Improving value chains of selected underutilized crops for the economic well-being of smallholder farmers in South-Eastern Sri Lanka

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Summary

Underutilized crops are widely recognized for their socio-economic, nutritional, and agrobiodiversity values. Studies on underutilized crop farming systems and value chains in Sri Lanka are limited. The research had been undertaken to investigate the underutilized crops in smallholder farming systems, economic contributions, and existing value chains. Primary data were collected from 30 Gramaniladari divisions (GN Divisions) located in twelve Divisional Secretariat (DS) from Uva and Eastern administrative provinces of Sri Lanka. A summary of the different chapters is presented below.

Chapter One: Introduction

At the onset of this chapter, I have attempted to correlate the global trends toward commercial agriculture and its negative influences on rural farming. In order to do so, I have further tried to see the context of Sri Lanka's development transition where the agricultural sector plays a decreasing but considerable contribution to the rural sector. Since the rural agricultural sector is considerably dominated by smallholder farmers and underutilized crops, the role of underutilized crops for the economic well-being of them is an important area for in-depth study. I reviewed past researchers' works related to underutilized crops in Sri Lanka, Asian countries as well as the rest of the world. Based on the review of the literature, I found the research gap of the study. Following the research gap, I formulated four research questions for this study.

Chapter Two: Review of literature

In this chapter, I have extensively reviewed the literature for the construction of the research framework. At the onset of the chapter, I briefly reviewed the evolution of agriculture and different underutilized crop farming systems. The role of the agricultural sector in rural development was reviewed and explored the performance of the agricultural sector in the Sri Lankan economy. I reviewed different concepts around underutilized crops, farming systems value chains, and smallholders. Second, I discussed the smallholder farming environment in the world. The discussion explored the characteristics of the smallholder farming sector and its potentials for farming underutilized crops. After that, I discussed different value chain concepts and the operation of value chains in the broader operating environment. This discussion further narrowed-down to explore the nature of agricultural value chains and some specific

features of those chains. Third, the discussion focuses on the concept of value chain analysis and different common and specific tools that can be adopted in different value chain environments and value chain governance.

Chapter Three: The common and potential underutilized crops in smallholders' farms of south-eastern Sri Lanka: Impact on farmers' economy and food security

In this chapter, I conducted farmers' household surveys and key informant interviews in Uva and Eastern provinces. At the very beginning, I used the key actor's perceptions of underutilized crops to define underutilized crops refer to the study region. Based on this definition, this chapter further extended to see the main farming systems, land use patterns, underutilized crop composition of farming systems, and the economic contribution of underutilized crops in household economics by identifying high potential underutilized crop for each region. The result indicated that the substantial availability of underutilized crops and contribute to the economic well-being of the farmers. However, the main perception of underutilized crops among involving actors are pretty much related to the current contextual health and nutritional issues in rural Sri Lanka.

Chapter Four: Operation of primary and supporting components of selected high potential underutilized crops

Identification of high potential underutilized crops brings the path to narrow-down this study by a focus on three main underutilized crops (Finger millet, Red cowpea, and Cashew). This chapter covers mainly production and marketing insights of the selected underutilized crops. To do so at the very beginning the chapter explores the nature of the current farming cycle of those selected crops. The major discussion of the chapter covers the distribution of selected crops in farming systems, the economics of production by exploring primary and supporting activities, and the existing market system. The results indicated that the value chains of underutilized crops are mainly reflected by producers, collectors, whole sellers, and retailers. The middle of the value nodes was complex and composed of several linkages. Farmers allocate a considerable extent of their lands and a significant amount of labour for the selected crop production. Those crops reflect reasonable economic potentials where their family labour plays a significant contribution.

Chapter Five: Economic returns on key value chain actors, constraints, and development potentials of high potential underutilized crops

By conducting key informant interviews and focus group discussions this chapter attempts to explore further identification of factors insight the existing inefficiencies of the value chains and to see the ways to overcome those inefficiencies. At the very beginning of this chapter explored value addition and value distribution characteristics among actors in selected crop value chains. This economic insight is further strengthened by identifying underlying causes, constraints, and visible consequences in the market systems of each selected crops. The findings showed different reasons behind the poor performances of the selected crop markets by enlightening the potential areas for development by adopting the most relevant interventions.

Chapter Six: General discussion and conclusion

In this chapter, I have conducted three main discussions such as a) key findings of the study by briefly describing major findings, b) key issues and existing challenges in sustainable farming as well as marking of underutilized crop products, c) main limitations of the study with conclusions and recommendations. The comparison of farming systems characteristics and economic contribution of two different study sites as well as the market systems of the selected underutilized crops show several common and specific features that need adjustments for the economic well-being of the farmers. This dissertation also has several academic contributions. Most importantly the findings bring local definition for underutilized crops while recognises high potential underutilized crops for each region. Market actors who are involved in business and their roles are identified to see the broader market environment. The findings open-up sustainable intensification potentials where new researchers may be interested.

Publications

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Chapter One
(Introduction)

1. General introduction

1.1.The context and overview of the study

The growing food demand in the world with the population increases pushes agriculturists and scientists to see the ways of intensification of agricultural production. This seems to be a relatively easy approach by adopting improved crop varieties under high input applications with commercial orientation(Pingali 2012; Tilman et al. 2011). However, the negligence of local farming systems may lead to the drop in productivity, crop diversity, and extinction of valuable traditional crop types that may contribute to simultaneous local issues such as nutritional deficiencies among children as well as increasing household expenditure(Mabhaudhi et al. 2016; Mayes et al. 2012; Massawe et al. 2016; Meldrum et al. 2020). The multiple issues related to the high input agriculture and growing crops only for commercial purposes created many problems in the world. Those issues are varied while developing countries experience serious economic and food security issues by losing self-sufficiency and sovereignty of food endowed from generations. (Brussaard et al. 2010; Damayanthi 2012; Omiti et al. 2007). However, these structural changes in rural farming systems and farmers' movement towards commercial crops have contributed to the increases in their household income levels, but drop the resilience of their communities. The attention of researchers and policymakers has now been focused on this complex issue (Herath et al. 2013; West and Haug 2017).

The research findings of the underutilized crops have proved that the ability to survive in marginal areas and produce a reasonable yield. This characteristic is particularly important for developing countries to ensure food, income, and nutritional security at the household level (Mabhaudhi et al. 2016). The global development directions reflected by Sustainable Development Goals (SDGs) also show significant spaces where underutilized crops can engage effectively (Adhikari et al. 2017; Baldermann et al. 2016; Dobermann 2018; Gil et al. 2018). The first and second goals emphasized ending poverty and hunger while goal three, eight, and fifteen emphasized healthy life, sustainable economic growth, and sustainable use of terrestrial ecosystems (Aguiar et al. 2018)

However, still there is no universally accepted unique definition for underutilized crops even though several scientific discussions are being held. The term, underutilized crops

is commonly used to refer to crop species whose potential has not been fully utilized. However, the term itself does not provide any information on geographical, social, and economic implications. It has been well recognized that the potential of these crops in sustaining livelihood and enhancing environmental health, poverty alleviation, and increasing local food production under climate change challenges. (Chivenge et al .2015; Hammer et al. 2001; Sthapit et al. 2010; Taylor et al. 2009).

When considering the context of Sri Lanka, the island is in lower-middle-income status in a development transition from agricultural orientation to industrial and service economy. The Gross Domestic Product (GDP) is still being significantly contributed by the agricultural sector by reducing the comparative importance of it against the service and industrial sectors (World Bank 2017). The country still consists of 75% of rural areas dominating smallholder farming systems. They cultivate both traditional and commercial crop types where commercial crops have been given the main attention of researchers and policymakers (Patel 2012). In this context, there is a need for assessing the socio-economic characteristics of farmers who cultivate such traditional crops and existing challenges upon those farming systems for the sustainability and potentials for sustainable intensification(Stephen et al. 2010; Waddington et al. 2010). Most of these crops are still cultivated in home gardens with the help of family labour input while some selected crops are cultivated in Chena lands on large scale. However, available crop types in farms, economic contribution to households, socio-economic potentials, and current challenges are not known or poorly researched. Thus the potential of those crops is adequately convinced by farmers to face such situations but the potential has poorly been utilized. (Senanayake et al. 2010).

1.2.Background and justification

The percentage of global Gross Domestic Product (GDP) attributable to agriculture is at historically low levels but the GDP contribution of agriculture in developing countries remains significant. Moreover 75% of the world's poor live in rural areas and it is widely recognized that agricultural development disproportionately benefits the rural poor. The need to develop and maximize the potential benefits derived from the agricultural sector remains an important element of efforts to combat poverty and foster economic growth (Kanza and Vitale 2015). However traditional development models are based on the idea that over time agricultural productivity increases through the adoption of input-intensive methods of extensive cultivation in which external inputs increase with a consequent

reduction in the unit price of agricultural output, in this scenario rural populations decline as the efficiency of agriculture increases. Increasingly in recent years, this orthodoxy has been challenged. There has been a renewed recognition that while smallholder farm households are at a considerable disadvantage when it comes to the production of relatively low-value monoculture crops by under their limited size and access to external inputs. Such systems possess characteristics that may serve as significant advantages concerning the production of other crops and their relationship to short and longer value chains (Friel et al. 2011; Vanderploeg 2003). Such systems draw on indigenous knowledge reflecting understandings of the local landscape, agronomic and climatic constraints, and cultural values. They tend to make better use of household labour and local resources for processing, storage, and trading. Also, these systems often incorporate local crops and cropping systems which are highly efficient in their use of limited resources and address the demand for crops that are in short supply. For such reasons it is now widely recognized, that smallholder agriculture in Asia is well-positioned to benefit from the flexible production of a range of high-value crops, including underutilized species (Gómez et al. 2011).

These issues are of particular significance in Sri Lanka where more than 70% of the population lives in rural areas with 80% of the population dependent on agriculture for their livelihoods. Over 3.3 million small and medium-scale family farms that dominate with the number of smallholdings (classified as less than 9 hectares) highlight the agriculture sector in Sri Lanka. Agricultural holdings in the country have been facing rapid fragmentation with the increasing population and a considerable portion (42.4 %) of these holdings are less than 0.4ha, producing primarily for home consumption (Mapa et al. 2002). Sri Lankan smallholder farmers face many challenges such as limited access to credit, poor trading relationships, lack of integration to market chains along with poor road conditions, and lack of storage facilities (Wickramasinghe et al. 2013).

Conventional approaches to commercialization, based on existing extension approaches that focus on major crops may be given limited value to smallholders. This is because such approaches do not speak to the needs or build on the strengths of traditional systems. Thus a question arises as to whether appropriate agricultural development strategies to improve the livelihood of small-scale farmers, can be devised drawing on the existing strengths of traditional farming systems. In Sri Lanka, the cultivation of established cash crops and staples in combination with one or many other crops including underutilized species is a key feature of current cropping practices. Where studies of smallholder

farming are undertaken, they often touch on the use of these crops tangentially as part of more generalized agronomic or social studies. However, a lack of awareness of the value, cropping strategies, together with limited agronomic knowledge of these crops may contribute to the abandonment of existing potentials. In particular, this may be the case in contexts where social and economic development is framed within the conventional development paradigm. By contrast, recent work undertaken in Sri Lanka points to the very significant potential of these crops to contribute more substantially to the nutritional well-being and livelihoods of small-scale producers (Malkanthi et al. 2012). This is particularly so as there is now a growing acceptance that no single solution exists to rural poverty rather a smallholder farming may provide a range of options or "pathways" out of poverty such as those offered by the cultivation of several underutilized species (Dorward 2013; Johns et al. 2013). Rather than looking for single solution research that identifies such pathways and supports the autonomous decisions of different smallholders may offer a better option for the future than one size fits all solutions.

1.3.Research Problem

Once the general area for the research is selected, it becomes important to identify a specific and precise problem within the general area to conduct a scientific study. Reviewing the existing research findings in the general area of the study helps to identify the directions and scopes of the past research that have already been completed as well as a specific research problem to be addressed by new research (Apuke 2018; Grewal et al. 2016; Yin, 2017). Such kind of review helps to pinpoint the remaining research gaps, from both theoretical and practical viewpoints, that exist in the general area, some gaps left by the previous researchers, and further research been recommended. Those gaps of research then translated to the specific research problem (Mackay 1960; Kroelinger 2002).

Sri Lanka is an agricultural country in South Asia. The wide variation of temperature, rainfall, topography, and soils in the country has provided a wide diversity of ecosystems with a rich diversity of plant species, which the Sri Lankan farmers have been able to maintain over thousands of years. Thus, there are nearly 3400 species of flowering plants and other large numbers of ferns, mosses, lichens, algal and fungal species (Darwin 2003; Gunatilleke et al. 2017; Muthukudaarachchi and Wijerathne 2008). According to studies, Sri Lanka is rich with around 60 varieties of underutilized crops. However, there isn't any organized or proper cultivation of these crop species as well as proper inventory work

has been done so far on underutilized species in different farming systems (Dahanayake 2015; Pushpakumara et al. 2016). Most of these underutilized plant species are fruit crops and they are found in wild or home gardens. Also, a significant number of underutilized crops are available in Chena (Shifting cultivation) and farming in off-season paddy lands. Cereals and pulses are dominant in both farming systems with many vegetables in mixed cropping systems. However, underutilized species have lost their significance among the present generation due to many reasons such as urbanization and changing food habits. (Dahanayake 2015; Edirisinghe 2017).

The analysis of literature showed that very little number of studies had been done on underutilized crop production systems and market structures in Sri Lanka. There have been few studies in South-eastern Sri Lanka where the Uva and Eastern provinces are located. In general, the available studies focus on small geographic areas. For example, Malkanthi, Karunarathne, Amuwala, and Silva (2010) examined the socio-economic characteristics of underutilized crop cultivating farmers in Thanamalvila DS division in Moneragala district. This study revealed about available underutilized crops in the area but no clear information about how those crops in different farming systems. The study of Senanayake et al. (2010) in Meegahakiuwla DS division in Badulla district focused only to identify variation of crops in home gardens in different altitudes and their ecological benefits. Sandika and Withana (2010) investigated the economic aspects of Chena farming and environmental constraints in Thanamalvila DS division in Moneragala district. Dhanayake (2015) investigated underutilized fruit crops in Sri Lanka, which shed light on the utilization and value addition potentials of fruit crops. Malkanthi (2017) examined available underutilized crop types in Thanamalvila DS division and the contribution of those crops to the household income and food demand of farming families.

On the other hand, a few value chain studies have been conducted in Sri Lanka. For example, Weerasooriya and Silva (2014) examined the value chain of ginger by interviewing the farmers in two selected sites in Kandy and Matale districts in the central province of Sri Lanka. The study examined market margin and profit distribution among key value chain actors. Siriwardane and Silva (2017) studied about organic rice value chain in Sri Lanka with the focus of identifying relationships among actors involved and possible strategies to strengthen those linkages. The studies done by Barry (2012) examined value chains of selected fruit crops (Bellwood apple and Rambuton) in North-

Western and North Central regions by using mapping techniques. Hatharusinghe and Vidanapathirana (2012) researched on Pineapple and Banana with a solid emphasis on value chain actors and their interaction with supporting environment actors. However, none of the above value chain studies were conducted in South-eastern Sri Lanka where a significant majority of underutilized crop farming systems and smallholder farmers are settled. The researchers purposively selected the crop they want to research and the locations where the selected crop available.

