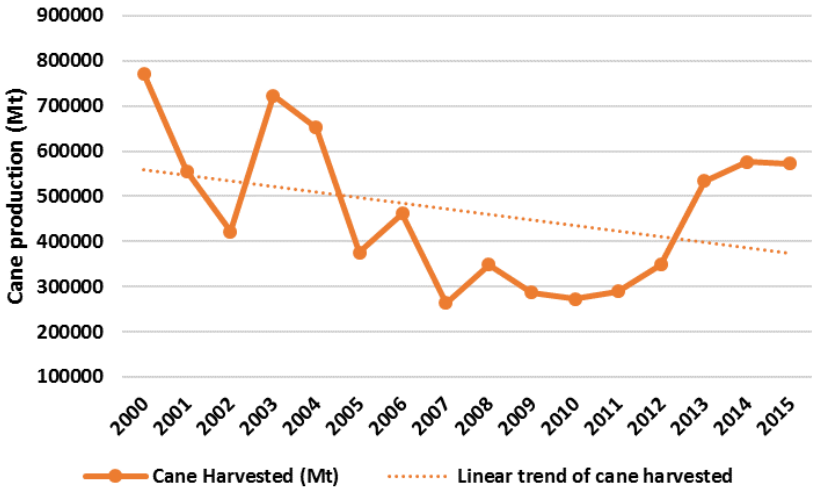
Figure 2.9: Average Yield of Groundnut

Figures 2.10, 2.11 and 2.12 illustrate the harvested extent, cane production and average yield of sugarcane for the period of 2000 to 2015 respectively.



Source: Annual Report, Central Bank of Sri Lanka

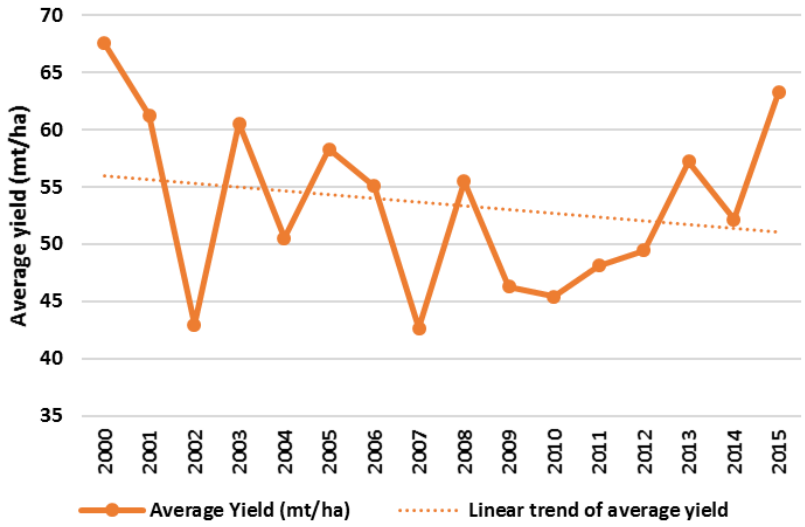
Figure 2.10: Harvested Extent of Sugarcane



Source: Annual Report, Central Bank of Sri Lanka

Figure 2.11: Production of Sugarcane

The highest extent was reported in the year 2004 and a sharp fall could be observed in 2005. Since then the harvested extent remained nearly unchanged and started to increase by 2012. As shown in the figure the overall trend of cane production over the period of 2000 to 2015 was decreasing while it has started to increase after the year 2012 with the expansion of harvested extent. The overall trend of average yield of sugarcane did not show considerable change during the period and continued to fluctuate over the years.



Source: Annual Report, Central Bank of Sri Lanka

Figure 2.12: Average Yield of Sugarcane

2.3.1 Major Producing Areas

Green gram cultivation is mainly popular in dry and intermediate zones and it is mainly cultivated during the *Maha* under rain-fed condition. As perceived in the last ten-year data (2006-2015), until the year 2009 Moneragala is the major green gram producing district in terms of production and extent of cultivation and from the year 2010 Hambantota district became the major green gram producing district both in terms of production and extent. This is mainly due to the introduction of third season cultivation of green gram in paddy lands in Hambantota district by the Ministry of Agriculture in 2010 in order to meet the country's green gram requirement. Hambantota, Moneragala and Ampara districts accounted for about 56 percent of the total green gram production in the country in the year 2015.

Table 2.3: Extent of Green gram by Major Producing Districts

District	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Hambantota	1135	1507	1369	1234	2315	2568	2330	2744	3644	2703
Moneragala	1730	1760	1880	1724	1938	1162	1664	1893	2044	2057
Kurunegala	1674	1585	1830	1924	1760	1610	1175	1803	1520	2164
Anuradhapura	579	706	677	712	787	522	645	586	643	560
Ampara	458	352	606	541	636	496	553	624	643	350
Kilinochchi	243	243	202	-	200	559	697	125	327	362
Other	2881	2611	2793	2437	2649	2150	2691	3372	3020	3151
Total	8700	8764	9357	8572	10285	9067	9755	11147	11841	11347

Source: Department of Census and Statistics

Table 2.4: Production of Green gram by Major Growing Districts

District	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Hambantota	1,103	2,048	1,700	1,554	3,122	3,808	3,612	4,271	4,706	5,308
Moneragala	1,938	1,473	1,615	2,428	2,147	1,416	1,788	2,168	2,170	2,291
Ampara	355	299	593	572	546	727	1,141	1,159	1,197	828
Kurunegala	1,042	1,116	915	978	1,130	807	589	1,583	753	982
Anuradhapura	504	574	606	849	941	492	747	678	708	583
Matale	80	202	442	285	287	280	387	591	611	823
Other	2,953	2,801	3,007	2,592	3,530	3,005	3,692	3,802	4,207	4,243
Total	7,975	8,513	8,878	9,258	11,703	10,535	11,956	14,252	14,352	15,055

Source: Department of Census and Statistics

As reflected in ten-year (2006-2015) data for the production and cultivated extent of groundnut, Moneragala was the leading groundnut producing district in both attributes until the year 2014. In 2015 Mullaitivu became a major groundnut producing district both in respect of cultivated extent and production. Mullaitivu, Moneragala, Kurunegala and Puttalam districts accounted for 68 percent and 69 percent of the total cultivated extent and total production respectively in 2015.

Table 2.5: Extent of Groundnut by Major Producing Districts

District	Extent (Ha)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Mullaitivu	1,820	1,820	871		111	295	2,558	943	1,933	5,377
Moneragala	2,666	2,260	2,778	2,568	2,948	2,815	2,823	3,404	3,555	3,360
Kurunegala	1,368	1,476	1,696	1,790	1,504	1,356	1,252	2,702	2,023	2,316
Puttalam	1,033	873	775	638	702	531	841	1,226	1,310	1,057
Ampara	894	633	727	627	874	691	565	613	640	863
Vavuniya	495	353	297	593	382	935	386	2,288	566	667
Batticaloa	463	59	152	173	370	86	237	328	382	533
Ratnapura	701	608	599	585	635	629	590	607	719	531
Anuradhapura	470	611	583	498	540	316	558	482	606	494
Trincomalee	319	245	200	278	263	167	288	466	421	477
Polonnaruwa	269	248	458	428	371	130	411	419	458	474
Kilinochchi	307	307	266		15	241	360	240	486	452
Hambantota	397	457	459	387	378	383	359	389	460	382
Mannar	80	44	19	53	83	453	100	721	376	369
Other	380	424	395	383	307	221	282	369	390	365
Total	11,662	10,418	10,272	9,002	9,481	9,251	11,609	15,198	14,326	17,716

Source: Department of Census and Statistics

Table 2.6: Production of Groundnut by Major Producing Districts

District	Production (Mt)									
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Mullaitivu	1,068	1,068	526		220	650	4,666	1,040	1,983	10,797
Moneragala	3,027	2,645	3,251	4,605	5,891	4,954	5,322	6,175	6,438	3,557
Kurunegala	846	1,011	1,317	1,701	1,233	3,676	3,234	8,275	5,123	3,107
Puttalam	928	831	804	807	1,111	1,135	1,959	2,840	2,740	2,333
Ampara	381	562	697	1,344	1,482	1,546	1,336	1,477	1,377	1,454
Polonnaruwa	288	300	515	841	832	283	898	945	907	1,090
Vavuniya	222	371	320	644	414	1,638	487	1,742	1,031	1,058
Ratnapura	677	570	543	608	651	624	648	694	886	707
Trincomalee	292	244	202	311	335	199	422	705	701	690
Kilinochchi	188	188	179		30	218	836	339	462	690
Anuradhapura	486	617	600	740	763	337	598	545	959	670
Hambantota	524	742	638	614	503	548	504	549	903	662
Batticaloa	394	36	91	101	241	70	433	342	723	581
Mannar	57	53	21	58	90	494	109	1,117	494	406
Other	444	593	547	703	558	391	501	701	705	701
Total	9,822	9,831	10,251	13,077	14,354	16,763	21,953	27,486	25,432	28,502

Source: Department of Census and Statistics

Cultivation of sugarcane was expanded in Sri Lanka under the World Bank funded project undertaken in 1978 to reduce the outflow of foreign currency from the country as the import bill of sugar. Initially sugarcane cultivation was started in Pelwatta area in Moneragala district under rain-fed conditions. Subsequently, sugarcane cultivation expanded as plantations in the nearby areas of sugar factories which were established in Hingurana, Kantale, Sevanagala and Galoya. Sugar production of these major factories from 1987 to 2015 is shown in Table 2.7.