In summary, the existing studies in the field of underutilized crop farming systems and value chains in Sri Lanka are limited. Authors restricted their scope of studies to small geographical locations where their interesting crop available. Past literature failed to identify leading underutilized crop farming systems, available crop types on those farms, and contribution to the household economy by those farm products. Regarding value chain studies, prioritizing crops for value chain studies was hardly ignored and selected based on their preference. The studies only focused on the chain of the primary actors by simply ignoring supporting actors who play a significant role in any market system. The data collection tools of past researchers are limited to the questionnaire-based surveys which produce limited information while data analysis is limited to simple descriptive applications. The above review paves the path to formulate below the broader research problem for this study.

"To what extent the underutilized crops can be used to uplift the economic well-being of smallholder farming communities in Sri Lanka by improving the value chains of potential underutilized crops".

This broader research problem is further simplified to specific research questions. Those research questions lead to developing specific objectives of the research study. The research questions of the study are mentioned below:

a. What are the common and potential underutilized crops in different farming systems of smallholder farmers in south-eastern Sri Lanka?
b. What is the economic contribution of key farming systems and underutilized crop sources to the livelihood of smallholder farmers?
c. How about the performances of existing value chains and operating environment of selected potential underutilized crops? and
d. How can the existing value chain structures can improve the sustainable economic well-being of smallholder farmers?

1.4.Objectives of the study

The broader research problem is further simplified as four research questions (Figure 1.2). The first research question is directly link with objective one which focuses on identifying crop compositions of different farming systems. The second research question links with objective two since this objective assess the economic contribution of underutilized crops for their household economy. It is pretty much connected with the livelihood of smallholder farmers. The third and fourth research questions are managed by the last two objectives that are focused on understanding existing value chain structures of selected high potential underutilized crops and possibilities to develop those market systems for a greater level of benefits. The study identified four specific interconnected objectives to cover all the aspects broader research problem.

Hence, by considering the research problem as well as the main concerns of the conceptual framework, the following main objectives are formulated for the study.

a) To identify the common and potential underutilized crops being cultivated by smallholder farmers in Sri Lanka
b) To explore the economic impact of underutilized crops on farmers' livelihood
c) To elucidate the existing value chains of selected potential underutilized crops, and
d) Developing the pathway(s) to improve the value chains of potential underutilized crops for the sustainable economic well-being of the farmers.

1.5 Conceptual framework of the study

I have identified the problem statement and research questions by reviewing the available studies on study locations and studies done in Sri Lanka on underutilized crops. The in-depth study and review of diverse global literature related to my study area explored the way my study needs to be executed by collecting appropriate qualitative and quantitative data to achieve the formulated research objectives to fill the gaps of knowledge. As such the developed conceptual framework illustrates the wider direction of the study including the focus of raw data collection, summary data, and the scope of the data analysis that needs to be performed to achieve the goals of the study. The Conceptual Framework of my study is a summary illustration of its overall operation.

A conceptual framework has potential usefulness as a tool to scaffold research and therefore, to assist a researcher to make meaning of subsequent findings (Smyth 2004).

Goetz and Lecompte (1984) stated it also contributes to the trustworthiness of the study. Reichel and Ramey (1987) described it as a set of broad ideas and principles taken from relevant fields of inquiry and is used to structure a subsequent presentation. Therefore, taking these into considerations we can consider the conceptual framework to act like a map, one which outlines the possible course of action for the research work to take place.

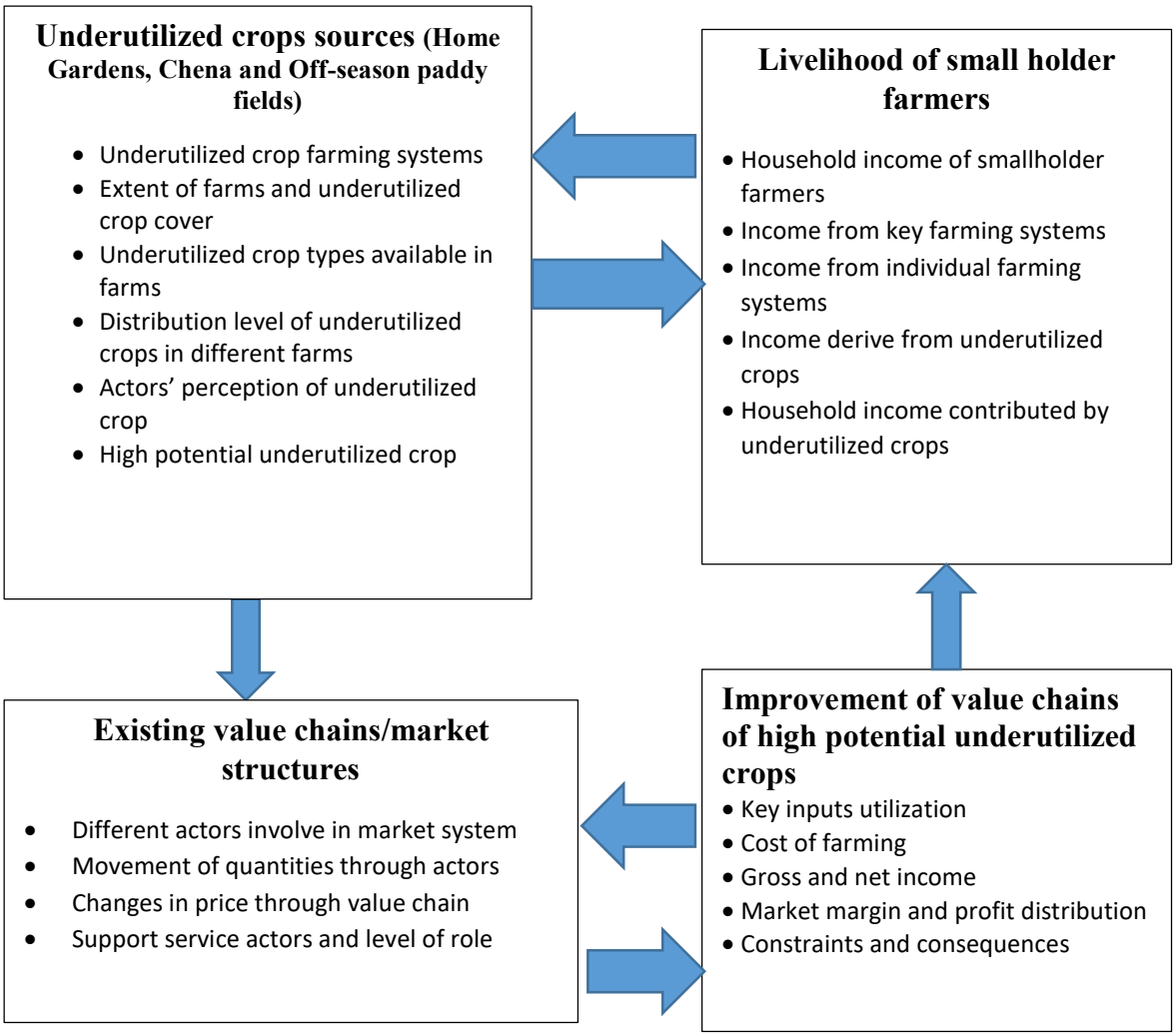

Figure 1. 1 Conceptual framework of the study (Source: Interpretation of the researcher)

If a researcher can identify a research problem, it would naturally lead to formulating research objectives by identifying variables and their measurements (Jabareen 2009). The conceptual framework helps to identify and correlate the objective needs to be measured by the study. Such a conceptual framework having four referral concepts are reflected the gaps of knowledge need to be addressed are in Figure 1.1.

1.6. A brief overview of methods used in this study

The socio-economic field surveys and community consultations investigate particular information from a selected group of participant categories(Seidman 2006). It involves challenging tasks to collect quantitative and qualitative types of information using both closed and open-ended questions. Researchers used different methods for field data collection. In the past (the late 80s and 90s), researchers used the method of "learning with people" which is recognized as Participatory Rural Appraisal (PRA) (Henman and Chambers 2009; Cavestro 2003).

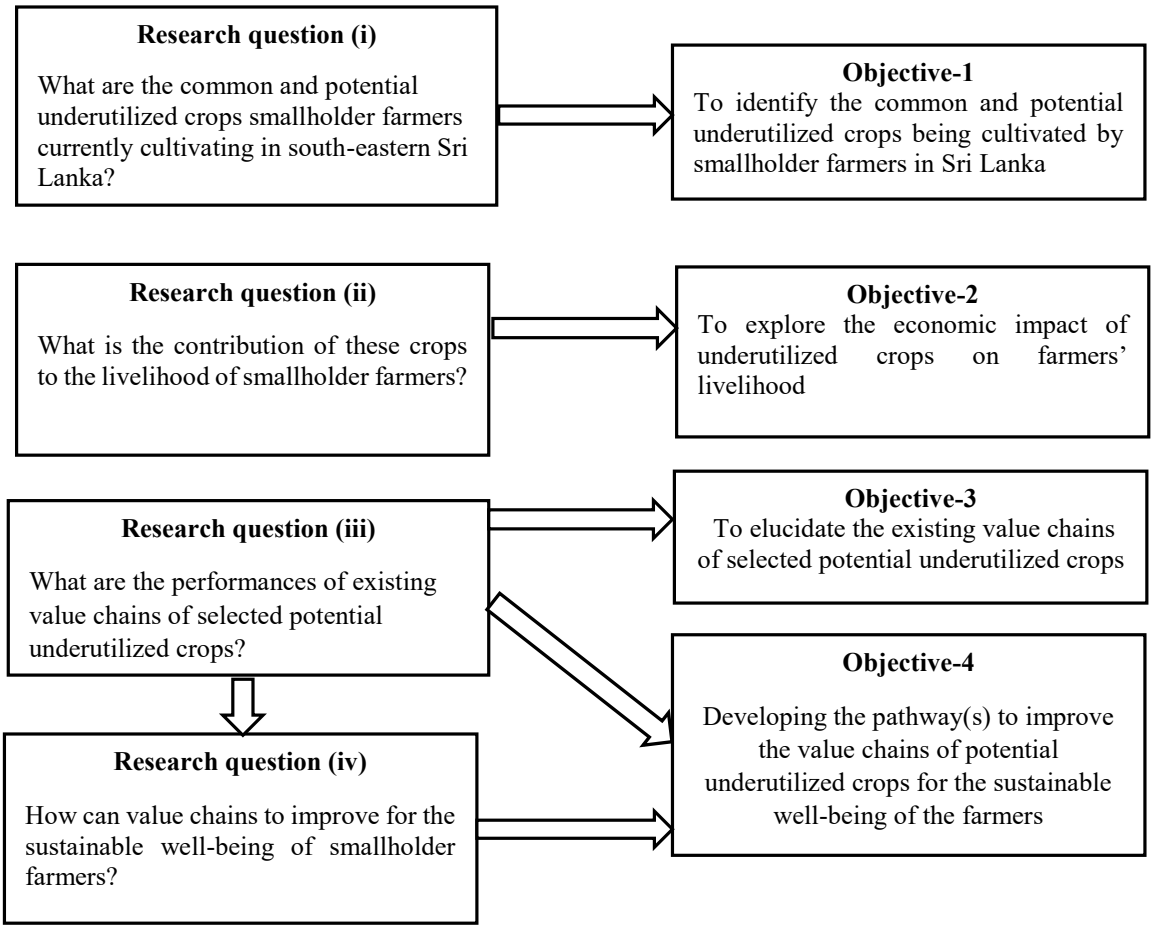

Figure 1. 2 The diagrammatic illustration of the relationship between research questions and objectives of the study (Source: Interpretation of the researcher)

For the collection of field data information, I followed the PRA approach and different tools of PRA as per the relevance. All the developed tools were undergone ethical screen process to ensure good standards on confidentiality of the participants (Appendix 9). At the very beginning, I reviewed different official documents related to the study areas such as mainly statistical abstracts of respective districts and resource profiles of selected DS

divisions. Structured interviews, semi-structured interviews, key informant interviews, focus group discussions, informal talks, personal observations, farm visits, village walks, seasonal diagrams, and flow diagrams are the main tools adopted in the data collection process. Both quantitative and qualitative data were collected. Pre-tested questionnaires containing both structured questions and checklists for semi-structured model interviews were used.

Cross-checking and validation of data and information generated through participatory methods were done in the following ways:

- Validation was pursued by approaching different individual farmers or farmer groups separately or together
- Different participatory methods used, in combination, was utilized to test and verify data
- Participant checking was also utilized to test data with a similar set of people who generate original information, and
- Conducted a series of farm visits to check whether collected primary data is close to the real ground situations

However, comprehensive methods of study used for each separate objective and respective study sites are elaborated in each chapter

1.7.Research sites

1.7.1. Overview of the research sites

The study was conducted in the Eastern and Uva provinces of Sri Lanka located in Eastern geographies and South-eastern geographies of the country (Figure 1.3). The central map of Sri Lanka shows four districts of both the Uva and Eastern provinces where the study was executed. The four satellite maps indicate each district map by indicating respective Divisional Secretariat Divisions (DS Divisions) covered by the study.

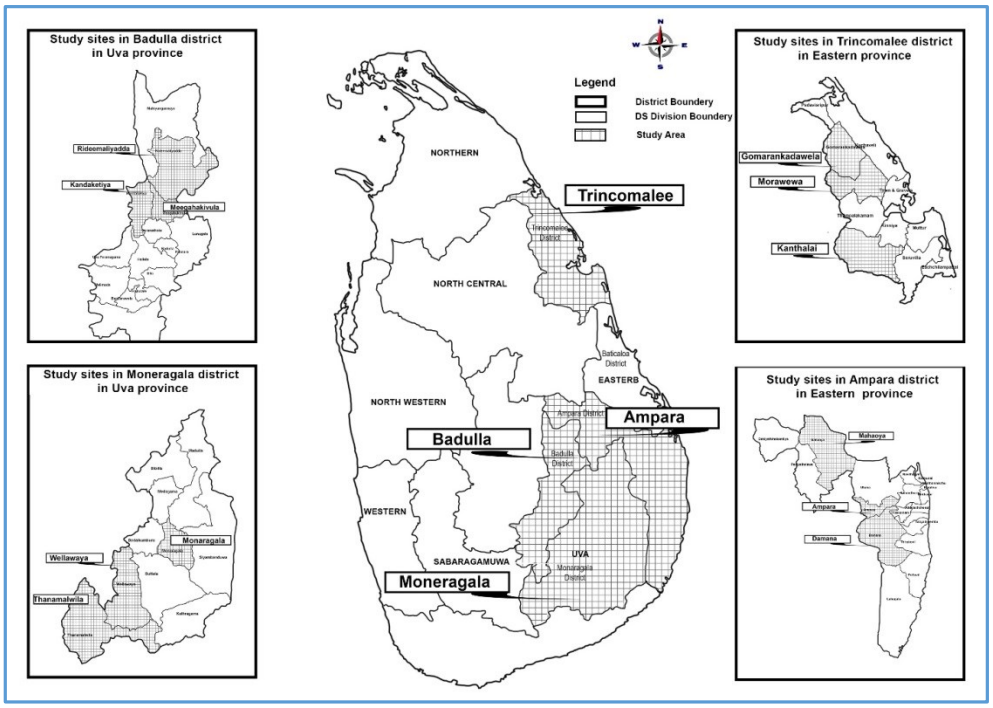

Figure1. 3 Selected areas for the research in Uva and Eastern provinces in south-eastern Sri Lanka.

Uva province consists Badulla and Moneragala district which is the second least populated province in the country with 1.3 million people. The land extent of the province is 8500 square kilometres, represents 82 percent of rural areas. Moneragala consists of 5639 square kilometres while Badulla district covers 2861 square kilometres. Moneragala is the second largest of the 25 districts of the country. Moneragala district covers a large south-east portion of the province while the rest of the central mountainous portion of the province is covered by Badulla district (Department of Census and Statistics Sri Lanka 2017).

The Eastern Province covers an area of 9950 square kilometres, which is about 15% of the total land area of the country. The province comprises three districts, named Ampara (4400 sq. km) Batticaloa (2850 sq. km), and Trincomalee (2700 sq.km.). The topography of the province is relatively flat in the coastal areas. The landscape of the province is varied, with paddy fields, forests, scrublands, wetlands, and lagoons being predominant. The population of the province is about 1.5 million (75 percent is rural), which is about 6.7% of the total population of Sri Lanka. The Eastern Province is relatively less developed in comparison with most of the other provinces of the country (Department of Census and Statistics Sri Lanka 2017; National Physical Planning Department SriLanka 2000).

1.7.2. Physical and demographic characteristics of South-eastern Sri Lanka

South-eastern Sri Lanka of this study covered eastern central high lands, transitional zones, and more flat-low landscapes geographies of the country. The Eastern province has flat and low land areas dominant (Trincomalee District Secretariat, 2015). While the high lands are mainly represented by Badulla district in Uva province having complicated ranges of mountains, plateaus, and narrow valley areas. Moneragala district is in a transitional format by representing both high and low lands (Road Development Authority of Sri Lanka 2017).

In general, the Eastern province gets rainfall mainly from North-east monsoons (December-January) and having a relatively low level of mean annual rainfall. The annual rainfalls of three districts of the Eastern province were Trincomalee (1603 mm), Ampara (1642mm), and Batticaloa(1753mm). On average the province gets around 42 percent of total rainfall from North-east monsoons whereas South-west (July-September) monsoons contribute around 18 percent of the total rainfall. The rest of the 40 percent of total rainfall receives during two inter-monsoon sessions (Road Development Authority of Sri Lanka 2017). This province comprises 15% of the total land area of the country which covers 25 percent of the coastal areas. However, the province represents only 8 percent of the population of the country. According to the 2012 census and statistics 39.79% of the population of the province is Tamils followed by Muslims (36.72%) and 23.15% of Sinhalese. (Sivakumar et al. 2013).

Uva province receives more rainfall from South-west monsoons. The annual rainfall of the Badulla district varies from 900 to 2500 mm. Moneragala district receives rainfall range from 1300-1800 mm per year. The province gets around thirty percent of rainfall derives from the Northeast monsoon and around 22 percent from the South-west monsoon. The remaining 48 percent of rainfall derives from inter-monsoonal contributions (Road Development Authority of Sri Lanka 2017). Uva province is the main contribution geography of South-eastern Sri Lanka consists of 26 divisional secretariat divisions where15 from Badulla and 11 from Moneragala (Tertiary and Vocational Education Commission, 2018). Both districts of the province show a significant majority number of Sinhalese followed by Indian Tamils, Moors, and Sri Lankan Tamils. Agriculture, livestock, and Tourism are key income generation sources of the province (Road Development Authority of Sri Lanka 2017).

1.7.3.The socio-economic and agricultural background of south-eastern Sri Lanka

Uva province of South-eastern Sri Lanka endowed a large extent of paddy fields in the pre-colonial era with prosperous economic conditions. The province had a great hydraulic civilization that was destroyed by the British colonial administration to control the Uva-Wellassa freedom struggle in the nineteen-fortieths (Razick et al. 2016). The province has been existing at a most marginalized level during the last two centuries where most of the agricultural activities depend on rain-fed Chena farming. However, the new project of Uma Oya plans to bring water to those destroyed tanks and rehabilitate agriculture in the region (Tertiary and Vocational Education Commission 2018). The agricultural sector is mainly dominated by tea, rubber, paddy, and the farming of diverse vegetables. Badulla District of the Uva province is the main up-country vegetable producing district of the country and the third-largest tea producing district. Moneragala district has a significant amount of paddy lands while people involve sugarcane, rainfed farming of vegetables, and some minor expert crops in the smallholder farming sector. (Road Development Authority of Sri Lanka 2017).

The Eastern province is recognized as a well-developed region in ancient times. The historical structures spread in the region such as water bodies, scattered over the whole landscape provide solid evidence on its past development status. However, at present, the province is relatively less developed compared to the other provinces of the country. Even though the region endows massive stocks of natural resources, the development process of the province suffered significantly by 30 years-long civil conflicts of the country. The economy of the province predominantly depends on agriculture. The province contributes approximately one-third of the current rice production of the country where the region is known as "Granary of the Island". (National Physical Planning Department SriLanka 2000)

Last five years the contribution of the Eastern province to the national economy had been remaining at five percent of the Gross Domestic Product (GDP) of the country. According to the statistics, the contribution of the Eastern province to the country's GDP is represented by 35 percent from Agriculture and allied sectors. The services sector contributed 47 percent of the GDP where the industrial sector contributes 18 percent. (National Physical Planning Department SriLanka 2000).

1.7.4.The administrative and political structure of South-eastern Sri Lanka

South-eastern Sri Lanka covers two administrative provinces called Uva and Eastern provinces. Those provinces are under the provincial administrative system. (Kruse 2007). The provincial council members are elected by province voters and the leader of the council majority is appointed as a Chief Minister. The provincial governor is appointed by the executive president of the country. The powers possessed by provincial councils are shared with the central government or the central government bear oversight power. However, those administrative units are autonomous bodies and are not under the ministry of the central government. (United Nations 2004)

1.8.The rationale for selecting research sites

The study selected rural divisional secretariat divisions in Uva and Eastern provinces. Eastern province represents historically famous agricultural lands since the long history of Sri Lanka. The province is famous for paddy production where a significant portion is contributed by the Ampara district. The province represents mainly low country dry zone agro-ecological areas, where traditional farming practices are dominant. The smallholder farmers in low country dry zone areas engage in farming of a variety of underutilized crops in three main farming systems recognized as Chena (Shifting cultivation), home gardening, and farming in off-season paddy lands.

The study selected both districts of the Uva province. The locations of the Moneragala district covered low and mid-country intermediate zones. Farmers have been engaging in the farming of traditional crops for a long time where a large number of underutilized crop types represent. Chena farming is the key practice of the farmers while engaging home gardening, and farming in off-season paddy lands. Crop compositions, crop types, and diversities are varied in those DS divisions. Badulla is the central geography of Sri Lanka represents elevated geographies. Most of the hilly areas of the district are covered by tea plantations. However, those are under plantation companies where smallholder farmers have not reasonable engagement in tea cultivation. The selected DS divisions of Badulla district represent the most marginalized areas of the district which cover up-country dry and intermediate zones. Farmers mainly engage in farming of different traditional crop varieties in their home gardens and some Chena lands.

1.9.Significance of the study

Being a developing country moving a slow transition from lower-middle-income to upper-middle-income status, Sri Lanka is being faced with different socio-economic issues. Poverty is the most deep-rooted economic issue among urban, rural, and estate sectors. Rural poverty is the most highlighted issue since over 70 % of the areas of the country are still rural where agriculture plays a key role in rural economies. Farmers cultivate a different kind of crop varieties in their uplands and low lands. Some crops are considered as a commercial cash crop while a large group of crops grown by farmers (mainly includes vegetables, fruits, and yam varieties) represents traditional crop types considered as underutilized crops. Part of the production of that crop they sell while use for their household consumption. The role of those crops is considerable from rural wellbeing viewpoint even-though government policies and attention are limited.

Almost all rich underutilized crop cultivating farming systems are seen in dry and intermediate zones of the country. Uva and Eastern provinces cover a large portion of those zones. Most of the agricultural research programs are concentrated on commercial crops where underutilized crops were considerably discriminated against. Farmers are in a comfortable environment to cultivate those crops under minimum input and their traditional knowledge. The recent challenges on monoculture-based commercial crops mainly due to climatic changes and high input costs have drawn the attention of the researcher to the potential of underutilized crop-based mixed cropping farming systems.

This study anticipates initially identifying a local definition for the underutilized crops in the study region. It is very important to recognize the local perception of underutilized crops since the global definitions are pretty much diluted. As a further elaboration study recognizes underutilized crop farming systems, crop compositions, and high potential underutilized crops for the study region. It is expected that the study will be able to find the economic contribution of underutilized crops for the household economics of farmers. By linking the economic and the market aspects of the potential underutilized crops, the study will make an in-depth value chain study on selected crops. The value chain studies expect to see the different dynamics of market channels and the interaction of actors with the supporting environment. The study recognizes underlying causes and existing constraints heading to the inefficiencies of the existing market systems and potential interventions to rectify those issues.

The study derives a number of outcomes where academics can revalidate under different conditions. The study itself opens opportunities for the researcher to expand the knowledge and experience. The lessons that will be learned might be of use for academics, policymakers, and politicians for conducting future research on the economic impact of underutilized crops in rural economics, formulating policies for replicating and implementing new interventions. The outcomes of the study are also helpful for the farmers and other actors who involve in the underutilized crop business.

From a theoretical perspective, the research will add to a growing international literature on the role and development capacity of traditional smallholder farming. Specifically, it will contribute to the re-theorization of this role in the context of wider national and global trends in agriculture-related to globalization, trade liberalization, and climate change. The socio-economic and environmental significance of the study is reflected by the identification of high potential underutilized crops for the farmers' well-being. Those crops can be adapted to ensure the income security of farmers by year around cash flows and foods for household consumption. This may help to address rural malnutrition and undernutrition issues which the country is faced for a significantly long time.

1.10.Structure of the dissertation

The dissertation consists of six chapters (Figure 1.4) including the present chapter. Chapter one describes the contextual background of the study and selected research sites for the study. Chapter one describes the background of the smallholder farmers in the region and their agricultural product and marketing facilities. The chapter shows the rationale for selecting the sites by illustrating the previous studies done in study locations and then identifying the research problem, objectives, and conceptual framework of the study.

Chapter two presents an extensive literature review by keeping in mind the research problem identified in chapter one. In view of literature mainly related to agriculture and rural livelihood, different farming systems with special emphasis to traditional farming systems, crop availability in rural farming systems, underutilized crop types and utilization, rural household income and food security, the concept of value chains, market systems, and underutilized crop value chains.

Chapter three describes the findings of an extensive field survey conducted in Uva and Eastern provinces by covering two districts in each province. With a sample of 30

Gramaniladari divisions, this part of the study analyzes land use patterns mainly in terms of underutilized crops. The chapter illustrates community perceptions of underutilized crops, crop compositions, high potential underutilized crops, and economic contributions to household economies.

Chapter four elucidates a detailed analysis of the existing market system of the selected high potential underutilized crops. Chapter four mainly discuss the economics of the farming of high potential underutilized crops. This chapter explores different actors in the market system with quantity and cash flow along the value chain.

Chapter five elaborates on the distribution of economic benefits among the actors along the value chains as well as insights into the existing inefficiencies of selected crop production and the market environment by highlighting deep-rooted issues and constraints. The chapter attempts to explore the connections of existing constraints to visible consequences of the production and marketing system. Finally, this chapter recognizes potential interventions for further development of existing market systems.

Chapter six, the final chapter of the dissertation, draws a comprehensive discussion and concludes by answering the research problem stated in chapter one and stating some recommendations to enhance the economic contribution of underutilized crops as well as the development of the existing marketing environment. This chapter explores the limitations of the study from different perspectives to bring the real picture to the scientific community in what condition the finding of the study is taken into consideration. Finally, this chapter explores the interventional scope to develop especially existing market systems of selected crops by proposing recommendations.

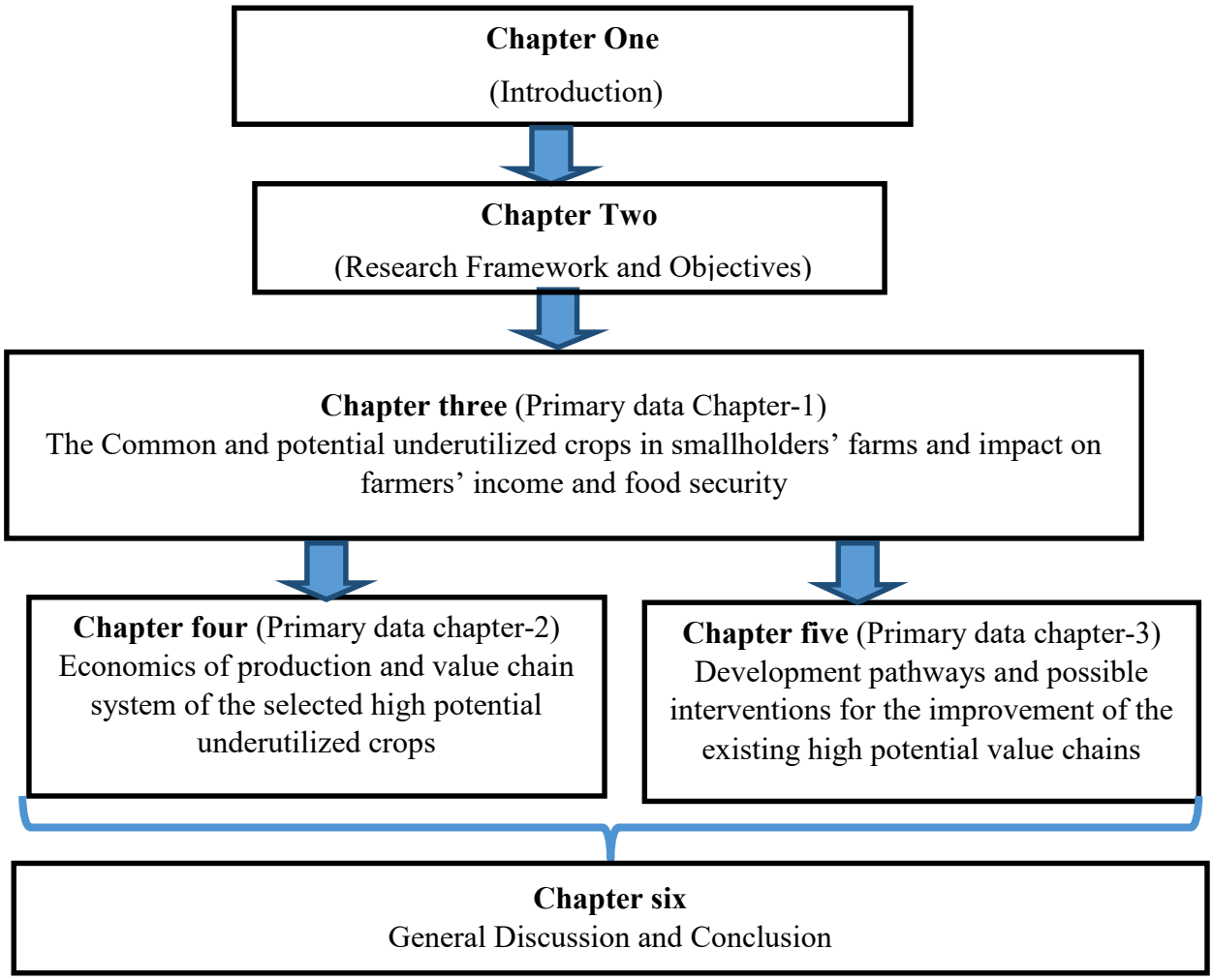

Figure 1. 4 Structure of the Dissertation

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Chapter Two

(Review of Literature)

2. Literature Review

The discussion on current literature related to underutilized crops, farming systems, economic contributions, and their value chain structures are explored to demonstrate where the current research will address a novel research need. In order to fulfill this requirement, the literature review covers four main areas of interest.