Table 2.7: Sugar Production by Major Companies in Sri Lanka

Year	Hingurana	Kantale	Sevanagala	Pelwatta	Galoya	Total
1987	8,640	2,282	4,106	14,269	0	29,297
1988	11,084	1,427	11,038	29,972	0	53,521
1989	14,256	2,305	8,928	28,350	0	53,839
1990	12,140	2,364	9,641	33,020	0	57,165
1991	9,374	2,558	10,554	43,964	0	66,450
1992	9,520	2,392	13,840	34,222	0	59,974
1993	12,880	366	15,895	39,462	0	68,603
1994	14,058	0	18,534	39,682	0	72,274
1995	9,681	0	18,654	43,081	0	71,416
1996	12,090	0	16,024	42,000	0	70,114
1997	5,887	0	14,774	42,445	0	63,106
1998	0	0	17,139	44,410	0	61,549
1999	0	0	16,984	48,535	0	65,519
2000	0	0	24,396	40,085	0	64,481
2001	0	0	19,536	28,398	0	47,934
2002	0	0	13,769	23,892	0	37,661
2003	0	0	18,609	42,411	0	61,020
2004	0	0	16,795	40,151	0	56,946
2005	0	0	14,235	39,141	0	53,376
2006	0	0	18,609	37,410	0	56,019
2007	0	0	12,184	17,360	0	29,544
2008	0	0	10,978	28,400	0	39,378
2009	0	0	8,718	23,450	0	32,168
2010	0	0	8,602	22,734	0	31,336
2011	0	0	6,015	28,860	0	34,875
2012	0	0	9,631	22,712	3,316	35,659
2013	0	0	14,190	28,358	10,513	53,061
2014	0	0	14,417	17,964	19,937	52,318
2015	0	0	14,377	27,612	13,994	55,983

Source: Annual Report, Central Bank of Sri Lanka

As illustrated in the table above, continuous production could be observed only in Pelwatta and Sewanagala sugar factories while the operations of Hingurana and Kantale have stopped in the 1990s and on the other hand operations of Galoya plantations started in 2012. Government decisions taken from time to time in changing governments could be the main reason for such changes. For example, Kantale and Hingurana factories closed down as a result of the decision made by the government to sell those two factories to the private sector in 1992.

2.4 Variations in Input Use and Cultural Practices

In the Dry and Intermediate Zones of Sri Lanka, green gram and groundnut cultivation is practised during the *Maha* season in slash and burn lands under rain-fed conditions and in paddy lands under irrigation during *Yala* season with very low levels of external inputs. Although there are fertilizer recommendations for both crops, being legumes, they have the ability to fix atmospheric nitrogen and therefore farmers do not use the recommended rates of fertilizer in green gram and groundnut cultivation. At the same time, most of the farmers use seed rates lower than the recommended rates and this situation may lead to a poor yield of the crop.

Use of farm machinery in both green gram and groundnut cultivations is mainly confined to land preparation while other operations such as weeding and harvesting are performed manually. Harvesting is the most labour intensive operation in green gram while more labour is required for the processing stage especially for removing pods from the plant in groundnut. In green gram, harvesting cannot be mechanized as the crop does not get matured simultaneously. Therefore, at least three harvests per crop cycle are common in green gram and the number of harvests may vary between two to five times.

Unlike these two crops, sugarcane is grown as a plantation crop with the use of high level of inputs such as fertilizer. Normally it will take about a year for the crop to get matured after planting of seed cane. Similar to green gram and groundnut land preparation is the only mechanized operation in sugarcane where weeding and harvesting is done manually. Meanwhile, harvesting is the most labour intensive operation in sugarcane. Intensive use of fertilizer could be observed in sugarcane cultivation and fertilizer application is done in several stages.

2.5 Government Interventions Towards Promotion of Crop

The promotion of OFCs was initiated in the mid-1960s with the introduction of the government's "Food Production Drive" programmes and since then all the governments have carried out a variety of programmes and implemented various policies to encourage the local production of the crop. "Api Wawamu Rata Nagamu" programme introduced by the government during the period of 2007 to 2010 also aimed at improving production and productivity of selected OFCs while aiming at self-sufficiency in groundnut and sesame by the year 2015. The "Mahinda Chinthana" policy document envisaged self-sufficiency in green gram by 2010. In line with this policy, the Department of Agriculture introduced a five-year plan for 2006-2010 and this programme identified green gram as one of the priority crops to be promoted considering the contribution to national economy, import substitution, consumer demand, agro-industrial potential and ability to increase farmer income. The national food production programme 2016-2018 proposed by the present government has paid special attention in promoting paddy, turmeric and ginger, vegetables, fruits, home-gardening and 11 other field crops (OFCs) while the programme envisages self-sufficiency in four OFCs including both green gram and groundnut by the year 2018. Meanwhile, it also constitutes a subsector of promotion of plantation crops.

Sugarcane is also an important crop grown in the country as it is the only crop used in the sugar industry. Although sugarcane has been cultivating in Sri Lanka since 1840s promotion of crop as an ingredient for sugar industry started after 1978. Initially, sugarcane was cultivated in Pelwatta area and the Pelwatta sugar manufacturing factory was established in the year 1981 as a state-owned company. Afterwards, several factories have been established and at present only three are functioning; Pelwatta, Sevanagala and Galoya. The national policy on Sri Lanka's sugar sector development was approved by the cabinet of ministers in 2005 and it was recognized that domestic sugar industry has the potential to produce at least half of the domestic requirement of sugar and other value-added products of sugarcane within the next nine years.

2.6 Summary

Although numerous measures have been taken in order to promote the production of these crops in the country, data shows that all such efforts fell below the expected levels of achievement despite huge investment made by the government. One major reason behind the situation is that national average figures on production, productivity and profitability are considered as main decision-making tools at the policy-making level which does not reflect the ground reality. As a result, the real situation in the ground level and actual reasons leading to poor achievement in the production and productivity of the crop are not adequately understood and properly addressed. This may lead to various social, economic and environmental issues within the farming community. Therefore, it is crucial to address social and environmental issues without making decisions solely based on economic performances to have more sustainable development in the sector.

CHAPTER THREE

Methodology

3.1 Definitions of the Study

3.1.1 Study Area

A specific region known as the South East Dry Zone (SEDZ) of Sri Lanka was selected as the study area for this study (Figure 3.1). The SEDZ comprises of three districts: Ampara, Moneragala and Hambantota and the SEDZ region covers virtually all that territory that lies east of the Walawe basin, south and south-east of the Haputale escarpment and east of the Passara hills. The SEDZ was selected as the study area considering the similarities within the region with respect to the climate, land use pattern, soil and availability of selected crops as prominent food crop production systems among existing farmer communities. The SEDZ covers approximately 520,387 ha and within the region at least about 23 land use types were present. With respect to agro-ecological regions, the area includes DL 1a, DL1b, DL2a, DL 2b and DL 5 regions.

Agriculture is still the mainstay of the life of the majority around 35 percent of the population in the South East Dry Zone of Sri Lanka. The SEDZ is the major farmlands for many food crops; paddy and other field crops including maize, green gram, sugarcane, groundnut, cowpea, big onion, gingerly and finger millet. The extent of maize grown in the SEDZ is ranked as number one, out of the total acreage of the country followed by sesame and groundnut.

The selection of dry zone for this study is generally due to its predominance in food crop production which provides a livelihood strategy for the rural population in the country. The largest agro-climatic zone of the country is known as the Low Country Dry Zone (LCDZ). It is further categorized into 11 Agro-Ecological Regions (AERs). Farming in LCDZ is characterized by the production of food crops largely in small land plots categorized under the small farm sector.

From the 11 AERs within the low country dry zone DL1a, DL2a DL1b and DL2b are further chosen as study sites. Thus the study locations will be within the administrative boundaries coming under these four AERs in the SEDZ.

The criterion used for the selection of comparable farming options was agro-ecological regions and administrative units within the SEDZ of Sri Lanka. The importance of agro-ecological regions is apparent for agriculture while the basis of administrative boundaries is where both resource allocations are for development programmes and collection and compilation of data. Therefore, primary data collection for this study will base on diverse farming options operated by the farming communities residing in the study locations demarcated on the basis of agro-ecological and administrative boundaries.