First, this chapter discusses the origin, historical development, and main features of the agricultural sector. The review further extends to discuss main farming systems where the underutilized crops are predominant. It is emphasized to review the past literature related to shifting cultivation, home gardening, and farming in off-season paddy fields to understand key features of those farming systems.

Second, this chapter explores the role of the agricultural sector for rural development from a broader perspective and potential contributions for economic development. This discussion paves the path to discuss the agricultural sector in Sri Lanka and its features and development directions.

Third, the discussion focuses on the conceptual background of underutilized crops, value chain, and operating environment, and smallholder farming. This section endeavours to discuss different perceptions of underutilized crops, value chains, and smallholder farmers. It is emphasized on the potentials of underutilized crops for the global food security and dynamics of the smallholder farming environment. The review makes special attention to exploring the different types of value chains, actor involvements, and the process of analysis of value chains. Then the discussion extends to see the constraints and possible interventions related to value chain upgrading by further exploring value chains of underutilized crops in Sri Lanka

2.1.The agricultural sector

Agriculture is considered as the industry related to the practicing of crop farming and rearing animals(Guthman 1998; Sydorovych and Wossink 2008). The history of agriculture extends up to the end of the ice era which approximately 11,000 years ago. It

was initially hunting and gathering practices that later transit to farming (Martin and Sauerborn 2012). Then the inception of agriculture occurred with wild species but further developed by the selection process by humans rather than the natural process by remarking domestication. This domestication process further developed and adopting technology contributed to the expansion of agriculture to different locations in the world (Mazoyer and Roudart 2006). During the next hundreds of years of periods most important crop species spread throughout the world. The development of new agricultural tools paved the path to modern agriculture and the starting point of modern agriculture denoted with the industrial revolution in the eighteenth century (Dethier and Effenberger 2012). The significant risk associated with rain-fed agriculture motivated to develop irrigation systems. Irrigation system development was caused by the expansion of agriculture further to most marginalized climatic and geographical localities such as arid and steep slope areas (Dethier and Effenberger 2012). The plant production led to a drop in soil fertility in agricultural lands over time. This remarked the production of fertilizer and agro-chemicals for agricultural purposes. Then in the recent history of agriculture came across plant breeding intending to change the genetic properties of the plants to cater to changing human needs with the production of hybrid varieties and the latest concepts of genetically modified crops (Altieri 2018; Martin and Sauerborn 2012b).

2.1.1. Key features of the agricultural sector

Agriculture plays a key role in the economics of most of the countries where its contribution to developing countries is significantly higher compared with developed countries. This sector consists of two main sub-sectors identified as subsistence and commercial sectors (Kanza and Vitale 2015). Subsistence agriculture is mainly characterized by the farmer having a small piece of land and cultivating crops mainly with the support of family labour. The main intention of subsistence farming is family consumption while small surplus sells in the market. Subsistence agriculture differs from the large scale farming practices in terms of using simple tools and technology as well as minimum use chemicals, and intensive cultivation systems. Reliable water supply is the most crucial factor for subsistence agriculture where motorized water supply or municipal water supply is essential to sustain the system. The productions of subsistence agriculture are mostly vegetables, grains, and fruits. The farmers' focus on subsistence farming systems emphasized more on quality than quantity with simple and economically feasible practices (Kegel 2003; Michalscheck et al. 2016). However commercial agriculture

reflects the farming practice, farmers cultivate crops for trade and commercial intention. They practice farming in a large area using modern machinery and high inputs. The application of modern irrigation techniques is the key to commercial farming. The farmlands are dominated by cash crops and cereals. When compared to the subsistence agriculture, commercial agriculture maintains pest and diseases are under well-controlled and receive a higher level of yield. Farming systems have their own storage and processing facilities. However commercial agriculture makes a higher level of environmental degradation compared to subsistence agriculture (Byerlee et al. 2011; Poulton et al. 2008).

2.1.2. Main underutilized crop farming systems and crop compositions

The choice of consumption and production decisions by farm household by arranging and managing complex resources such as crops, livestock, on-farm, and off-farm enterprises is considered as a farming system (Giller 2004; Kobrich et al. 2003). Smallholder farming systems are mainly characterized by limited access to land, financial capital, and inputs, a greater level of vulnerability, and restricted participation in the markets (Chamberlin 2007; Chamberlin 2008). However, those farming systems succeed to shape the constraints associated with those systems by continuous interaction with the local social and biophysical contexts (Chapoto et al. 2013; Michalscheck et al. 2016; Ngeleza et al. 2011). Traditional farming systems are closely connected with a wide range of social practices and those systems mainly depend on local resources, skills, and benefits (Kala 2010; Sabar 2012). However, many types of traditional cultivation and management practices are either completely lost or at the threshold of extinction due to the rapid rate of erosion in traditional knowledge. However, the increasing level of negative impacts of high input modern farming systems especially for human health push to think on traditional wisdom now than the past (Kala 2014,2015).

The underutilized crop farming systems in Sri Lanka is fallen under domestic non-plantation agriculture dominated by smallholder farmers. The lands under this system mainly cover valley bottoms, slopes, and ridges. Domestic agriculture consists of diverse agricultural eco-systems. Leading underutilized crop farming systems of shifting cultivation and home gardens are recognized as two different ecosystems under domestic agriculture in Sri Lanka (Ganeshan et al. 1996). The non-plantation agricultural sector in Sri Lanka is represented by the cultivation of crops such as cereals, pulses, grains, roots, and tubers mainly for the purpose of domestic consumption. The sector contributed

around 11 percent of the GDP of the country where 25 percent of the labour force involved. Non- plantation crop sector covers around 58 percent of the total arable lands including paddy while contributing the livelihood of over 60 percent of the Sri Lankan population(Gunawardana and Somaratne 2000).

2.1.2.1. Shifting Cultivation (Chena farming)

Even though emerging emphasis in the world regarding the development potentials of irrigated agriculture, still a massive number of agricultural lands is not likely to come under major irrigation soon. The utilization of a large extent of agricultural lands beyond irrigation facilities depends on the strategies of overcome challenges upon rain-fed agriculture. Shifting cultivation is the main form of rain-fed dry farming practice in the world is being practiced in many regions in the world. This farming system practice cultivation under extensive land use, less labour intensive, and associated with marginalized areas (Gooneratne et al. 1980; Kingwell-banham and Fuller 2012).

This system characterizes, farmers clean and burn forested land to cultivate annual crop varieties. Then the farmer moves to different forest locations by leaving formerly cultivated land for a fallow period which helps for soil regeneration. The mixture of crops, long fallow periods, and less usage of agrochemicals and chemical fertilizer are the main characteristics of this farming system (Erni 2015). Shifting cultivation is generally considered as detrimental farming systems to natural habitat due to the conversion of forest lands to agriculture with shallow conservation value. However, it is a diversified farming practice having harmful as well as beneficial impacts. It is very much important an extended assessment of its impact on wider biodiversity conservation (Pastorini et al. 2013). The whole characteristics of the farming system are connected with the maintenance of the fallow period. Generally, it takes around 10-15 years of the period to recover the fertility of fallow lands. Shifting cultivation is considered as a suitable agricultural practice as long as fallow periods are long enough to re-establish the soil fertility. However, research findings have been shown that shorter fallow period due to limitations of forest lands and population increases. This is the main reason to lead shifting cultivation increasingly unproductive in many parts of the world (Edirisinghe 2017). As viewed by many agricultural and forest scientists as well as development workers, shifting cultivation is a form of agroforestry that has been providing a livelihood for millions of people. In this context, replacing of shifting cultivation by any other land

use can negatively affect food production systems and livelihood of farmers. However, some researchers argued that this resource-based subsistence farming system is no longer valid under rapid population growth and increasing demand. They emphasized that the issue of the destabilization of the system with long cultivation periods and short fallow periods and need to transform towards sustainable intensification (Edirisinghe 2017; Lal 2005).

In Sri Lanka, shifting cultivation was considered as the backbone of the dry zone economy in the past. However, the system underwent significant changes to align with changes in national and international market systems. This farming system in Sri Lanka is based on the exploitation of natural fertility of the soil structure to fulfill the needs of the traditional societies. However, the system is now considerably contributing to domestic agricultural production especially refer to the subsidiary food crops (Gooneratne et al. 1980; Woost 2004). The current trends of shifting cultivation in Sri Lanka are characterized by monocropping, high input utilization, short fallow periods, or repeated annual use of the same land plot. The average use of land size is less than one hectare and shifting cultivation isn't restricted to poor farmers. It is visible that relatively rich farmers move shifting cultivation though they have their lands (Edirisinghe 2017).

2.1.2.2. Home gardening

The perception of researchers and scientists on home gardening defines poorly and there is no universally accepted definition. It is used different names to explain about home gardens such as agroforestry home garden, household farm, homestead farm, compound forms, backyard gardens, village forest gardens, dooryard gardens and house gardens (Huai and Hamilton 2009; Kumar and Nair 2006) However, most of the researchers suggested that it as an intimate, smaller in size, multi-story structure, multi-species having trees and crops with domestic animals around the homestead. Clear data on the extent of home gardens in the world is not available. It is difficult to estimate the size of home gardens mainly because of not having clear boundaries. In this context home, gardens are not existing for agricultural statistics or land revenue records. However, the home garden maps in the world show that a large number of home garden concentration is in the tropics. It includes South and Southeast Asia, the Pacific islands, and East and West Africa (Anwar et al.2016; Hual et al. 2009; Kunhamu 2013).

As viewed by Kumar and Nair (2004) home gardens are the oldest land use activity just second to the shifting cultivation. Home gardens are the main contributor to the local

subsistence economy and food security, developed over centuries by accommodating the great extent of traditional knowledge and insights. Diversity of species is a common feature of the home gardens all over the world and reported the most common species all over the world (Freedman 2015; Kumar and Nair 2004; Soini 2005). However, traditional home gardens are used for different purposes in varies region in the world. However, the common uses are for food, medicinal and ornamental purposes. Traditionally, home gardens mainly produce vegetables and fruits by supplementing the staple food. Home gardens are responsible to maintain the quality of the life of the people in both economic and social welfare perspectives with agrobiodiversity (Blanckaert 2004; Zaldivar et al. 2002). In some cases, socio-cultural, ecological, and aesthetic values of the home gardens may exceed the economic value of it (Kunhamu, 2013; Huai and Hamilton 2009).

In the modern context, plants in home gardens under three categories based on the intensity of management. Those types are cultivated (under intensive management), protected or encouraged (spontaneously growing but owner encourage to grow) and spared (spontaneously growing but left unwedded). Home gardening practice has already been extended to urban areas by moving this concept to commercial outlook (Abdoellah et al. 2006; Drescher et al. 2006; Thaman et al. 2006; Wiersum 2006; Yamada and Osaqui 2006).

Sri Lankan home gardens are considered the oldest farming system in which seconds only to the shifting cultivation. This farming system covered more than 13% of land use of the country. SriLankan farmers practiced home gardens for generations by growing mainly annuals and perennials in mix cropping culture supported by rainfall. The mixed cropping system consists of a variety of tree species. Sri Lankan home gardens are characterized by incorporated livestock components and animal and plant waste are recycled. This system mainly produced fruits and vegetables as well as spices and medical products (Ganashan et al. 1996). The total land area under home gardens in Sri Lanka has been increasing in the last decade and considered as most appropriate farming system even though having concerns about environmental impacts and land use in new development context (Mattsson et al. 2018; Krishmal and Weerahewa 2004; Ostwald and Nissanka 2018; Pushpakumara et al. 2012). The national development policy frame of Sri Lanka has well-recognized home gardens' potential for facing future emerging challenges. However, as reflected by past literature, plant diversity and different home gardening

systems are less researched in Sri Lanka(Freedman 2015; Geiger 2015; Krishmal and Weerahewa 2004)

2.1.2.3. Farming on off-season paddy fields

Paddy farming based on minor irrigation tanks with cascade model irrigation is a historical practice in Sri Lanka. Such tanks collect the rainwater during the rainy season and mainly supply water for paddy farming in Maha season. The role of minor irrigation systems in centuries for food security, livelihood development, and ecological sustainability is commendable (Henegedera 2002). According to the current estimation, 37 percent of the irrigated lands in Sri Lanka are under minor irrigation facilities (Aheeyar 2013). The significant majority of those lands have been used for paddy farming in Maha season under the water from those tanks but keep fallow or cultivate some field crops in the Yala season with limited water sources. The productivity of those lands is very low but the capacity to improve the productivity remains by using those off-season paddy lands for the selected crop farming. The cropping intensity of those lands in off paddy season (Yala season) ranges from 8 to 83 percent in dry and intermediate zones in Sri Lanka (Kumara et al. 2017). However, a common characteristic in Sri Lanka is that farmers keep fallow their paddy lands periods between main seasons without cultivating paddy even though relevant minor irrigation tanks having enough water for other field crops. Department of Agriculture recommends cultivating off-season field crops under such conditions. Cultivation of different field crops in paddy fields is a long term practice of Sri Lankan farmers. They expect to achieve a higher income and better living standards by practicing off-season farming (Chandrasiri et al. 2014). However, the maximum benefit and success of this practice are limited by various factors. Farmers tend to ignore the short rain period in April-May because of avoiding flooding of their croplands. However, the potential of growing crops in those lands by using residual moisture in the soil and remaining water in the minor tanks are well emphasized (Kumara et al. 2017).

2.2.Role of agriculture in rural and economic development

The agricultural sector is considered as engine of the economy of developing countries since contribution to gross domestic product (GDP), employment generation capacity and foreign exchange earnings. Agricultural sector ensures the food and income security of more than half of the population living in less developing countries (LDCs). In this context, the overall economic and social development of LDCs clearly depend on the

productive capacity of the sector and needs special attention rather than neglecting policy and investment opportunities (FAO 2002).

Even though globalization opened windows of opportunities for growth and development, the agricultural sector in developing countries failed to capitalize on its benefits. The combined share of agricultural exports in developing counties dropped from 5% to 1% from the 70s to 90s (Dethier 2011). Thus primary agricultural products of developing countries are hardly competitive in globally integrated markets as well as in their home country markets. Developing countries face internal as well as external difficulties to develop the agricultural sector to improve their food security as well as income standards. Low productivity, low skilled labour, poor infrastructure, and poor institutional and policy frameworks are the main internal constraints (Cervantes-Godoy and Dewbre 2010; FAO 2002).

The powerful forces engage in the general development process remarks on the reduction of labour force involved in the agricultural sector while reducing the importance of the agricultural sector. However, at a certain stage of development, the capitalist sector never produces the foods and this situation is proved that the importance of industrial development goes together with agricultural sector improvements. It is emphasized that no availability of sustainable industrial development under the existence of a stagnant agricultural sector (Mazoyer and Roudart 2006; Timmer 2005). Thus the role of the agricultural sector is well described as the sector is to provide cheap labour and cheap food for the fast-growing modern sector. As per the further explanations, the agricultural sector can develop forward linkages to the non-agricultural production sectors by providing raw materials to the industries. From a consumption perspective, higher productivity in the agricultural sector improves the income levels of the rural communities and they have the potential to create a demand for domestically produced industrial products. Anyway, this way of development is possible only under the agricultural demand led industrialization (Dethier and Effenberger 2012; Eswaran and Kotwal 2006) .