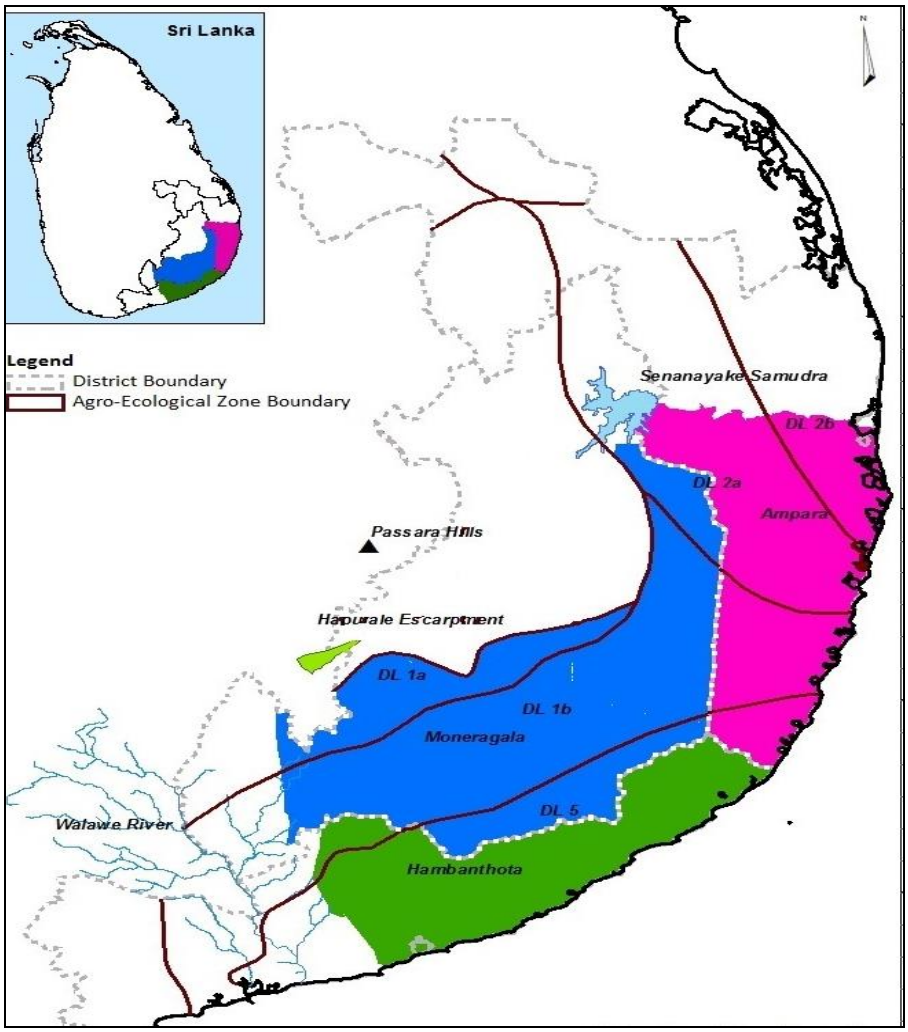


Figure 3.1: Location of SEDZ Region

3.1.2 Selection of Cropping Systems

Farming operations in the area are based on mixed dry grains, sugarcane, paddy and fruit crops. However, the farming systems are diverse among existing farming communities even within one particular AER. Hence the identification of diverse farmer groups was carried out based on the major crop produced by each sample unit i.e. farming household.

Food crop production system was referred to as a crop production system where relevant farmers cultivate similar crop as their main farming activity which their household income was generated through cultivating the particular crop. Accordingly, green gram, groundnut and sugarcane were selected for this study.

Sugarcane production system was mainly found around Moneragala district and Hingurana areas in Ampara district and Sevanagala area in Hambantota district as a commercialized cultivation. Groundnut production was prominent in Panama, Komari and Thambiluvil areas in Ampara district and in Thellulla, Balaharuwa and Thanamalvila areas in Moneragala district. Green gram was mainly found in Wellawaya, Buttala and Thanamalvila areas of Moneragala district and Kirinda, Yodakandiya and Hambantota areas in Hambantota district.

Accordingly, selection of farmer households as sample units for primary data collection for a particular food crop production system was carried out within the major cultivation area of each selected crop as mentioned above.

3.2 Sample Selection

Compiled lists of farmers available in District/Divisional Offices of Department of Agrarian Development were used as the sample frames to determine the sample.

Multistage sampling technique was used to derive the study sample. In the first stage, districts were selected. Accordingly, out of the three districts included in the SEDZ, for each crop, districts were selected to represent at least 80 percent of the total cultivated extent of the SEDZ region for the particular crop. Accordingly, Ampara and Moneragala district for groundnut, Hambantota and Moneragala for green gram and Moneragala for sugarcane were selected for data collection.

At the second stage, ASCs/Outgrow Zones (for sugarcane) were selected from each district to represent at least 80 percent of the total cultivated extent within each district for each selected crop. As the third stage, GNDs/Field Assistant Areas (for sugarcane) from each ASC were selected to represent at least 80 percent of the total cultivated extent within each selected ASC, and, in the final stage at least eight percent of the farmers who cultivate selected crops, i.e. groundnut, green gram and sugarcane in each GND were selected for the primary data collection survey on a random basis. A detailed description of the study sample is given in Table 3.1.

Table 3.1: Details of Selected Sample

Crop	District	ASC/Out-grower zone	GND/Field assistant sections	No of HHs
Green gram	Hambantota (53%)	Tissamaharama	Dutugemunupura	54
			Mahasenpura	
			Joolpallama	
			Uddagandara	
			Yodakandiya	
	Moneragala (40%)	Buttala	Gonagan Ara	59
			Konketiya	
			Wandama	
Sub total				**113**
Groundnut	Ampara (17%)	Panama	Panama	12
		Komari	Pothuvil - 22	9
			Pothuvil - 23	
		Thambiluvil	Vinayagapuram- 3	15
			Vinayagapuram- 1	
			Tangawelaipuram	
			Kanchikudichchiaru	
			Thirukkovi- 3	
	Moneragala (72%)	Thelulla	Kuda oya	43
			Balaharuwa	
			Debara ara	
		Thanamalvila	Kiul ara	72
			Bodagama	
			Siththarama	
Sub total				**151**
Sugarcane	Moneragala	Buttala	FA 3-1	46
			FA 3-3	
			FA 3-4	
			FA 3-5	
		Pelwatta	FA 2-1	34
			FA 2-3	
			FA 2-4	
			FA 2-6	
		Wellawaya	FA 5-1	18
			FA 5-2	
			FA 5-4	
Sub total				**98**
Total				**362**

Note: figures in the parenthesis represent the percentage extent of each District or ASC out of the total extent of the SEDZ region or District

3.3 Data Collection Process

Questionnaire Survey was used in collecting primary data from a total of 362 household units for three production systems. In that, information about the socio-economic condition of the households and sustainability of the food crop production systems were gathered.

Focus Group Discussions were also used to collect primary data especially to gather information common to a particular farmer group cultivating the same crop and from the other relevant stakeholder groups for each production system.

Key Informant Interviews were conducted to collect information from relevant officers working in the sample locations especially to collect information regarding the potential strategies which could be suggested in future planning in order to achieve sustainability in each production system.

Secondary data was collected from relevant sources and authorities.

3.4 Methods of Analysis

Among the various techniques used in assessing the sustainability, index approach is a widely used in empirical studies and used for this study as well. In here, overall sustainability is computed as a composite index. Following the concept which sustainability defined according to three pillars namely, social, economic and environmental sustainability; a three sub-indices *i.e*. Social Sustainability Index (SOSI), Environmental Sustainability Index (ENSI) and Economic Sustainability Index (ECSI) were constructed to derive the composite index and thereby value the overall sustainability. Each sub-index was assessed by setting appropriate variables/ indicators to represent the relevant sub-index/pillar.

In order to compute the composite sustainable index, several steps have been followed as illustrated in the analytical framework (Figure 3.2).

As the first step, primary data collected via questionnaire was standardized by transforming them into the normalized values prior to being used in further analysis. This operation ensured that all the data in different scales or unit of measures is arranged into a common scale which allows comparing against each on a common platform.

In order to standardize each variable, equation 1 was used.

$$NX_m = \frac{X_{actual} - X_{min}}{X_{max} - X_{min}} \quad \text{----------} \quad (1)$$

Where;

NX = normalized value of relevant variable
X_{actual} = actual value/observation of the variable
X_{min} = minimum value of the variable recorded
X_{max} = maximum value of the variable recorded

As the next step, sub composite indices (that are combined to derive the composite sustainable index) were calculated using equation 2;

$$SCI = \frac{\sum_{i=k=1}^{nk} W_k X_{ki}}{\sum_{k=1}^{k} W_k} \quad \text{----------} \quad (2)$$

Where;

SCI = each sub component index (i.e. SOSI, ENSI, ECSI)
W = weight allocated for each variable
X = variable/s

During the process, aggregation of variables was done according to the functional relationship (as described in Table 3.2) of different variables to the overall sustainable index, by either adding or deducting (additive and subtractive method).

Weights for different variables (to calculate Sub Component Index) and for each subcomponent index (to calculate the overall sustainable index) determined according to the expert knowledge, where views of various stakeholders collected in a participatory method (either focused group discussion or key informant interview).

As the next step, considering the three-pillar concept, and the composite index approach sustainability index calculated using equation 3,

$$SI = \frac{W_{SSI}(SSI_i) + W_{EnSI}(EnSI_i) + W_{EcSI}(EcSI_i)}{W_{SSI} + W_{EnSI} + W_{EcSI}} \quad \text{----------} \quad (3)$$

Where;

SI = composite sustainability index
W_{SOSI} = weight allocated for the social sustainable index
W_{ENSI} = weight allocated for environment sustainable index
W_{ECSI} = weight allocated for the economic sustainable index
SSOI = social sustainable index
ENSI = environment sustainable index
ECSI = economic sustainable index

Following the steps described above, the sustainable index was obtained for each farmer in the sample.

At the final step, sustainable index values of individuals were averaged to obtain the sustainable index for different food cropping systems.

The value of sustainability index varied between 0 to 1 where 0 denotes the least sustainability and 1 refers to the highest sustainability of a system.

These values of sustainability indices need to be considered in relative terms and comparison of results/output could only be done in similar context, in relation to indicators/variables, normalization methods, weighing and aggregation methods.

The indicators selected for assessing the three pillars/components of sustainability, respective variables, measuring units, method of aggregation and weights are presented in Table 3.2. Development of a composite index for sustainability assessment and selection of sub-indicators and variables were selected according to Waney *et.al.* (2014*)*; Hahn *et.al.* (2009); OECD (2008); and UNEP and SETAC (2013).