Since the presence of rural areas throughout the world, agriculture comes as the major component of the rural sector viability. In some countries farming is the primary economic activity that provides a significant amount of employment to the people. In such a situation overall social and political stability strongly connect with the agricultural

sector. Since the level of contribution farming for rural development in countries, policy responses need to be adjusted to maximize benefits to the societies (European Commission 2000; Eririogu et al. 2019; Sarris 2001). Meanwhile mainly European Union countries, Japan, Norway, and Switzerland made their argument of that the importance of looking at agriculture in a more holistic viewpoint. They believe that agriculture needs to play its own local or regional economic welfare role rather than a global food supply chain driven development(FAO 2006).

However, agriculture disappeared from the development agendas of donors and development programs of developing countries last few decades of the 20th century. However, the subject of agriculture again appeared in the programs of the first decade of the 21st century. Now again renewed interest evolved regarding the issues of the agricultural sector (Janvry 2010).

2.3.Performances of the agricultural sector in the Sri Lankan economy

Sri Lanka has a long civilization in agriculture from its ancient kingdoms. Pre-colonial era agriculture had been a source of domestic consumption in the country. However, during the colonial era, the country faced significant changes with the introduction of commercial agricultural crops such as tea, rubber, coconut, and coffee (UK Essays 2013; Wickramasinghe 2006). The drastic changes in consumption-based agriculture to commercial orientation in Sri Lanka evolved diverse challenges and experiences to the agricultural societies (Jayasinghe-Mudalige 2010). In the present context, the agricultural sector in Sri Lanka is categorized under four major subsectors namely as agriculture(plantations), forestry, fisheries, and livestock. Though successive governments made considerable effort to develop the sector, agricultural experts mentioned about the stagnation and decline of the sector. (Gunawardana 2018).

However, as shown by Central Bank (2018) the agricultural sector contributes 7.8 percent to the Gross Domestic Product (GDP) while generating 30 percent of employment to strengthen the economy. The new development trends of the Sri Lankan agricultural sector are highlighted by organic farming, improving agricultural productivity, improvement of market access, and promoting value addition options for smallholder farmers. However, according to Weerahewa (2004), forty-five percent of the agricultural holdings are covered by paddy cultivation. Paddy farming is an unprofitable business due to yield reductions by climatic changes (mainly impacts of high temperature) and natural

disasters as well as high input cost mainly for fertilizer and agrochemicals (Epaarachchi et al. 2002; Shanmuganathan 2013; Thiruchelwam 2005).

As shown by Esham et al. (2006) fruits and vegetable sector in Sri Lanka has the potential to develop with good training to farmers towards commercialization and diversification with value addition targeting export and supermarkets. Further, views of Nagahage et al. (2012) and Jayasooriya (2017) emphasized the main challenges such as climatic changes and environmental impacts and the existing poor financial capacity of farmers to achieve such targets. Any way Somarathne (2000) emphasized the importance of adaptation of demand drive technology for the horticultural sector (such as Rambutan, Guava, Cashew nut, mango, etc.) as well as tea rubber and coconut. Productivity achievements of SriLankan farmers are necessary which can be accelerated by improving their knowledge, skills, and entrepreneurship and focus on high volumes of green and organic products (Aheeyar et al. 2006). Tea along with rubber and coconut contributes a significant proportion of export earnings of the country. However, sustainable growth of these three leading crops was retarded due to poor cultivation techniques, poor business practices, and poor perceptions among farmers on sustainable agricultural practices (Perera 2014; Samaraweera et al. 2013). Tea is special for Sri Lanka since world second largest tea exporter in the past but dropped international competitiveness mainly due to the high cost of production and low productivity performances (Ganewattha et al. 2000; Thushara 2015)

2.4.Underutilized crops, smallholder farmers and value chains

2.4.1. Concept and different perceptions of underutilized crops

The term of underutilized crops is related to the unexploited economic potential of crops and appropriate focus for market development. Underutilized cops are the group of crops that globally rare but locally abundant in general. Further, scientific knowledge about those crops is limited while current usage is much below their economic potentials (Gruère et al. 2009; Williams and Haq 2002). According to Engels et al. (2001) underutilized crops are the group of crops that were once more widely cultivated but are today falling into abandonment for a range of agronomic, genetic economic, and cultural factors. The use of these crops by farmers and consumers is quite insignificant because they are in some way not competitive with other crop species in the same agricultural environment. However, underutilized crops are a wealth of agrobiodiversity, improved income, food security and nutrition (Dansi et al. 2012; Hammer et al. 2001; Jaenicke and

Höschle-Zeledon 2006; Idowu 2009; Williams and Haq 2010). Many countries in Asia and Africa have understood the importance of these crops and engaged in research on various aspects of these crops for further improvements and development (Idowu 2009; Illukpitiya 2008).

2.4.2. Potential of underutilized crops to global food security

The large numbers of underutilized crop species potentially represent a massive unexploited global resource. The potential of many of these crop resources has been neglected with the development of modern agricultural practices. On the other hand, the world food supply depends on few crops species, reflected as more than half of the global food requirement depend on three major staple crops (rice, maize, and wheat) and almost ninety-five percent of the requirement is covered by thirty plant species (Ahmad and Javed 2007; Pasiecznik 2009; Shin et al. 2015). Meanwhile, Staple crops are facing major challenges due to climate changes and the soil becoming infertile. Diversification away from staples to new varieties of crops is important as part of the progress towards the goal of achieving the security of food production. Underutilized crops are in the best position to address this issue with inherited characteristics such as physical appearance, taste, nutritional properties, cultivation methods, processing qualities, and potential economic gains (Ahmad and Javed 2007; Pasiecznik 2009; Shin et al. 2015).

As compared to the major crops, underutilized crops are required relatively low inputs which is an important factor for sustainable agricultural production. The researchers (e.g. Chandrarathne 2007; Mayes et al. 2011) discussed the potentials of underutilized crops to support food security. They highlighted the unexploited capacity of underutilized crops to support the poor for subsistence as well as their income. Under-utilized species are extremely important for food production in low-income food-deficit countries. Asia and the Pacific region have a great diversity of crop resources and therefore a tremendous opportunity to utilize the diversity for sustainably improved livelihood and the environment in the region. On the other hand, underutilized crops support the development of niche markets for global trade in an increasingly competitive world. Thus there is an increasing endorsement at the national and international level of the important role of sustainable farming systems employing less-used crops and species that can play in supporting human wellbeing. (Taylor et al. 2004).

The potential contribution of underutilized crops is broadly in the areas of poverty reduction, improved human health, biodiversity conservation, and natural resources management, empowerment of women and disadvantaged groups of societies, and raising food production. The key to unlocking their real potential of underutilized crops depends on the global capacity to utilize their multiple uses rather than following traditional single-use enhancement approaches. However, the Cultivation of underutilized crops has continuously fallen due to their inability to compete with the major crops that dominate most agricultural systems (Hag and Hughes 2002; Hoeschle 2009; Nandal and Bhardwaj 2014; Padulosi et al. 1999; Thies 2000; Williams and Haq 2010).

2.4.3.Smallholder farming sector and farming environments

Smallholder farmers are distinguished by having a smaller size of arable lands on their own to engage in agriculture. A significant number of smallholder farmers live in developing countries. Smallholder farms are generally defined as the operating size of 2 or less than 2 hectares. (Sangakkara and Frossard 2016). In addition to the small size of land parcels, these farming systems are characterized by the application of highly undeveloped preliminary production technologies, poorly enjoying public provisions of infrastructure, the extension supports, and poor labour provision structures. Family labour is one of the key determinants of the existence of the farms (Wickramasinghe and Weinberger 2013).

In the world, 85% of the agricultural farms are under smallholders where approximately 2.5 billion people living on 500 million smallholder farms in developing countries. The majority of them earn less than 2 dollars ($2) per day. The statistics are further revealed that 87 percent of small farms are located in Asia and the Pacific's regions followed by 8 percent in Africa. (International Fund for Agricultural Development 2013; Nagayet 2005; Padulosi et al. 2013; Wickramasinghe and Weinberger 2013; Mackinnon et al. 2014). Smallholder farmers face diverse risk and uncertainty factors in their agricultural production. Climate change is affected them disproportionately by making their livelihoods in further troubles. Thus, in brief smallholder farmers are less likely to overcome poverty barriers in inclusive value chains under several resource limitations. Further labor-intensive cropping systems followed by smallholder farmers provide a basis for recognizing their potential strengths to be producers in competitive value chains

The investment by farmers for value addition and upgrading decisions are taken by their assessment of risk-adjusted return to upgrading, with the context of their alternative opportunities, their resources and capabilities and their access to information and learning opportunities (Dunn et al.2006; Fowler and Brand 2011; Garloach 2012; Gruère et al. 2006; MacKinnon et al. 2014; Nagayet 2005)

2.5.Conceptualization of Value chain, Value chain analysis, and smallholders

2.5.1. The concept and types of value chains

The initial conceptual development of value-chains was introduced by Shaffer in 1970. This analysis encompasses a grouping of different economic activities and link by market relationships by linking suppliers, processors, transport suppliers and traders to connect producers to consumers. Later in the 1980s, Porter develops a value chain analysis tool by covering the steps of the production process. This tool identified primary activities that are directed to add value and supporting activities having an influence on the value of the final product (Nangole et al. 2011). However, as viewed by Kaplinsky and Morris (2002) value chain is a full range of activities needed to bring a product from inception to the final consumer through different phases. This understanding emphasized, different chain activities and value created at a different level in value chain analysis. By the way, Hobbs et al. (2000) define the value chain as a form of the supply chain. The supply chain includes all vertical chain activities from production to consumption. As viewed by Stafano (2007) and Vandenberg et al. (2007) value chain analysis is viewed in both narrow and broad sense. In a narrow sense, value-chain is explained by a range of activities performed within a firm to produce a certain output while in a broader sense, it involves a complex range of activities implemented by different actors.

The value chains having key four activity levels and linked horizontally as the simple value chain. Simple value chain should have key four nodes such as design and product development, production, marketing, and consumption. However, it can be more complex when other actors are involved in the chain playing different roles. The complex chain allows more opportunities for competitive farmers. However, farmers' comparative advantage in value chains can be improved by increasing the volume of supply, quality of the product, and consistency of supply, which is often possible when farmers act as a group (Kilelu et al. 2017; Mayoux 2003). The concept of extended value chain have made a significant emphasis on the core value chain and its linked service delivery

environment. They also draw attention to input supply actors who are located away from the core value chain but strongly linked to it. A further advanced version of the value chain reflects a number of value chains linked together. The key feature of this concept is that intermediary producers in a particular value chain may feed into a number of different value chains. In this concept, each alternative value chains absorb a small portion of the production of the intermediary producer of the particular value chain. The process of industrialization may have more chances to develop value chains of such crops and their position in the global market (FAO 2005; Kaplinsky and Morris 2000).

2.5.2. Nature of agricultural value chains

A 'value chain' in agriculture encompasses the set of actors linked together through all the stages of the production, processing, sale, and ultimate consumption of an agricultural product. Each actor undertakes activities that are required to bring a basic agricultural product or a service from production in the field to its end users' point. It is also linked to a range of services needed in the value chain including technical support (extension), business enabling and financial services, innovation, communication, and information brokering. These process actors and service providers interact locally, nationally, and internationally However, it is emphasized that the efficient operation of a value chain is dependent on the effective and uninterrupted flow of value through the chain which in turn relies on the competent, effective, and efficient interaction between all actors in the chain (Emana and Nigussie 2011; Gómez et al. 2011; Kaplinsky and Morris 2000; Nangole et al. 2011; Trienekens 2011). Fundamental characteristics of agricultural value-chains are similar to the other value chains. However, the agricultural value chain gives a higher level of emphasis on the quality of the product, safety concerns, and climate-related variabilities. However, agro product-related characteristics such as short shelf life, frequent demand, and price fluctuations make those value chains are more complex and difficult to manage than other chains(Ahumada and Villalobos 2009).

2.5.3. Value chain analysis, analytical tools, and its importance

There are different types of value chain approaches used in value chain analysis and those depend on the research question. In general, analysis of agricultural value chain analysis applied four different applications such as value chain mapping, identifying the distribution of benefits of actors in the chain, examining the role of upgrading within the chain and role of governance in the value chain (Kaplinsky and Morris 2001; Nangole et al. 2011). Value chain mapping allows researchers to systematically map the actors'

participating in different activities and profit and cost structures, employment characteristics, flow of goods and the destination and volumes. The margins and profits analysis in the chain allows identifying levels of benefits on each actor by participation in the value chain. The analysis of upgrading processes identifies constraints currently present such as the structure of regulations, entry barriers, trade restrictions, and standards. This allows for the development of value chain innovations (upgrading) which can improve the position of value chain participants. Upgrading may include process upgrading, product upgrading, and function upgrading. In addition, governance issues play a key role in how such upgrading occurs. The importance of value chain analysis of products became an interesting study area in a rapid global development context. The findings of value chain analysis assist to recognize the level of competitiveness of the market system, production system efficiencies and support to acquire sustainable income growth. (Chagomoka et al. 2014; Kaplinsky and Morris 2000)

2.6.Governance of value chains

The concept of value chain governance transforms the concept of value chain towards the analytical platform by recognizing the various activities in the chain. It connected with the identification of actors, their roles and responsibilities and functions. This is not exactly similar to the concept of coordination. The value chain governance encompasses not only positioning required resources, input, and services for the function of the value chain but included the integration of different components to ensure the expected final product. In this viewpoint, power asymmetry is central to the value chain. Three forms of value chain governance are identified based on the classical separation of powers. Legislative governances related to basic rules and regulations related to participating in the value chain. Those rules and conditions ensure the supply of the required quantity of the final product at the right price. Auditing the performance value chain actors to check whether they work compliance with set rules and regulations explains judicial governance. However, actors of the value chains need a kind of proactive assistance to meet the operational rules and regulations. This scope of governance is identified as executive governance. All three levels of governance need to involve different parties who are internal to the chain and external to the chain. However, this is not realized in the real world by taking the responsibility of all forms of governance by the same firm. In this context value chain literature face difficulties in explaining the inefficiencies related to the value chain in the real world(Kaplinsky and Morris 2000)

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Chapter Three

The common and potential underutilized crops in smallholders' farms: Impact on farmers' income and food security

3.1. Introduction

Globally, over 90% of food demand is fulfilled by only a few dominant crops (e.g., rice, wheat, maize), thereby causing large numbers of crops to be underutilized (Cheng et al. 2017; Padulosi et al. 2014; Tyagi et al. 2018; Williams and Haq 2000). However, these underutilized crops have significant economic value and maintain a more diversified and sustainable production system, though the potential of these crops has been neglected for a long time (Cheng et al. 2017; Galluzzi and Noriega 2014; Padulosi and Hoeschle-Zeledon 2004). These crops provide subsistence, additional income, and nutrition to rural communities, preserve cultural and dietary diversity, enrich agro-biodiversity in marginal areas, and are highly resilient to climate change (Baldermann et al. 2016; Chivenge et al. 2015; Dansi et al. 2012; Ebert 2014; Konuma 2018; Leal et al. 2018; Malkanthi et al. 2014; Mayes et al. 2012; Ravi et al. 2010). Mainstreaming these crops into local food systems can help alleviate malnutrition and food insecurity, especially in rural communities (Baldermann et al. 2016; Konuma 2018). However, promises of these underutilized crops were overlooked by research, extension services, and policymakers (Mabhaudhi et al. 2017; Rangani et al. 2015; Tyagi et al. 2018), and hence a coherent strategy is needed to reveal the importance of these crops for sustainable rural development (Mabhaudhi et al. 2017).