Relationship of the steps followed during the process of analysis and index preparation (i.e. analytical framework) is presented as a graphical illustration in Figure 3.2.

Table 3.2: Sustainability Indicators, Its Measurements and Weights

Pillar	Indicator	Variable	Unit of measure	Aggregation	Weight
Social Sustainability	Employment generation	Total labour usage (Family and hired)	Man days/Acre	(+)	20%
	Source of income	Net return to family labour	Rs/man day	(+)	30%
	Competitiveness	Mean difference between breakeven and the actual price of a particular crop	Rs/kg	(+)	30%
	Input availability	Seed quality	5-Very good 4-Good 3-Acceptable 2-Poor] 1-Poorest	(+)	20%
Environment Sustainability	Chemical fertilizer application	Severity of chemical fertilizer application	Rs/acre	(-)	40%
	Pesticide application	Severity of pesticide application	Rs/acre	(-)	40%
	Depletion of land	The severity of soil erosion in particular land	5-Very severe 4-Severe 3-Moderate 2- Less 1-No erosion	(-)	20%
Economic Sustainability	Profit	Net farm income	Rs/acre	(+)	40%
	Crop productivity	Over time trend of productivity change	Kg/ac (mean /last 3 years)	(+)	40%
	Relative economic importance of crop	Contribution to total family income from crop production	% per crop cycle	(+)	20%
Overall Sustainability	Social Sustainability				30%
	Environmental Sustainability				30%
	Economic Sustainability				40%

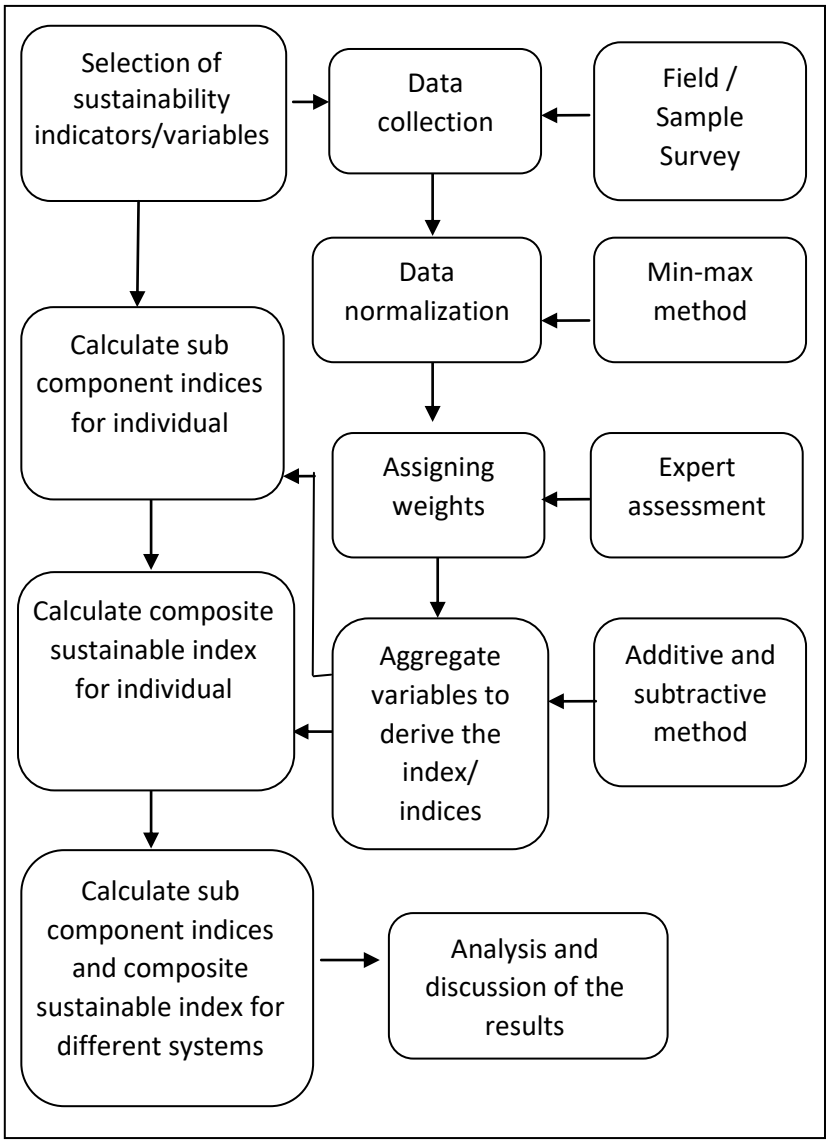


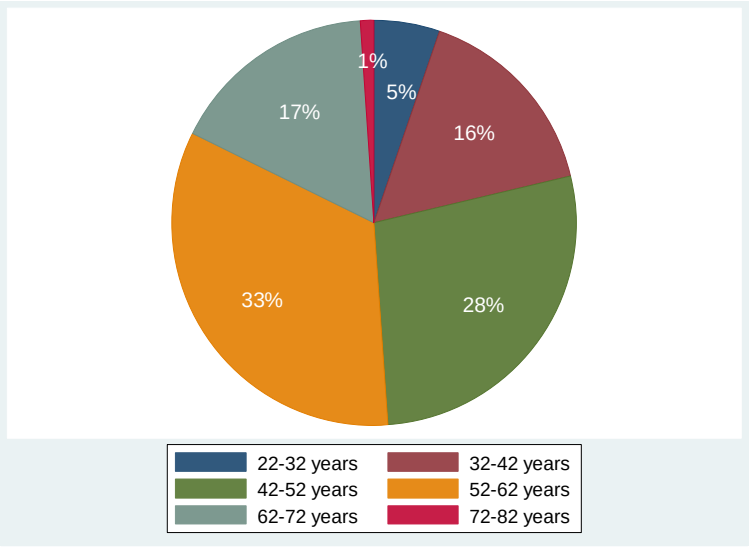
Figure 3.2: Analytical Framework

CHAPTER FOUR

Socio-Economic Features of the Sample

4.1 Age and Education Level of the Farmers

Labour force participation rate for agricultural activities is an important component for measuring the sustainability level of the crop production systems for it is related to social sustainability. Employment generation provides a direct benefit to society. And also age profile of the farming community reflects the nature of the farmers engaged in crop production systems. More than half of the farmers were above 50 years while 28 percent of them were in the group of 42-52 years. One-fifth of the farming community engaged in the age of 22-42 years. These are common characteristics of the non-plantation sector in Sri Lanka.



Source: HARTI survey data, 2016

Figure 4.1: Age Distribution of the Farmers in SEDZ

Low education level and engaging in agricultural activities shows a high correlation in the agriculture sector. One-third of the farmers had completed only primary education and 23 percent have completed junior education while the senior secondary level was completed by 33 percent of them. Accordingly, the majority of the farmers in SEDZ were in low education level and it did not vary with respect to the crops (Table 4.1).

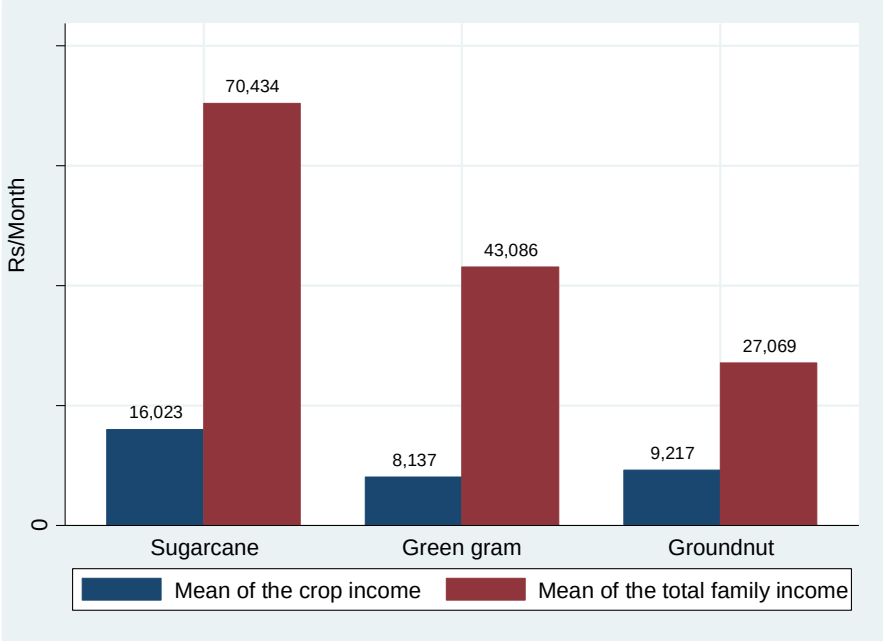
Table 4.1: Education Level of the Farmers in SEDZ (Percentage)

Education level	Sugarcane	Green gram	Groundnut	Total
Up to grade 5	9	11	16	36
Grade 5-8	4	7	12	23
Grade 9-11	12	10	11	33
O/L passed	1	1	0	2
A/L passed	2	1	2	5
Graduate	1	0	0	1
Total	28	30	42	100

Source: HARTI Survey Data, 2016

4.2 Family Income of the Farmers

Farming is one of the main income sources in the family. Total family income depends on the other income sources of the family. Other crop income has provided a significant contribution to the total family income in SEDZ since farming is the major income generating activity in this area.



Source: HARTI Survey Data, 2016

Figure 4.2: Income Distribution of the Households in SEDZ

According to Figure 4.2, sugarcane farmers' family income was the highest among those selected crops growers. However, around 23 percent of the sugarcane, 19 percent of the green gram and 33 percent of the groundnut contributed to the total family income. Accordingly, groundnut farmers highly depending on the income received from the crop while least contributory crop to the total family income was green gram. Generally, green gram cultivating farmers practiced green gram cultivation as a minor crop.