Sri Lanka is rich in agro-biodiversity that provides diversified products to the livelihoods of small-scale farmers and indigenous people. Most of the underutilized crops in Sri Lanka have lost their significance among the present generation due to many reasons, including lack of awareness, urbanization, and changing food habits (Malkanthi 2017; Rangani et al. 2015). However, these crops have the potential to be cultivated in marginal areas under limited input application which can bring additional income to farmers during lean seasons (Katupitiya and Sangakkara 2015; Padulosi et al. 2013).

Underutilized crops in Sri Lanka can be seen in mixture with other dominant cash crops (e.g., paddy, maize, cassava, pepper, banana, green chilies, ladies fingers, coconut, betel nut, sugarcane, sweet melon, and papaya) in various types of agricultural farms, including shifting cultivation (locally known as *chena*), home gardens, and off-season paddy farms

(Bandula et al. 2016; Malkanthi 2017; Muthukudaarachchi and Wijerathne 2008; Sangakkara and Frossard 2014). Dahanayake (2015) reported that many underutilized crops in Sri Lanka face extinction or severe genetic loss, and lack detailed information. Research on underutilized crops in Sri Lanka is limited. Bandula et al. (2016) reported that underutilized crop value chains played an important role in rural food and income security. Dahanayake (2015) described the importance of conservation strategies of some underutilized fruit crops. Malkanthi (2017) found that farmers were positive towards the cultivation of underutilized crops as these crops enhanced their food security. Rangani et al. (2015) reported 16 underutilized fruit trees from urban areas of the Colombo district and commented that most of the sampled urban residents were not consuming underutilized fruits. While Bandula et al. (2016), Malkanthi (2017), and Rangani et al. (2015) reported from field studies with a small sample size and focused only on income and food security, Dahanayake (2015) described conservation strategies through a literature synthesis. So it is clear that little information on the composition of available and high potential underutilized crops or key actors' (farmers, collectors, traders) knowledge of and preference for underutilized crops. In order to bridge the gaps, this chapter was aimed at identifying common underutilized crops in three main types of agricultural farms (*chena*, home garden, and off-season paddy lands) available in the south-eastern region of Sri Lanka and estimating the contribution of underutilized crops to farmers' household income. The chapter explored key-actors' (leaders of farmers' associations, collectors, and wholesalers) knowledge of and preference of potential underutilized crops in the region. The findings of this chapter would provide a baseline of information on the composition of available and highly preferred underutilized crops in the study region, and relevant agricultural departments would take actions towards sustainable cultivation of these underutilized crops in the agricultural farms of Sri Lanka.

3.2. Materials and methods

3.2.1.Study area and sampling protocol

The study was carried out in four districts Badulla and Moneragala districts in Uva province, and Trincomalee and Ampara districts in Eastern province which fairly cover the south-eastern geographies of Sri Lanka (Fig.1.3). These districts were selected considering the presence of varying topography, such as hilly and flat areas, and diverse farms where farmers grew underutilized crops. The presence of underutilized crops in these areas was cross-checked with local agricultural officers, rural poverty alleviating

officers *(Samurdhi officers),* development officers *(Sanwardana Niladari),* and village headmen *(Gramailadaries)*. For the selection of study sites in each district, discussions were held with the Deputy Director of Agriculture, field-level Agricultural Instructors (AI), and Agricultural Research and Production Assistants. They were government agricultural officials and were found in every district.

Table 3. 1 Selected areas for the study in Uva and Eastern provinces

Uva Province/Moneragala District		
DS Divisions	**Covering Agro-climatological zones***	**GN Divisions**
Thanamalwila	DL1a, DL1b, DL5, IM2b	Kahakurullanpalassa, Mahawewa, Bodagama
Wellawaya	DL1a, DL1b, IL1c, IM2b, IU3a,	Buduruwagala, Adawalayaya, Nugayaya,
Moneragala	DL1a, DL1b, IL1c, IL2, IM2b	Thennegallanda, Kahambana, Kolonwinna

Uva Province/Badulla District		
DS Divisions	**Covering Agro-climatological zones**	**GN Divisions**
Meegahakiwula	IL2, IM1a, IM1c, IU2	Ketawatta, Morahela, Ellanda,
Kandeketiya	IL2,IM1b,IM1c,IU3e	Gottunna, Mudagamuwa,Thattilla
Rideemaliyadda	IL2, IM1a, IU2	Kuruvithennna, Bubula, Mahagama

Eastern Province/Ampara District		
DS Divisions		**GN Divisions**
Ampara	DL2a, DL2b	Namaloya/mullegama, Wavinna-South
Mahaoya	DL1c,DL2a,DL2b,IL2	Pollebedha,Warapitiya
Damana	DL2a,DL2b	Mullegama, Wadinagala
Eastern Province/Trincomalee District		
DS Divisions		**GN Divisions**
Gomarankadawala	DL1d, DL1e	Mahadiwulwawa,Morawewa
Kantale	DL1c,DL1e,DL2b	Sooriyapura,Wanela
Mahawewa	IL1a	Pansalgodella,Morawewa

D-Dry Zone W-Wet Zone I-Intermediate Zone (Classified based on the rainfall and temperature)
L-Low Country M-Mid Country U-Up Country (Classified based on elevation)
1-6 number with English letter(a-e): Subzones (Based on topography, humidity, temperature variations, vegetation, and soil characteristics)
*Source: Soils and Agro-Ecological Environment of Sri Lanka, Panabokke, C.R.,1996

In the discussions, I briefed them about the objectives of the study and for their understanding, underutilized crops were described with the following characteristics: crops widely grown in the past, limited current cultivation, growing in marginal areas with minimum input, tasty and nutritious, less attention, and less market demand.

However, it was reported that crops that were underutilized in the study region might be common in other parts of Sri Lanka and elsewhere in the world. The locations initially selected based on the recommendation of government agricultural officers were revalidated through field observation and informal talks with some farmers. Based on field observation, discussions with farmers, and the recommendation of government agricultural officers, 12 Divisional Secretariat Divisions (hereafter DS Divisions) were selected randomly, six from each province, and three from each district. The selected sites covered both dry and intermediate zones covering up, mid and low elevations (Table. 3.1)

Following a snowball sampling technique, 88 farmers, 52 from Uva province and 36 from Eastern province, distributed in six villages, were selected for the household survey. The snowball sampling facilitated access to informants through the contacts that are provided by other informants when the researchers did not have ample information on the best informants to interview for accurate information (Noy 2008).

Table 3. 2 Distribution of survey samples in the study areas

Location (Province)	**Phase 1: Farmers household survey**	**Phase 2: Key actors survey**		
	Farmers	**Farmers**	**Collectors (Primary/secondary)**	**Traders(whole/retail)**
Uva	52	12	4	2
Eastern	36	12	4	2
Total	88	24	08	04

When interviewed N.S.K Rathnayake (personal communication, July 23, 2018) confirmed that the selected study areas of the Uva province comprise 4040 farmer households. In this total number of farmers,around 60 percent (approximately 2424 households) bear a minimum level of representation of underutilized crops in their farming systems. However, only around 20 percent (approximately 486 households) engage in underutilized crop cultivation for minimum of consecutive 5 years and considered permanent farmers. So the selected 52 permanent farmers out of this 486 from Uva province for household survey covers 11 percent of the intended population. The

selected areas of the Eastern province consist of 3040 farmer households. From this total 63 percent (1904) households bear a minimum level of representation of underutilized crops in their farming systems. However, only 18 percent of them (350 households) engage in underutilized crop cultivation for minimum of consecutive 5 years and considered permanent farmers (S.Disanayake, personal communication, July 27, 2018). So selected 36 such farmers for the household survey from Eastern province which covers 11 percent of the intended population.

3.2.2.Data collection methods

3.2.2.1. Household surveys, Group discussions, and Farm visits

Data were collected following a participatory rural appraisal method and household surveys, group discussions, and farm visits. Household surveys were carried out in the morning and afternoon considering farmers' convenience and avoiding wild elephant movement at night. In each selected village, a lead farmer accompanied the researchers to conduct household surveys. For household interviews, the head of the household was interviewed, but adult family members present also participated. A pre-tested semi-structured questionnaire was developed by reviewing related research in Sri Lanka and elsewhere (Emana and Nigussie 2011; Malkanthi 2017; Menike and Arachchi 2016) and discussions with agricultural officers and a few farmers. The questionnaire was first developed in English and then translated into the local language (*Sinhala*) because the villagers were comfortable with their local language; interviews were conducted in the Sinhala language. The questions asked were related to landholdings and land types, size of farms, household income, and sources, and contribution of underutilized crops to household income and food security.

A total of six group discussions were held with 5–8 farmers in six villages, where researchers discussed characteristics of three farms, farmers' perception on underutilized crops, availability of underutilized crops on their farms, challenges of underutilized crops cultivation, and contribution of underutilized crops to their livelihood. Thirty farms, ten in each category, were visited to observe crop composition. Farmers and AI identified the local names of crops, photographs of each crop were taken, and final identification was done by a plant taxonomist.

Ethical approval for the participants' survey was obtained from the Faculty of Science, University of Nottingham Malaysia. Written permission to conduct field interviews was also obtained from the Provincial Director of Agriculture. Participants were anonymous,

remained unidentified, and verbal consent was obtained to participate in the survey. The fieldwork was carried out from September to December 2017.

3.2.2.2. Key actor interviews

Key actors were leaders of farmers' associations at the village level, collectors/middlemen who purchase crops including underutilized crops from farmers and sell to traders in suburban/urban areas, and the wholesalers. The purposes of key actors' interviews were to understand their knowledge of underutilized crops, their preference of potential underutilized crops to enhance the socio-economy of farmers, and to identify potential underutilized crops based on their criteria for the study regions. A total of 36 individuals (24 farmers' leaders, 8 collectors, and 4 wholesalers) were interviewed. Evening and early evening sessions were used to conduct interviews and were held close to the main roads where wild elephant threats were limited. A separate checklist was used. The questions included were related to their understanding of the characteristics of underutilized crops, main underutilized crops available in the market, and perception of criteria for selecting high potential underutilized crops. Based on their opinions, 13 criteria were identified along with their explanations. A scoring exercise was conducted for selecting priority underutilized crops in the four districts. The actors were asked to assign a score from 1 to 5 for each criterion for each underutilized crop they identified. Then, all scores were aggregated for each underutilized crop and identified for priority crops based on higher aggregated scores.

3.2.3. Data analysis

Raw data tables were organized using Microsoft Excel and household wise primary data were entered into those tables. Basic descriptive statistic values (means, standard deviations, variances, and coefficient of variance) were calculated at the district level and then further summarized to provincial values. A one-way ANOVA and Chi-square test were used to analyze the difference and association between selected variables (land areas under three farms, income from various sources) between two provinces. Pierson correlation test was conducted to explore the relationship between income and income sources. Key actors' opinions were described qualitatively and their scoring was presented quantitatively.

3.3. Results

3.3.1.Land resources, farms, and diversity of underutilized crops

Two types of agricultural lands were noted in the study region. In both provinces, a major portion of land (76%) was under rain-fed cultivation (Table3.3).

Table 3.3 Land resources and farms observed in the studied areas of southeastern Sri Lanka.

Variable	Uva province (n = 52)	Eastern province (n = 36)
Irrigated lands (%) (df=1 p=0.05 chi-critical=3.84 Chi stat=21.33)	9	40
Rain-fed lands (%) (df=1 p=0.05 chi-critical=3.84 Chi stat=6.36)	91	60
Mean landholding per household (ha)	2.45	3.36
Land blocks less than 0.40 ha in size (%)	28	13
Land blocks between 0.40–0.80 ha in size (%)	41	40
Land blocks larger than 0.80 ha in size (%)	31	47
Home Gardens		
Mean area (ha)	0.83	0.77
Mean area under underutilized crops (ha)	0.44 (53%)	0.30 (39%)
Chena/Shifting Cultivation		
Mean area (ha)	0.91	0.72
Mean area under underutilized crops (ha) (p=0.001, F=10.256, df=1)	0.69 (76%)	0.13 (18%)
Farming in Off-season Paddy Fields		
Mean area (ha) (p=0.0001,F=30.478 df=1)	0.53	1.78
Mean area under underutilized crops (ha)	0.11 (21%)	0.11 (3%)

Note: n*=Sample size/ Statistical Test-Chi-squire*
** Land block refers to a demarcated by a live fence, a barbed wire fence or any land area having its own any kind of legal documents which indicated the size of the portion of the referred land*
^Figures in parenthesis indicates the percentage of land area covered by underutilized crops

The mean landholding was 2.91 ha in both provinces and land was distributed into three types of land blocks. Three agricultural farms, namely chena, home gardens, and off-season paddy lands, were observed where farmers grew underutilized crops along with other crops.

All sampled farmers had three types of agricultural farms. Table 3.4 shows the general features of these farms. It was observed that nearly 50% of *chena* and home garden lands were covered by underutilized crops where farmers practiced mixed cropping. The common types of underutilized crops were cereals and pulses in *chena* and off-season paddy lands, and fruits, vegetables, and yams in home gardens. The majority of underutilized crops were being cultivated annually with minimum use of agro-chemicals and hired labour. Family members, both male, and female took part in cultivation, and products were mostly used for their own consumption. Farmers said that the main challenges in these farms were water scarcity and damage by wild animals.

In both provinces, 37 underutilized crops were identified in the visited farms; the highest number (27) was recorded from home gardens, followed by *chena* and off-season paddy lands (Table 3.5). There were 32 and 22 underutilized crops in Uva and Eastern province, respectively. Based on the percentage of households having underutilized crops, finger millet (*Eleusine coracana* [L.] Gaertn.) was most common, followed by cowpea (*Vigna unguiculata* L. Walp.), cassava (*Manihot esculenta* Cratz), sweet melon (*Citrullus lanatus* [Thunb.] Matsum. & Nakai), and cashew (*Anacardium occidentale* L.) in the study areas.

Table 3.4 Qualitative features of three studied farms in southeastern Sri Lanka where farmers grow underutilized crops.