4.3 Wealth Index

Wealth is the ownership of valuable resources. Income, consumption or expenditure information would reflect household wealth approximately. Therefore, Socio-Economic Status (SES) could be measured using the wealth index. In the survey, information was collected on durable asset ownership (Household and agricultural equipment), access to utilities and infrastructure (Sanitation facility and source of drinking water) and housing characteristics (Number of bed rooms and building materials), which were included in constructing wealth index. Principal Component Analysis (PCA) applied to construct this index. Generally, a variable with a positive factor score is associated with higher SES and a variable with a negative factor score is associated with lower SES (Vyas and Kumaranayake, 2006). Accordingly, classified household into quintiles (Vyas and Kumaranayake, 2006) and calculated mean socio-economic score of each category are presented in Table 4.2.

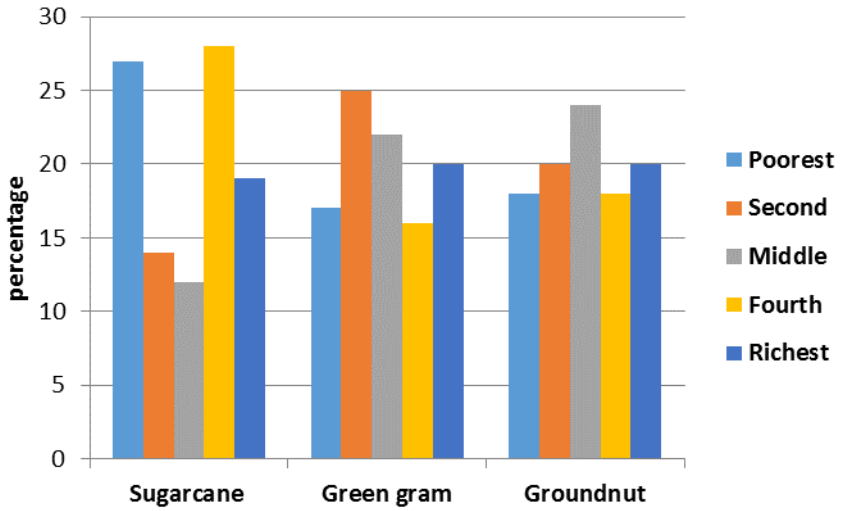
Table 4.2: Mean Socio-Economic Score by Quintiles

Crops	Poorest	Second	Middle	Fourth	Richest
Sugarcane	-2.63	-1.08	0.05	1.00	2.94
Green gram	-3.42	-0.97	-0.10	1.05	3.24
Groundnut	-3.26	-0.97	-0.09	1.00	3.14
SEDZ	-3.07	-0.99	-0.07	1.01	3.12

Source: Authors' Computation, 2017

Sugarcane farmers are fairly well off farmers as compared to the poorest category. According to the second poorest group, the mean socio-economic score is less in sugarcane farming community with compared to other crops. However, sugarcane farmers' socio-economic status is higher compared to other crops in the middle group. There is no difference in the

fourth category. Though, green gram and groundnut cultivating farmers' socio-economic status is better than that of sugarcane farmers in the richest category, one-fourth of the sugarcane farmers remains poorest segment. Around a quarter of the green gram cultivating farmers is the second poorest category and 24 percent of groundnut farmers are included in the middle socio-economic status group. Most of the sugarcane farmers are in fourth socio-economic status category (28%) and the richest percentage of all crops is the equal amount which is around 20 percent of the particular crop cultivated farmers.



Source: HARTI Survey Data, 2016

Figure 4.3: Wealth Index Categorization of the Farming Community

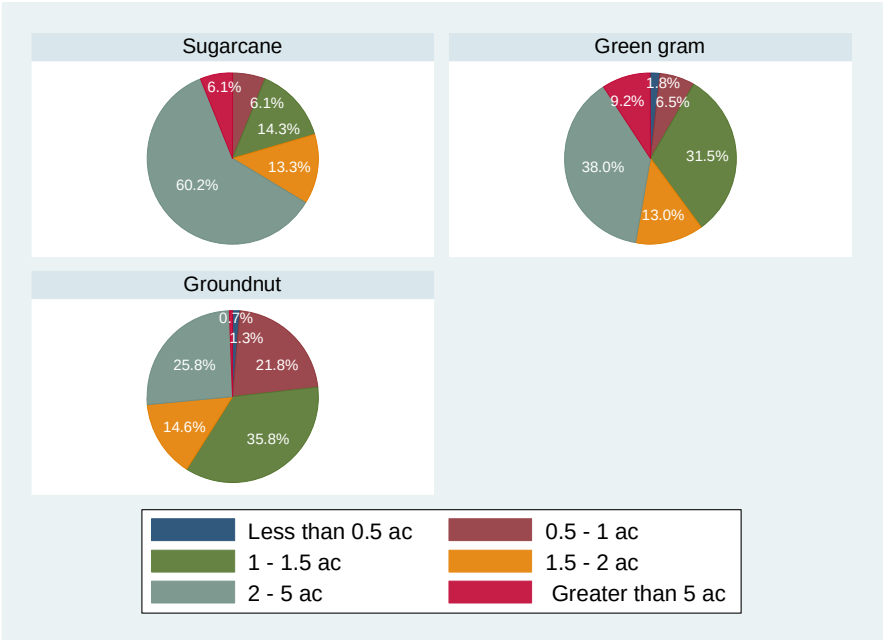
However, around 40 percent of the total farming community is poor with respect to the wealth index (Figure 4.3). One-fifth of the farmers are richest and the rest, belong to the middle and fourth category according to the SES of the crops. Thus, sustainability issues among those engaging in this selected crop production systems would be highlighted. Those crops have been cultivating for many decades in this area but farmers are still suffering from many issues related to crop production systems.

CHAPTER FIVE

Descriptive Analysis of the Input Utilization in Selected Crop

5.1 Land Use Type of SEDZ

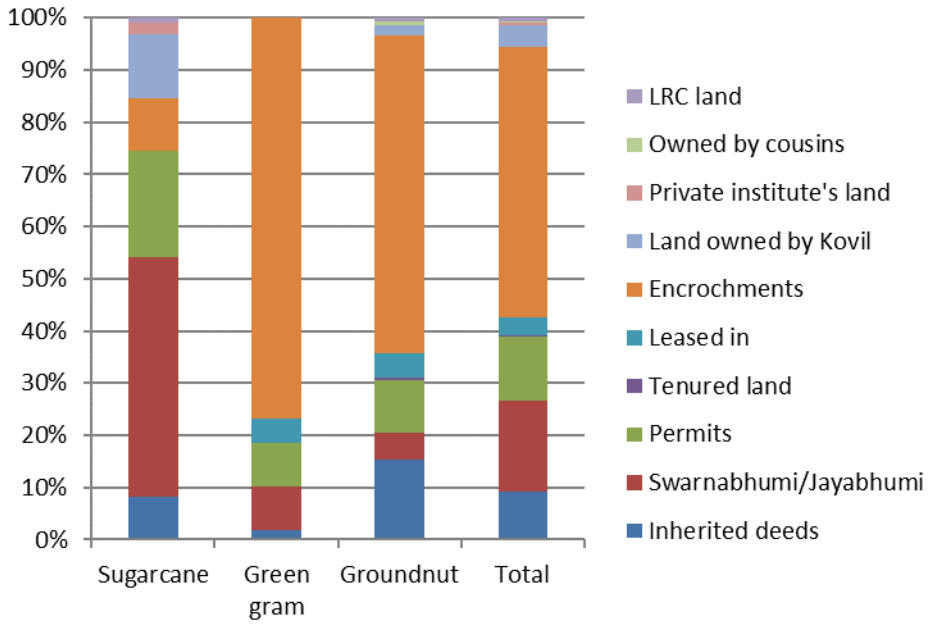
Majority of the sugarcane growers were operating large-scale lands which were 66 percent of more than two acres and 27 percent of 1-2 acre sugarcane lands. However, around 50 percent were owned lands while around 20 percent cultivated in permitted lands. The special character of the land ownership was 10 percent of the total sugarcane cultivated lands owned by the temple (*Katharagama Devalaya*). Green gram cultivation differs from sugarcane farming. More than half (53%) of the people cultivated less than two acres of lands and 47 percent were over two acres while around nine percent was greater than five acres. Further, a three-fourth of the total green gram cultivation were grown in encroachment areas due to Chena cultivation which is still being practised in this area. However, green gram cultivation in this area provides a significant contribution to the total green gram production in the country. Otherwise, they are cultivating for three to four decades in those encroachment areas.



Source: HARTI Survey Data, 2016

Figure 5.1: Scale of Farming in the Selected Crops

Groundnut cultivation is of rather different nature compared to other crops. Around 23 percent was less than one acre while 50 percent operated one to two acre for groundnut. Rest of the lands cultivated were more than two acres. More than a quarter of the lands were owned lands but around 60 percent of the total groundnut farming was operated in encroachment areas. Landholding rights will be a problem in SEDZ, therefore, policymakers should pay their attention to this matter.



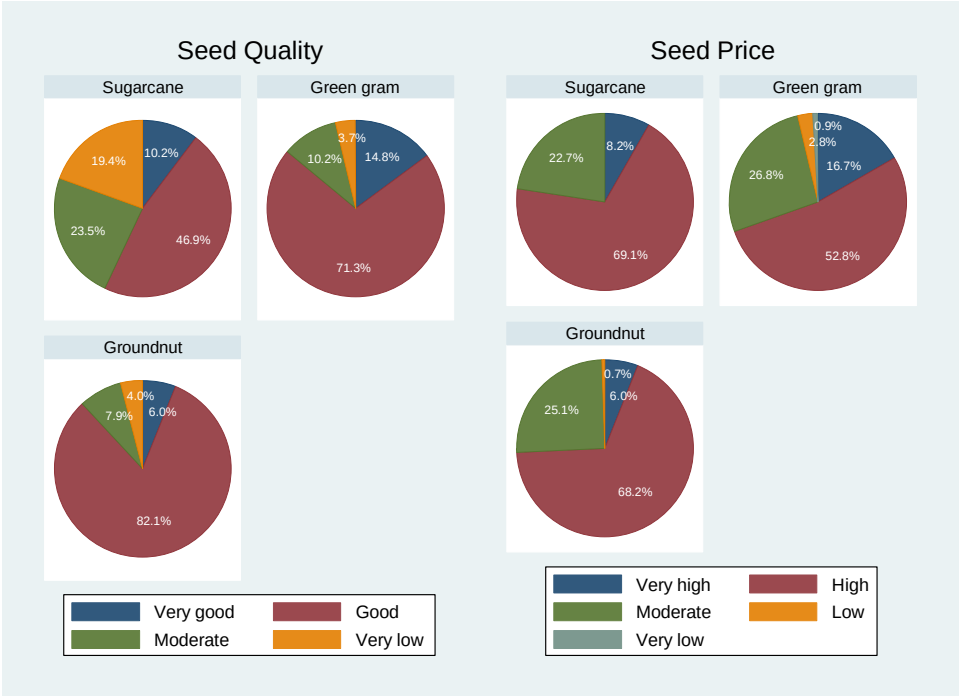
Source: HARTI Survey Data, 2016

Figure 5.2: Type of the Land Ownership in SEDZ

5.2 Seed

Seed is one of the fundamental inputs of the cultivations. Seed availability and accessibility at affordable price are the key determinants of making decision on crop cultivation in a particular season. On the other hand, good quality seeds may lead to enhancing productivity. It would help obtain a better economic benefit for the farming community. Sugarcane farmers were highly worried about the quality of the seed cane compared to green gram and groundnut. Around 43 percent of the total sugarcane growers have highlighted their dissatisfaction with regard to seed quality. Less than one fifth (14%) stressed low-quality issues of the green gram

seeds while around 12 percent of the groundnut cultivated farmers have noted the same quality issues of the seed. More than 70 percent of the farmers who cultivated sugarcane, green gram and groundnut have emphasized that the price of the seed was not affordable.



Source: HARTI Survey Data, 2016

Figure 5.3: Farmers' Perception towards Seed Quality and Price

Most of the crop production systems in SEDZ depend on rainwater and water scarcity which is one of the major problems in that area. Therefore, more than 90 percent of the crop production systems were rain-fed and a few of groundnut cultivators had used other water sources (Table 5.1) to supply water.

Table 5.1: Water Supply Sources for Selected Crops

Nature of water supply		Sugarcane	Green gram	Ground nut	Total
Rain-fed	No	97	107	128	332
	%	98.98	99.07	84.77	93.00
Farm wells	No	0	1	14	15
	%	0	0.93	9.27	4.20
Small scale irrigation	No	1	0	7	8
	%	1.02	0	4.64	2.24
Pumping (from river/tank)	No	0	0	2	2
	%	0	0	1.32	0.56
Total	No	98	108	151	357
	%	100	100	100	100

Source: HARTI Survey Data, 2016

5.3 Labour

Employment generation of any production systems provides an important service to the national economy by reduction of unemployment rate in the country. Otherwise cultivating crops in that area may create employment opportunities for the local community and it would be the social impact of the crop production systems.

Table 5.2: Labour Utilizations of the Selected Crops

Labour	District	Sugarcane (Mean)	Green gram (Mean)	Groundnut (Mean)
Family labour (man day/ac)	Moneragala	25	48	88
	Ampara			41
	Hambantota		58	
Hired labour (man day/ac)	Moneragala	6	9	18
	Ampara			23
	Hambantota		20	
Total labour (man day/ac)	Moneragala	31	57	106
	Ampara			64
	Hambantota		78	
Total (man day/ac)		**31**	**68**	**95**

Source: HARTI Survey, 2016

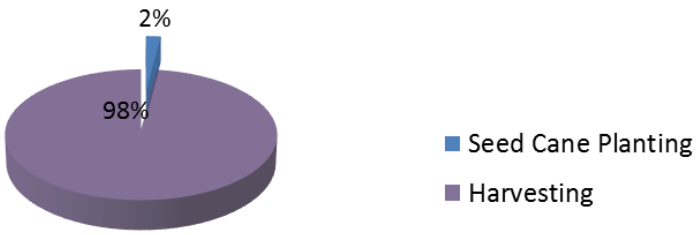
When considering the crop production systems, on average 31 man days from sugarcane, 68 man days from green gram and 95 man days from groundnut were created in SEDZ for the local community. However, there was district wise variation of the labour utilization in green gram and groundnut cultivation. The only reason for that variation is utilizing additional time for protecting their cultivation from wild animals as most of the farmers in particular crops cultivated in encroachment areas in the form of Chena cultivation.

Further, sugarcane production system has consumed more hired labour as in Table 5.2 during the harvesting period. There was a peak time for the labour requirement. Green gram and groundnut were also in the same position during the harvesting period due to manual harvesting of those crops. But sugarcane harvesting is one of the difficult tasks and required a special skill to cut the cane.

Cane harvesting after burning sugarcane

Therefore, growers are unable to harvest and they have to hire labour from outside of the system. A well-established system for harvesting which is contract labour system is in operation. Contract teams stay over during the harvesting period and sugarcane growers have to provide

accommodation and food for them. The leader of the contract team assumes the responsibility for harvesting and reach an agreement with sugarcane grower. However, the contract has been undertaken with the payment of output basis. Contractors have obtained Rs. 1700/ton for harvesting. Generally, one labourer can cut half a ton per day without burning sugarcanes and burnt canes can be one and a half tons per day. Around Rs. 60,000/ac has to be spent on contract labour for cane harvesting. Contract labour has been used for two operations but 98 percent of the total contract labour cost was cane harvesting.



Source: HARTI Survey, 2016

Figure 5.4: Contract Labour Use of Sugarcane Cultivation

5.4 Cost of Production

Farmers are able to earn a different income by cultivating those crops in SEDZ (Table 5.3). If a farmer who cultivates an acre of those crops in SEDZ in a year, he can be obtained a net income as shown in Table 5.3. Accordingly, sugarcane and groundnut cultivation have fetched better economic benefit than green gram crop production system. Sugarcane and groundnut farmers have received around Rs. 57,000/= and Rs. 48,000/= by cultivating an acre of land in SEDZ. However green gram cultivated farmers have obtained around Rs. 9,500/= by growing an acre. On the other hand, the highest cost of production was reported for sugarcane followed by groundnut while green gram showed the lowest cost of production. Hired

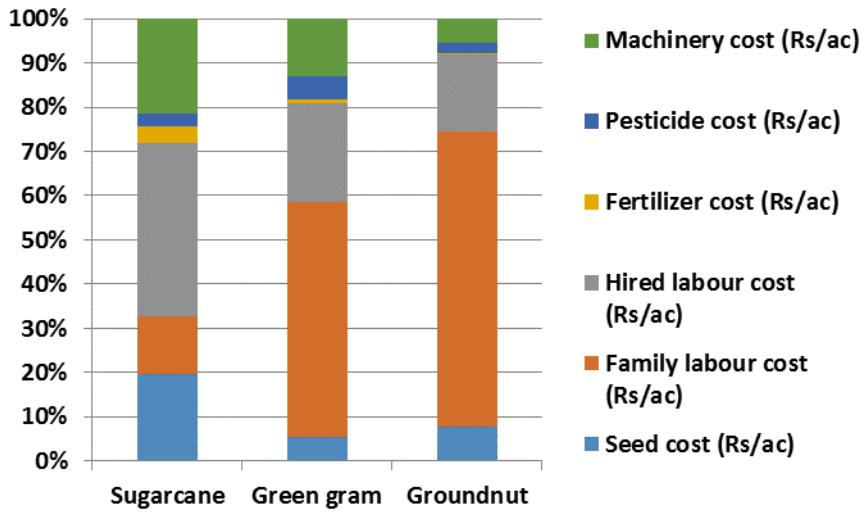
labour cost, machinery cost and seed cost have significantly influenced the total cost of sugarcane cultivation. Contract labour cost in harvesting period was also included in computing the hired labour cost.

Table 5.3: Distribution of the Cost of Cultivation (Rs/ac/year)

Variables	Sugarcane	Green gram	Groundnut
	Mean	Mean	Mean
Seed cost (Rs/ac)	23,315	3,551	9,466
Family labour cost (Rs/ac)	15,371	35,101	81,151
Hired labour cost (Rs/ac)	46,011	14,791	21,126
Fertilizer cost (Rs/ac)	4,353	734	434
Pesticide cost (Rs/ac)	3,633	3,417	2,965
Machinery cost (Rs/ac)	25,118	8,569	6,543
Total cost (Rs/ac)*	90,312	33,705	46,841
Total cost (Rs/ac)**	105,683	68,806	127,991
Net income (Rs/ac)	56,895	9,503	48,139

Note: * Excluding family labour ** including family labour
Source: HARTI Survey, 2016

More than half of the sugarcane, 70 percent of the green gram and 80 percent of the groundnut crop production systems cost for labour is the major component. Seed cost and machinery cost are the major contributory components in the sugarcane production system rather than the labour cost. Machinery, seeds and pesticide costs have also significantly contributed to the total cost of green gram cultivation. Around 20 percent of the total cost of production was included seeds, machinery and pesticide cost in groundnut cultivation (Figure 5.5).