Characteristics	*Chena*	Home garden	Farming in off-season paddy lands
Land size (mean)	0.82ha	0.80 ha	1.16 ha
The land area (mean) under underutilized crops	0.41 ha; 47% of *chena* land	0.37 ha; 46% of home garden land	0.11 ha; 12% of paddy land
Distance from the home	Average1.5–2km	Surrounding home	Maximum up to 1 km
Land ownership	Forest land (traditional)	Personal	Personal/lease
Crop combination	Mixed cropping	Mixed cropping	Mixed cropping
Underutilized crops	Available	Fairly available	Only a few
Main underutilized crops	Cereals and pulses	Fruits,vegetables,Yams	Pulses
The lifespan of the common crop types	Mostly annual	Annual, bi-annual, and perennial	Mostly annual
Origin of the crop	Cultivated	Cultivated and naturally grown	Cultivated
Labour utilization	Family and hired	Family only	Family and hired
Female labor input	Mainly for weeding and harvesting	Planting, harvesting	Mainly for harvesting
Agro-chemicals usage	Minimum	Zero	Minimum
Dependency on rainfall	High	Low	High
Irrigation	Agro-wells and pumping systems	Agro-wells, rainwater collecting ponds	Rare
Product utilization	Own consumption and sell	Own consumption and sell	Mostly sell
Income	Relatively high	Relatively low	Medium
Immediate marketing point	Collector, fair, or village/town wholesalers	Village fair or village collector	Village or town wholesalers
Storage	Short duration	Minimum storage	Short duration
Processing and value addition	Basic value addition	No value addition	No value addition
Challenges (main)	Wild animals, water, land tenure	Water	Wild animals and water
Main coping strategies	Electric fences,agro-wells,night patrolling	Agro wells and rainwater collecting ponds	Night patrolling

Table 3.5 Available underutilized crops in three farms in the study areas

Name of underutilized crop			Availability in three agricultural farms in Uva and Eastern provinces				
English Name	Local Name	Scientific Name	Home Gardens	*Chena*	Off-season paddy lands	Percentage of households having the crop	
						Uva province	Eastern province
Alocasia	Kiriala	*Alocasia alba* Schott	U/E			27	15
Ash plantain	Alu kesel	*Musa paradisiaca* L.	U/E		E	17	16
Avocado	Alligator Pera	*Persea americana* Mill.	U			30	N/A
Bitter melon	Batu karavila	*Momordica charantia* L.var. charantia C.B. Clarke	U	U		33	N/A
Black gram	Udu	*Vigna radiata* (L.) R. Wilczek	U			11	N/A
Cashew	Gaskaju	*Anacardium occidentale* L.	U/E	U		35	13
Cassava	Mayyokka	*Manihot esculenta* Cratz	U/E			37	45
Chilies	Henmiris	*Capsicum annuum* L.		U/E		28	19
Bullock's Heart.	Weli Anoda	*Annona reticulata* A.K.A.	U			21	N/A
Devil's snare	Danthuraala	*Datura stramonium* L.	U			12	N/A
Eggplant	Wambotu	*Solanum macrocarpon* L.	E			N/A	17
Elephant foot yam	Rajala/Kidaran	*Amorphophallus campanulatus* (Roxb.) BL. exDence	U			14	N/A
Finger millet	Kurakkan	*Eleusine coracana* (L.) Gaertn.		U/E		71	48
Foxtail millet	Thanahal	*Setaria italica* (L.) P. Beauvois	U	E		11	12
Gingelly	Thala	*Sesamum indicum* L.	E	U		19	18
Groundnut	Ratakaju	*Arachis hypogaea* L.		U	U	34	N/A
Guava	Pera	*Psidium guajava* L.	U/E			29	11
Horse gram	Kollu	*Macrotyloma uniflorum* (Lam.) Verdc.		U		9	N/A
Jackfruit	Kos	*Artocarpus heterophyllus* Lam.	U/E			17	22
Kaupea	Cowpea	*Vigna unguiculata* L. Walp.	U/E	U/E	U/E	33	66
Lesser yam	Kukulala	*Dioscorea esculenta* (Lour.) Burkill	U			15	N/A
Maize	Badairingu (Local)	*Zea mays* L.		U/E	U	8	10
Moringa	Murunga	*Moringa oleifera* Lam.	U	U		27	N/A
Mung bean/green gram	Mungeta	*Vigna radiata* (L.) R.Wilczek		U/E	U/E	11	15
Musk melon	Kekiri/Gon kekiri	*Cucumis melo* L.		U		32	N/A
Okra	Bandakka	*Abelmoschus esculentus* (L.) Moench		E		N/A	21
Pomegranate	Delum	*Punica granatum* L.	U/E			35	9
Proso millet	Meneri	*Panicum miliaceum* L.		U/E		43	9
Pumpkin	Henwattakka	*Cucurbita maxima* L.	E	U/E	U/E	16	33
Ridged gourd	Henwatakolu	*Luffa acutangula* L. Roxb.		U		15	N/A
Spine gourd	Thumba Karavila	*Momordica dioica* Roxb. Ex Willd.	U	U		55	N/A
Stone apple	Beli	*Aegle marmelos* (L.) Correa				23	N/A
Sweet melon	Panikomadu (*Pathtakka*)	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	U	U/E	U/E	33	39
Sweet potato	Batala	*Ipomoea batatas* (L.) Lam.	E			N/A	20
Tomato	Takkali	*Lycopersicon esculentum* Mill.	E			N/A	11
Winged bean	Dambala	*Psophocarpus tetragonolobus* (L.) DC.	E			N/A	22
Wood apple	Divul	*Feronia limonia* (L.) Swingle	U			25	N/A

Note: U–Availability of underutilized crops in three studied farms in Uva province.
E–Availability of underutilized crops in three studied farms in Eastern province. N/A–Species was not available on the site.

3.3.2.Contribution of underutilized crops to household income

In the study region, agriculture was the main source of farmers' household income. Three types of studied farms (N = 88) combined contributed to 65% of mean household income in both provinces (Table 3.6). *Chena* contributed a large portion of farming income (64% in Uva and 40% in Eastern province, respectively). The correlation test also confirmed that income from *chena* was highly correlated to farm income (r = 0.97). Income from *chena* was significantly different between the two provinces. In Uva province, farmers were growing more underutilized crops (76% of *chena* land), which had better market prices and so their income was higher. The contribution of underutilized crops to mean household income in Uva and Eastern province was 31% and 16%, respectively, and it was significantly different. During group discussions, farmers in both Uva and Eastern provinces commented that underutilized crops contributed about 61–43% of food supply for their household consumption, respectively.

Table 3.6 Farmers' mean annual household income (USD) and the contribution of underutilized crops in two studied provinces in southeastern Sri Lanka (2017).

Income Source (Mean income/yr)	**Uva Province n= 52**	**East.Province n= 36**	**Remarks**
Household	2,924.90 ± 102.46	2,448.13 ± 46.43	Df = 1, F = 0.0073, P>0.9
Three types of farms	1,965.94 ± 288.42	1,536.17 ± 233.07	
Chena	1,250.03 ± 238.43	619.56 ± 203.09	Df = 1, F = 3.72, P<0.05
Home Garden	301.24 ± 55.32	404.78 ± 54.81	
Off-season paddy land	414.67 ± 32.86	511.87 ± 23.95	Df = 1. F = 6.55 P<0.02
Underutilized crops	915.47 ± 102.46	391.82 ± 46.43	Df = 1, F = 5.59, P<0.02
Underutilized crop contribution	31%	16%	

Note: n=Sample size; Statistical Test-One-sided anova figures followed by ± indicate standard error of means.

3.3.3. Key actors' understanding and preference of high potential underutilized crops

When asked about their understanding of characteristics of underutilized crops, key actors (N = 36) reported at least 15 different characteristics by which they defined these crops (data not shown here). Among actors, there was no remarkable difference in characterizing underutilized crops. The highest number of actors (64%) recognized underutilized crops for better nutritional values. Another 61% stated health-related values that could prevent non-communicable diseases. Fifty percent mentioned multiple characteristics of underutilized crops, such as these crops were being marginalized due to the introduction and promotion of high yielding hybrid crops, less familiarity among the young population, lack of knowledge about the values of these crops, poor demand in the markets, less input required, and adaptability to changing climate. For others, the underutilized crops generated less profit, were homegrown for self-consumption, pest and disease resistant, scarcity of planting materials, and decreasing youth interest.

In order to identify potential underutilized crops for enhancing the socio-economic development of farmers in the study region, key actors ascertained 13 criteria or prerequisites (Table3.7). They commented that the presence of these criteria would encourage sustainable cultivation of underutilized crops, and thereby improve farmers' livelihoods. They said that if a large portion of farmers cultivates these crops, have reasonable market demand, and have the chance to increase farmers' income, then underutilized crops could be promoted for better socio-economic development. They also asserted that for encouraging farmers to continue the cultivation of these crops, the inclusion of the private sector, the interest of agricultural officials, the scope for value addition, availability of low-cost inputs, and favourable government regulations and policies are necessary.

Table 3.7 Criteria of underutilized crops ascertained by the actors to determine the potential priority crops for the socio-economic development of farmers and their explanations.

No.	Criteria	Explanation
01	The crop is cultivated by a large number of farmers.	There should be a significant number of farmers engaged in the crop in all study areas at reasonable level.
02	The crop needs to have an existing reasonable marketing network	The crop products should have existing marketing links beyond the village level
03	Potential to increase the income of smallholder farmers	The crop is cultivated by a significant majority of farmers who were interested in underutilized crops
04	Presence of willing private sector	Availability of any existing or potentials with private sector and they engage in value-added products
05	The interest of government agricultural officers	Increased interest by state agricultural officers to promote the selected crops and some provisions for the development
06	Local resource (raw materials, support services), availability	Land, raw material, skills, heritage, expertise, experience
07	Favourable market demand	Unmet demand, high growth potential, potentials in local/regional/national/export market
08	Scope for value addition	Scope for creating new products, reduce the cost of production, improve an existing product, improve efficiency
09	Input requirement level	Ability to cultivate the crops with minimum inputs including the potential of the crop to cultivate under organic farming
10	Outreach/scalability	Number of people that can be engaged (both current farmers and the wider population in the region)
11	Sensitivity to low-cost interventions	To what extent the value chain of the proposed crop can be enhanced by interventions to help poor farmers
12	Favorable regulations and policies	Government's policy to stimulate market; environmental sensitivity; cultural sensitivity
13	Adaptability to the climatic changes	The potential of the crop to survive under extreme climatic conditions such as heavy rains and droughts

By considering the above criteria, key actors identified 25 potential marketable underutilized crops currently available in the markets of the study region (Table 3.8). Fifty-seven percent preferred finger millet as the most important underutilized crop for the whole study region. This crop was also highly scored by actors in the Moneragala district as a potential underutilized crop. They commented that finger millet had enormous demand in local and regional markets, had a scope of value addition using simple technology, private sectors' interest in value-added products, greater level of government support, and capacity to withstand drought conditions. Cowpea, green gram

(*Vigna radiata* L. R.Wilczek), and cashew were highly preferred in the Ampara, Trincomalee, and Badulla district, respectively. In Ampara district, a large number of farmers were cultivating cowpea with reasonable support from agricultural officers, and with minimum input, and had market demand in the state. Cashew could grow in drought conditions and apparently needed no input, had greater demand from private sectors, and a large number of farmers were cultivating this underutilized crop.

Table 3.8 Key actors' scoring of potential underutilized crops for the socio-economic development of farmers in southeastern Sri Lanka.

No.	Name of the crop	Key actors' scores on underutilized crops based on 13 criteria in the following districts				Mean Score	Preference of key actors for the individual crop in the study region (%)
		Moneragala district	Badulla district	Ampara district	Trincomalee district		
1	Banana (Local)	-	142	-	-	47.33	6
2	Black gram	143	-	78	-	36.83	8
3	Brinjal	-	-	-	35	35.50	3
4	Cashew nut	-	395	-	-	56.43	12
5	Chili (local)	-	123	-	37	40.00	6
6	Cowpea	38	49	395	173	46.00	22
7	Cucumber	-	-	-	175	44.50	8
8	Elephant yam	42	-	-	-	43.67	6
9	Finger millet	312	391	321	217	48.10	57
10	Ginger	_	45	51	-	48.00	3
11	Gingerly	265	-	161	-	42.69	19
12	Green gram	38	-	167	371	44.07	22
13	Groundnut	185	39	141	166	48.92	19
14	Long bean	-	167	-	-	41.88	6
15	Maize	-	301	-	123	47.27	17
16	Mango	-	188	-	-	47.00	6
17	Manihot	42	-	127	208	41.80	17
18	Moringa	-	136	-	39	43.75	6
19	Paddy/Traditional (H4)	-	103	36	-	46.50	6
20	Proso millet	82	-	-	-	41.00	3
21	Soya bean	41	-	-	-	41.00	3
22	Tamarind	_	-	109	-	54.50	3
23	Tomato	-	39	-	35	37.00	3
24	Turkey berries	-	-	120	125	40.83	8
25	Wild bitter gourd	104	48	237	195	38.93	22

3.4. Discussion

3.4.1.Land resources, types of farms, diversity of underutilized crops, and contribution to household economy

Farmers in the study sites have been growing underutilized crops for a long time. They allocate a substantial quantity of agricultural land, especially *chena* land, for growing them. It was revealed that due to the shortage of land, farmers practiced *chena* on government forest land. The study identified 37 underutilized crops, even though many other mainstream crops were also being cultivated. In each farm type, the composition of underutilized crops was similar. Farmers commented that their preference for underutilized crops was mainly for subsistence even though they sold surplus production in markets. Although the exact number of underutilized crops in Sri Lanka is unknown, Rangani et al. (2015) reported 60 high potential underutilized crops in the country.

Farmers in group discussions reported that along with ignorance of the value of underutilized crops, the critical factor responsible for declining underutilized crops was water scarcity. They commented that the water scarcity situation was critical in Uva province. Researchers (e.g., Karunaratne and Pathmarajah 2002; Pathmarajah 2014; Perera and Chandima 2011) reported that dry zones of Sri Lanka receive only seasonal and irregular rainfall (November–January), and so farmers experience water shortage for agriculture. Farmers in the Eastern province had relatively advanced minor and major irrigation facilities connected with water-tanks. However, these irrigation systems ensured supplementary water supply only in the paddy farming season, and so off-season paddy fields face water scarcity. Nonetheless, farmers in Uva province reported that they had agro-wells and some rainwater collecting ponds collectively managed by them to mitigate water scarcity, particularly in *chena* land. They adopted minimum or zero tillage in *chena*, and grew drought-tolerant underutilized crops like finger millet, proso millet (*Panicum miliaceum* L.), pomegranate, cashew, etc. Similar collective management of irrigation facilities in Sri Lanka was also reported in a newspaper report which claimed that collective actions of 70 families in a large single *chena* plot could solve water scarcity through digging cultivation wells and connecting village lakes through a small canal (Krishan 2018). These collective efforts helped farmers to grow a variety of crops in their *chena*. Researchers (Pretty 2018; Pretty et al. 2018) commented that collective actions can reduce the costs of working together and facilitate cooperation and support for innovating farming techniques.

Farmers claimed that many underutilized crops in *chena* and home gardens grow reasonably well in dry conditions. This was evident from the composition of underutilized crops (Table 3.5) where farmers in both provinces grew most of their underutilized crops in *chena* and home gardens. Farmers in Uva province, where water scarcity was comparatively worse, allocated significantly more land (0.91 ha) for *chena* than that of the Eastern province (Table 3.3) because underutilized crops in *chena* could grow under water shortage conditions. These crops have a wide genetic base in the form of local cultivars grown in different parts of the dry and arid zones, and they are comparatively drought-resistant and of short duration (FAO 1999). Mabhaudhi et al. (2017, 2019) and Tadele (2018) reported that many underutilized crops (e.g., cowpea, cassava) in African regions are drought tolerant which makes them an important resource for addressing key challenges of improving food and nutrition security under water scarcity and in a changing climate.

Findings revealed that home gardens and *chena* where farmers practice mixed cropping systems were abundant in underutilized crops. In *chena*, underutilized crops consisted of annual and bi-annual crops dominated by cereals and pulses. However, unsecured land tenure was an issue of sustainability of *chena* and hence the continuation of underutilized crops cultivation. A similar situation has been reported elsewhere (Nath et al. 2016). Population pressure and legal restrictions had caused people either to abandon *chena* or to grow perennials on *chena* land, which has significantly diminished the area with underutilized crops (FAO 1999; Wickramasinghe 2013). In the home gardens, underutilized crops were mostly perennial fruit trees, and farmers cultivated few legumes in between. Home gardens in Sri Lanka connect natural ecological functions with the socio-economic well-being of farmers and are considered as sustainable complex farming systems having annual and perennial crops, livestock, and fruit trees (Krishmal and Weerahewa 2014; Mattsson et al. 2018; Pushpakumara et al. 2012).