Source: HARTI Survey, 2016

Figure 5.5: Contribution of the Inputs on Total Cost Determination

CHAPTER SIX

Sustainability of Selected Crop Production Systems in SEDZ

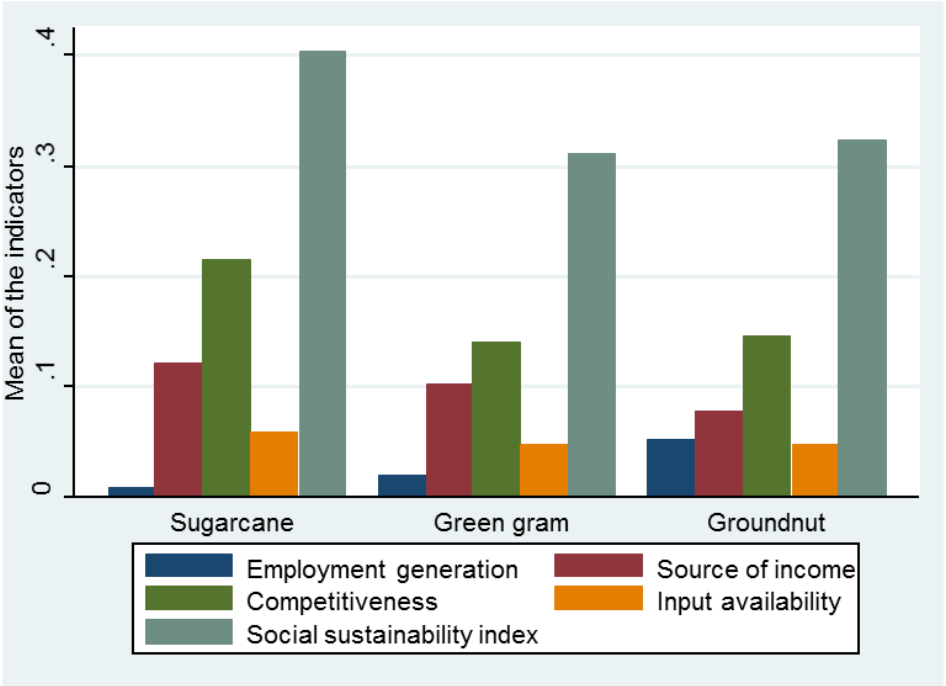
As described in Chapter three (3.4 Methods of Analysis), all indices were computed. Several steps were followed to assess the sustainability indices. At the first stage, all the variables were standardised using the Min-Max method due to different measuring units of the selected variables used for indicators. Assigning weights was the second step and next additive and subtractive method (Table 3.2, chapter three) was employed to obtain aggregations. Accordingly, sub-component indices which are social, environmental and economic were computed. Next using weights for sub-component, crop sustainability index was computed according to the equation number 3.

6.1 Social Sustainability Index

To measure the social sustainability of the crops, we used four indicators: employment generation, source of income, competitiveness and input availability. Employment generation has been measured using total labour days utilized for crop production per unit. The number of man-days created in both family and hired labour from cultivating a unit of extent were applied to measure employment opportunities in the local community. Net return to family labour or wage rate for engaged family labour in the crop production systems was used for measuring the source of income. This rate can be used to make a decision whether entering into the business or leaving the business. Net return to a unit of family labour indicates that farmers received sufficient income for engaging in farming activities. Competitiveness has been measured using the mean difference between breakeven and actual price. Breakeven price denotes that minimum price should sell a unit of production to cover the cost of production. Therefore, the difference of breakeven price and actual price indicates market competitiveness of the particular crop. Seed quality which is farmer rating of the quality has been applied to measure input availability. Since accessibility of quality seeds reflects availability of the input in the market as seed is one of the fundamental inputs on one hand and significant issues being not associated with other inputs on the other.

Figure 6.1 presents the social sustainability index (SOSI) and its variations with regard to the selected crop production systems. However, we can compare those crop production systems using this sub composite indicator

as relative terms since the indicator depends on selected variables for measuring a particular aspect. According to the SOSI, the sugarcane crop production system is performing well compared to the green gram and groundnut production systems. Consequently, the sugarcane production system is a more socially accepted system among those three crops in SEDZ. Higher values of competitiveness/mean difference between breakeven price and actual price lead to enhance SOSI of sugarcane compared to other crops. Even though, green gram and groundnut production systems show a relatively equal situation in terms of SOSI. Input availability seems to provide with equal weights on the sub-indicators. Net return to family labour is higher the green gram than groundnut. Further, employment generation and competitiveness have been led to enhance SSI of the groundnut production system. Overall in terms of the social sustainability index, sugarcane is the first while groundnut and green gram are the second and third respectively.



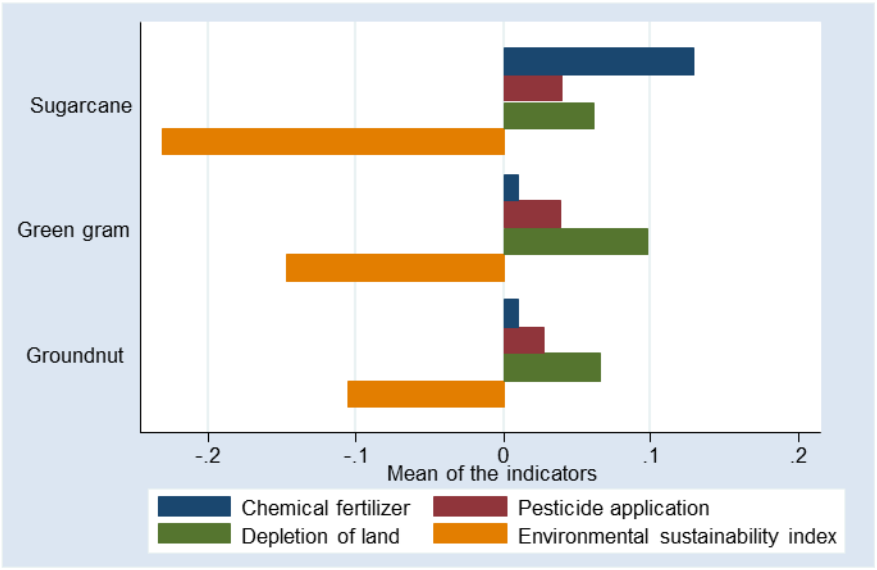
Source: HARTI Survey, 2016

Figure 6.1: Social Sustainability Index and Its Dimensions

6.2 Environmental Sustainability Index

Crop production systems are highly correlated with the environment, therefore, environmental impacts of the crop cultivation cannot be overlooked since those externalities may be positively and negatively related to crop cultivation. Thus we have applied three variables which are the severity of chemical fertilizer, severity of pesticide applications and severity of disturbing the soil in particular land to measure the sustainability of the environment. However, those variables have negative impact on the environment in terms of the environmental aspect.

The sugarcane crop production system is the worst with regard to environmental aspect compared to the other two crops. Chemical fertilizer application has a high impact on increasing environmental sustainability index (ENSI) of the sugarcane production in SEDZ. However, green gram and groundnut do not depend on the chemical fertilizer as shown in Figure 6.2. Severity of disturbing the soil has led to enhance index value of the green gram as well as pesticide application. Thus, we can conclud that groundnut, green gram and sugarcane are the first, second and third when rating the positive impact of the environmental impact. Otherwise, groundnut farming in SEDZ was the best for the environment comparatively (Figure 6.2).

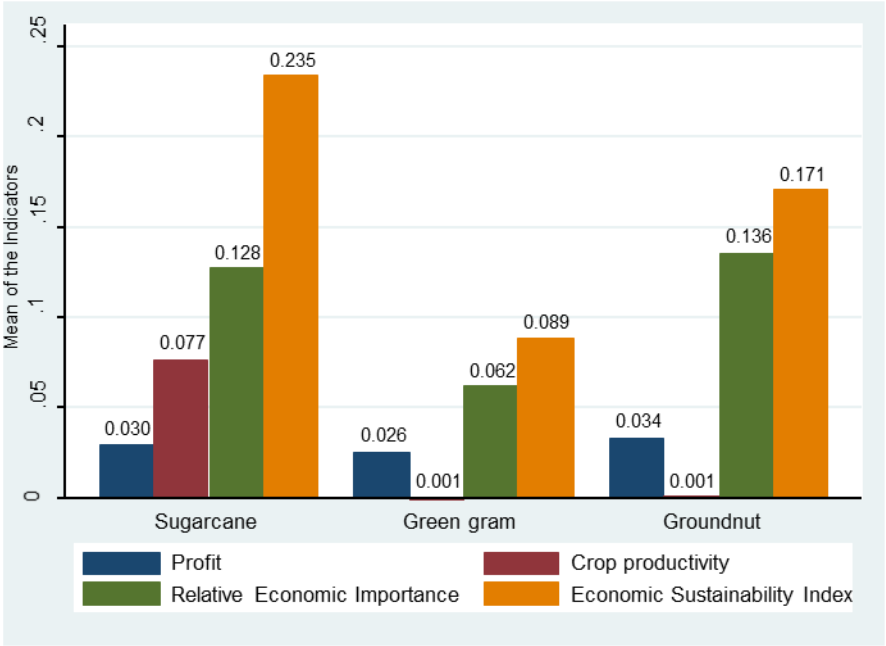


Source: HARTI Survey, 2016

Figure 6.2: Environmental Sustainability Index and Its Dimensions

6.3 Economic Sustainability Index

Basically, the economic viability of the crop production systems is essential for drawing farmers' attention to the crop production systems. Therefore, the economic feasibility of the crop cultivation is very important when making decisions of selecting crops for cultivation. Three variables which are net farm income of the crop, over time trend of productivity and contribution to total family income from crop production have been used to compute economic sustainability index (ECSI). Sugarcane performs better economic viability when compared to green gram and groundnut in SEDZ. However, relative economic importance and productivity may be the major leading indicators for keeping sugarcane in the first place relatively. The relative economic importance of the groundnut crop production system has raised its economic sustainability level. According to Figure 6.3, sugarcane, groundnut and green gram are to be the first, second and third in terms of economic sustainability.



Source: HARTI Survey, 2016

Figure 6.3: Economic Sustainability Index and Its Dimensions

6.4 Crop Sustainability Index

The output reveals that sugarcane is the best followed by groundnut while green gram is third with regard to the crop sustainability index (Table 6.1). Higher contribution of the social and economic components of the sugarcane may lead to increase overall sustainability in spite of higher negative environmental impact. In the environmental aspect, groundnut is an environmental friendly crop production system compared to others due to not significant of ENSI (Table 6.1). Though green gram production system is socially accepted, it is economically not viable but environmental-friendly than sugarcane. Therefore, green gram is placed third. However, those crop production systems are socially accepted by the local community in SEDZ. Environmental consequences of the three systems seem to be of low contribution but since sugarcane is the worst. Sugarcane and groundnut production systems are economically viable than green gram in the SEDZ.

Table 6.1: Sustainability Indices of the Selected Crops in SEDZ

Indicators	Crops		
	Sugarcane	**Green gram**	**Groundnut**
Social Sustainability Index	0.13***	0.10***	0.11***
Environmental Sustainability Index	-0.07*	-0.04*	-0.03
Economic Sustainability Index	0.09**	0.03	0.06*
Crop Sustainability Index	0.15***	0.09***	0.14***

***, ** and * denote significant at 1%, 5% and 10% respectively
Source: Authors' Computation

We applied ANOVA for testing whether a significant difference between the overall sustainability of the selected crops. ANOVA analysis exhibits that whether there is a statistically significant difference between the mean of the crops sustainability (Table 6.2). Thus, the output of the ANOVA reveals that there is a significant difference in sustainability among crops. Based on that, crop wise variation of sustainability could be discussed. Overall sustainability of the crops has been computed with respect to the three dimensions of the sustainability/three aspects which are social, environmental and economic.

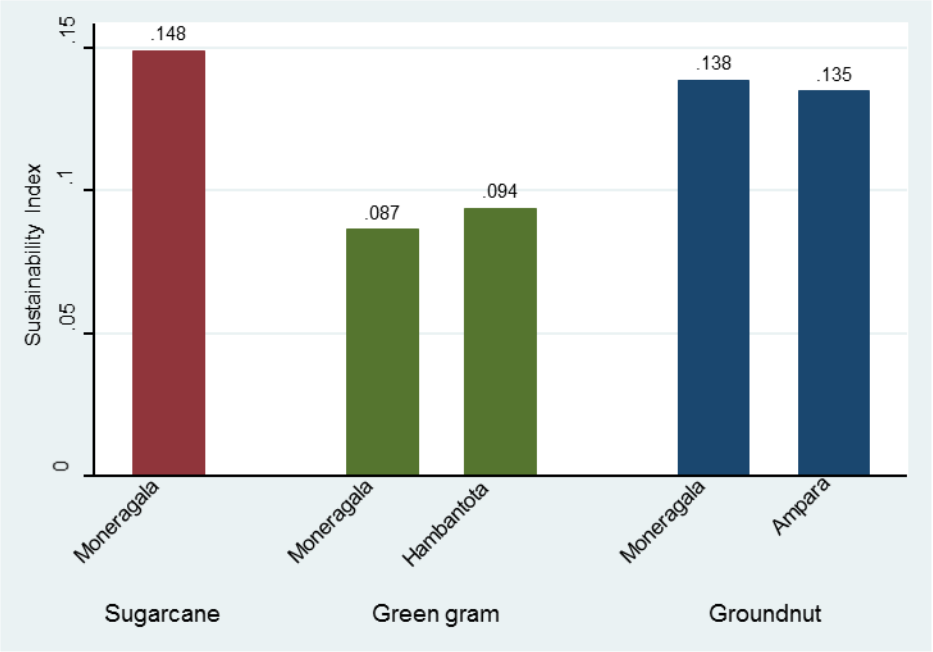
H_0: There are no sustainability variations among crops
H_a: There are crop wise variations of the sustainability

Table 6.2: Mean Comparison of Crops Sustainability in SEDZ Analysis of Variation (ANOVA) Test

Source	Sum of Squares	Df.	Mean Square	F	Sig.
Between crops	0.2098	2	0.1049	48.94	0.00
Within crops	0.7590	354	0.0021		
Total	0.9688	356	0.0027		

Source: HARTI Survey, 2016

Even though a large number of indicators have been developed they do not cover all dimensions and levels. Therefore, indicators used for agricultural sustainability should be location specific (Hayati *et al,* 2010). Consequently, the overall sustainability of the crops has been discussed with respect to location-specific variations. District wise variation of the sustainability might occur in those crop production systems. However, sugarcane represents only one district. Green gram and groundnut would be discussed in terms of whether there is a location specific variation or not. According to Figure 6.4, green gram cultivation in Hambantota district may be sustainable than Moneragala district while Moneragala groundnut cultivation seems to be superior to that in the Ampara district. But two sample t-test would provide enough evidence whether there is district wise variation of sustainability. According to the results of t-test shown in Table 6.3, we could not reject the null hypothesis. Therefore, we can conclude that crop production system wise variation of the sustainability are in the SEDZ and there is no location-specific variation of sustainability in the particular crop production system.



Source: HARTI Survey, 2016

Figure 6.4: District wise Variations of the Overall Sustainability

Table 6.3: Mean Difference of the Sustainability: Two-Sample T-Test with Equal Variance

Crop	Group	Obs.	Mean	Std. Dev.	Hypothesis Testing		
					H_0	H_a	P-values
Green gram	Moneragala	54	0.087	0.039	diff=0	diff≠0	0.34
	Hambantota	54	0.094	0.040			
	diff.		-0.007				
Groundnut	Moneragala	115	0.138	0.045	diff=0	diff≠0	0.67
	Ampara	36	0.135	0.046			
	diff.		0.004				

Note: Obs. – Observations, Std.Dev. – Standard Deviations, H_0 – Null hypothesis, H_a – Alternative hypothesis, Difference (diff) = mean (District 1) – mean (District 2)
Source: Authors' Computations

H_0: There is no district wise difference of the sustainability
H_a: Sustainability of the crops differs with respect to the district

CHAPTER SEVEN

Conclusion and Recommendations

Conclusion

1. According to the crop sustainability index value, sugarcane production system (0.15), groundnut production system (0.14) and green gram production system (0.09) could be rated as "Least sustainable" level (according to the policy matrix applied in this study)

2. Among three production systems, highest social acceptance and economic viability were recorded in sugarcane, where groundnut was recorded as the most environmental friendly production system.

3. Compared to other two pillars, social sustainability was the major contributory factor in generating the crop sustainability index while major contribution for developing social sustainability index was provided by 'competitiveness' (*mean difference between breakeven and actual price*) in all three production systems.

4. A major contribution for developing environmental sustainability index was provided by the 'chemical fertilizer application' (*severity of chemical fertilizer application*).

5. A major contribution for developing economic sustainability index was provided by the 'relative economic importance' (*Contribution to total family income from crop production*).

6. No significant difference could be observed with respect to the overall sustainability either in groundnut production system in Ampara and Moneragala districts; or in green gram production system in Hambantota and Moneragala districts.

Recommendations

1. Overall sustainability of all three food production systems in SEDZ should improve significantly to ensure better economic status of respective farming communities.

2. In order to improve economic sustainability, the productivity of all FCPS and profitability need to be increased through;
   a. Increasing the availability of quality seeds with higher yield potential for SEDZ with respect to green gram and groundnut.

   b. Introducing new sugarcane variety with a higher yield and a high number of rations to increase the productivity of sugarcane in SEDZ.

3. Social sustainability of all FCPS could be increased by increasing the net return to family labour by means of;
   a. Introducing green gram variety with the character of one-time maturity to facilitate machinery harvesting and develop suitable machines for the same.

   b. Introduce suitable machines for harvesting and processing (pod separation and seed separation).

   c. Introduce suitable machinery for sugarcane harvesting which can be used in existing field conditions.

   d. Help farmers to cut down the labour usage for crop protection in all FCPS in SEDZ by providing assistance for electric fence establishment (for wild elephant) either at the farm level or cluster level.

4. Increase profitability of groundnut and green gram systems through;
   a. Promoting varieties with special demanding characters to obtain a higher profit margin from groundnut production (e.g. – suitable varieties could be used for Jumbo peanut production)

   b. Encourage farmers for value addition, both in green gram and groundnut and provide required technical and infrastructure support.

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