Underutilized crops in the study areas contributed to farmers' household food demand and to household income (Table 3.6). Farmers commented that they consumed a major portion of their underutilized crops (61–43%) that provide for the nutritional requirements of household members. They said that a variety of underutilized crops produced in *chena* and home gardens supplied various food items around the year. Land allocation, income, and contribution to food security from underutilized crops were higher in Uva province than in the Eastern province. This indicates that underutilized crops can support farmers through additional income, food security, and nutritional

values. Malkanthi (2017) reported that the underutilized crops in Sri Lanka have the potential to contribute to food security, health, income generation, and environmental services. Mabhaudhi et al. (2019), drawing information from African countries, reported that despite constituting a small share of global food systems, underutilized crops have the potential to contribute toward socio-economic development of low-input–low-output farming systems. However, they could not quantify the contribution of such orphan crops to socio-economic development

3.4.2.Key actors' knowledge of underutilized crops and preferences

Key actors' understanding and knowledge of underutilized crops are comparable to what has been cited by researchers (Baldermann et al. 2016; Chivenge et al. 2015; Malkanthi et al. 2014). They characterized underutilized crops as having high nutritional and health values, providing food for poor farmers, adaptability to the harsh environment, but poor demand in modern urban societies. Researchers (e.g., Chivenge et al. 2015; Konuma 2018; Leal et al. 2018) also reported similar characteristics of underutilized crops from different regions of the world. Key actors identified 25 underutilized crops that were available in the market chains and they prioritized a few of them following 13 criteria (Table 6). Among these 25 crops, 10 were also observed in visited farms. This revealed that only 10 underutilized crops out of 37 found in the visited farms were available in the markets, and other crops were being consumed by farmers. Based on the highest aggregated scores, key actors identified four underutilized crops, namely finger millet, cowpea, green gram, and cashew, as the most important crops for the socio-economic development of farmers in four districts of south-eastern Sri Lanka. These crops were also being cultivated by farmers mostly in their *chena* and home gardens. Mabhaudhi et al. (2017) suggested that prioritization of potential underutilized crops is important for future research and development.

3.5. Conclusions

The available agricultural farms in the study region support a number of underutilized crops. Farmers grew these crops in the past for food and income. They had a sound understanding of cultivation techniques and knowledge of the features of underutilized crops. The key actors involved in market chains had comprehensive knowledge of socio-economic and biophysical attributes of underutilized crops through which they could prioritize available tradable crops in the study region. Farmers experienced several

challenges such as poor market demand and water scarcity. As underutilized crops have many health benefits and ensure sustainable food supply to farmers, it is important to promote their cultivation. It is highlighted the importance of identification of drought-tolerant crops and value addition of potential priority crops. A comprehensive value chain study of potential underutilized crops may help to sort out constraints and opportunities for better socio-economic development of the farmers. An integrated approach is needed wherein researchers, agricultural extension staff, farmers, business people, and policymakers can join together to formulate the necessary policy guidelines in light of research findings for the awareness creation and promotion of the importance of underutilized crops. If this happens, it can be anticipated that the declining agro-biodiversity will be reversed and farmers will benefit.

Currently, the Sri Lankan government has been implementing a Biodiversity for Food and Nutrition (BFN) project addressing the conservation, utilization, and marketing strategies of under-exploited, fast disappearing, highly nutritious underutilized local crops for food security and health (BFN, 2019). Along with the BFN project, the Ministry of Agriculture has another national promotional program on home gardening aiming at developing 0.5 million home gardens to augment overall food production in Sri Lanka (Ministry of Agriculture 2016). In the studied regions where farmers grew underutilized crops for food security and nutrition, there were no promotional programs. Therefore, the BFN project and home gardening activities could be extended there. In addition to home gardens, the project activities can also be expanded in *chena* lands because underutilized crops, which can grow with little or no irrigation, were common in *chena*. The current National Agriculture Policy of Sri Lanka also emphasized promoting maximum use of *chena* lands to ensure higher productivity of land (Ministry of Agriculture 2019). Having these initiatives, it can be recommended that the BFN and other national promotional program need to include key actors' prioritized underutilized crops in climatically similar areas of Sri Lanka, and support cultivation wells managed collectively by farmers in water scarcity areas, particularly in *chena* lands.

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Chapter Four

Operation of primary and supporting components of high potential underutilized crops

4.1. Introduction

The structural transformation of agriculture from subsistence to commercialized models contributes to rising farm income and reduction of poverty in general. However, farmers in developing countries still receive poor income for agricultural products even market prices are high at the consumer level. The main reason for this issue is the poor integration of farmers into the existing market systems. (International Fund for Agricultural Development 2011; Stein and Barron 2017; Shin et al. 2015; Timmer 2005). Improved levels of market participation keep smallholder farmers in the agricultural sector on sustainable grounds and encourage them to experiment with product commercialization and understand comparative advantages. This is well-accepted among researchers but has not been adequately discussed among research communities. (ADB 2013; Wickramasinghe and Weinberger 2013; Wickramasinghe et al. 2014). However, the potential benefits of such a market-driven approach are proved both conceptually and empirically. The value chain studies explore the insight of the market and help to identify improvement potentials of the existing markets. Findings of the value chain studies are now used at a greater level to design market-oriented rural development strategies (Maestre et al 2017; Wickramasinghe and Weinberger 2013; Nangole et al. 2011).

The quality standards of agricultural products and safety factors connected with value-chain structures may be a significant challenge in the process of upgrading smallholder farmers (Henson and Humphrey 2009; Henson and Reardon 2005). However, there is an argument that the introduction of agricultural product standards hinders the progress of smallholders in developing countries (Graffham and Karehu 2006; Maertens et al. 2009). However, value chain structures and food standards needed the conditions for smallholders by giving them options for multiple improvements (Lee et al. 2010; Memedovic and Shepherd 2009; Rearden et al. 2009). One of the most highlighted market changes in the current context is the development of integrated food supply chains where a greater level of coordination and connection among different value chain actors as well as other stakeholders. This kind of coordination culture is encouraged by changing food consumption patterns with an increased level of quality consciousness among food

consumers. However, it is still questionable whether smallholder farmers are in the right position to acquire those benefits due to a number of operational barriers in their environment in reference to production and marketing (Birthal et al. 2007; Dries et al. 2004; Maertens and Swinnen 2006; Minten et al. 2007; Kumar et al. 2011).

The analysis of agricultural value chains helps to identify barriers on actors to join the marketing chains as well as causes behind the poor performances in the market system. However, the value chain analysis tools differ from study to study. Some tools are considered as general tools such as prioritizing value chains for analysis, mapping of the selected value chains and governance, coordination, regulation, and control. The main qualitative tools include linkage, relationship, and trust, analyzing options for demand-driven upgrading, knowledge, technology, and support services. The quantitative tools cover-up mainly analyzing cost and margins, analyzing income distribution, and analyzing employment distribution (Stefano 2007; Vroegindewey and Hodbod 2018). Even though having several value chain analysis tools the best suit and most appropriate tools have to be adopted to the respective studies based on the scope and objectives of the study (Nangole et al. 2011; Stefano 2007). However, as stated by Hellin and Meijer 2006; Kaplinsky and Morris 2003; Zott et al. 2011 and Zamora 2016, there are no clear guidelines on the way value chain analysis needs to be executed but better to consist of both qualitative and quantitate approaches. They recommended observations, semi-structured interviews, focus group discussions, and questionnaire-based surveys to recognize interaction among different actors.

In Sri Lanka, very few numbers of value chain studies have been reported related to the agricultural crop. Weerasooriya and Silva (2014) examined the value chain of ginger in the central province in Sri Lanka. The researchers narrowed down to a small geographic area and simply calculate market margin and profit distribution among value chain actors. The study done by Siriwardane and Silva (2017) on the organic rice value chain in Sri Lanka focused on identifying relationships among respective value chain actors and strengthening potentials. The studies completed by Barry (2012) on Beli and wood apple sub-sectors as well as Rambuton sub-sector covered mapping those value chains in view of identifying constraints in the market system to improve businesses. The study done by Hatharusinghe and Vidanapathirana (2012) made a deep analysis of the Pineapple and Banana market system by emphasizing service delivery and policy environments where the value chain operates in addition to the key value chain. However, none of the above

studies were conducted in South-eastern Sri Lanka where a significant majority of underutilized crop farming systems and smallholder farmers are settled. Thus almost all studies done in Sri Lanka had a narrow focus instead of studying both the production and marketing aspects of the respective crop. In order to bridge the gaps, this chapter was aimed at identifying the production dynamics of selected high potential underutilized crops and market architecture. The chapter identified paid as well as unpaid cost elements of production and revenue to see the gross and net income features of the farming. The market actors involved in the value chain were identified and develop the market map to understand different marketing channels. The findings of this chapter would provide baseline information on both the economics of production and insight into the market operation. The findings are very important for further research as well as agricultural departments in view of formulation policies on sustainable production as well as the marketing of selected crops.

4.2. Material and methods

4.2.1 Selection of high potential underutilized crops

The key actors' survey (N=36) identified 25 potential underutilized crops and further recognized high potential underutilized crops for each region by using scoring techniques against 13 different criteria as mentioned in chapter three. The crops that scored the highest marks in the four districts were selected as the best crops for the socio-economic development of farmers and other actors. Finger millet and Cashew scored the highest marks by representing Moneragala and Badulla districts in Uva province while Red cowpea scored the highest marks in Ampara district in Eastern Province.

4.2.1.1 Cowpea [Vigna unguiculata(L.) Walp.]

The origin of Cowpea [Vigna unguiculata(L.) Walp.] is not known. However, it is believed that the crop originated in the West and South African regions and distributed to India, Asia, and Central America. Nigeria is the largest Cowpea producer in the world which contributes 45 percent of world production (Langyintuo et al. 2003; Ngalamu et al. 2015; Singh 2005; Timko et al. 2007). The crop has a high potential to restore the soil fertility through nitrogen fixation as well as drought-tolerant capacity. These two qualities are important to address food and income security issues in marginalized rural communities and adopt mixed cropping systems (Craufurd et al. 1997; Etana et al. 2013; Mayz 2017; Pushpakumara et al. 2016). However, the new trend of Cowpea is to cultivate

in mono-cropping. (David 2017; Hunter et al. 2019). Cowpea is called a "hungry season crop" because it is harvested before the other cereals. The crop shows a greater level of flexibility to the farmers. If farmers apply more inputs to the crop yields more beans for consumption and generation of income. On the other hand, if farmers use less input to the crop leads to produce more foliage reversely uses as animal feed. (Augustine et al. 2006; Etana et al. 2013; Tarawali et al.2002; Timko and Singh 2008). The nutritional profile of Cowpea shows that low-fat contents, rich mineral, and vitamin contents while two to four times higher protein content than cereals and tuber crops (Akintayo 2005; Hall et al. 2003; Nabirye et al. 2003). However, pest attacks on stored cowpea are a considerable problem which pushes the producers to sell their products quickly at low prices and traders compel to buy large quantities. (David 2017).

Cowpea is available in rain-fed dry zone farming systems in Sri Lanka. The improved Cowpea varieties produce 1.6-1.8 metric tons per hectare under research conditions though the average field-level yield remains at 1.18 metric tons per hectare (Department of Agriculture 2010). Lack of quality seeds and high-yielding varieties, uncertain rainfall, pest and disease attacks, and resistance of farmers to new varieties are key issues leading to poor yield at field conditions (Hewavitharane et al. 2010; Jayamanne 1989).

4.2.1.2 Finger millet (Eleusine coracana(L.) Gaertn.)

Finger millet (Eleusine coracana(L.) Gaertn.) is considered an underutilized cereal crop having African and Indian origin. It is one of the oldest indigenous domesticated tropical cereal in the world. (Bisht and Mukai 2002; Dasanayaka 2016; Hillu and Johnson 1992; Watt and Breyer-Brandwijk 1962). Finger millet is hardly lost and generally neglected both scientifically and internationally. However, it is one of a few underutilized crop species are being contributed to feeding millions of people, especially in Asian and African regions. The global land extent under the crop is over four million hectares (Belton and Taylor 2004; Mal et al. 2010).

This crop can grow under the most vulnerable environmental and soil conditions. High pest resistance capacity and long storage ability of seeds ensure year-round food supply for farming families. So this crop ensures food supply in difficult seasons where other crops fail and so-called as “famine crop” (Crops et al. 1996; Gull et al. 2014; Gana et al. 2013; Mgonja et al. 2007). The crop showed a significant yield gap under experimental and field conditions mainly due to poor irrigation and fertilizer applications. The recent

improvement of global production finger millet is contributed by expanding the land extent of cultivation which ended up with environmental and sustainability issues (Belton and Taylor 2004; Haile and Hofsvang 2001; National Research Council 1996; Nyende et al. 2001).

The long-term storage capacity and higher nutritional value with high protein, vitamins, minerals, fibre, and energy of finger millet attract the world attention to feed the millions of people who depend on starchy foods like cassava. As well as high fibre content of the finger millet seeds promotes a slow digestion process and blood sugar stability (Devi et al. 2014; Gull et al. 2014; Subbarao and Muralikrisna 2001; Shashi et al. 2007; Tripathi and Platel 2010). It has been cultivating in Sri Lanka since ancient history and is considered a second staple food second to rice. However, the crop has been at a neglected level compared to other cereals due to poor social esteem in the past though having a growing trend in the current context.

4.2.1.3 Cashew [Anacardium oxidentale(L.) Walp.]

The cashew tree is a tropical evergreen tree. The cashew tree is a native crop of Brazil and was introduced to Asia and Africa first and then further spread to other parts of the world. The crop was initially used as a means of controlling coastal erosion (Azam-Ali and Judge 2000; International Finance Corporation 2010; Weber and History 1999). Cashew can be cultivated under minimum attention but needs good soil and adequate moisture for maximum productivity. The extensive root system of the tree tolerates a wide range of soil types and moisture ranges. The tree starts bearing fruits from the third or fourth year by reaching mature yield in the seventh year under favourable conditions. A mature tree yields 7-11 kilograms per annum. The tree has 50-60 years of life span but a productive maximum of up to 20 years (Azam-Ali and Judge 2001).

At present, there are around thirty-two cashew producing countries in the world covering Asia, Africa, and South-America where smallholder farmers are dominant. It is a major contributor to the National income (NI) especially in the African region and a major source of livelihood of smallholder farmers. India and Brazil are major cashew exporters in the world contribute 60 percent and 31 percent of the market share respectively. The United States is the major importer of cashew by consuming 55 percent of world cashew production. The cashew market in the United States is well established with a price of US$ 9 to 23 per kilogram. Cashew contains a high nutritional value. Fat is the highest

component (47 percent) followed by carbohydrates (22 percent) and 21 percent protein. (Mathew and Shobana 2013; Shalini 2010).

The existing extent of cashew cultivation in Sri Lanka including private plantation is approximately 25500 hectares. Cashew farming spread in 125 Divisional Secretarial divisions of 16 Administrative Districts in the country (Cashew Corporation Sri Lanka, 2010). Sri Lanka produces raw Cashew nuts (approximately 6,000 metric tonnes per year) where 90 percent have been consumed in the local market The current cashew yield productivity in Sri Lanka remains at 350 kg/ha/year level which has been half of the potential productivity (Spices and Products 2014).

4.2.2. Selection of divisional secretariat divisions (DS divisions) and Grama niladari divisions (GN Divisions)

4.2.2.1. Selection of suitable DS and GN divisions for the value chain study of selected high potential underutilized crops and identification of sample units

After identification of high potential underutilized crop based on the highest score under five scale Rickets method for each district (Table 8), I reviewed the resource profiles of districts followed by resource profiles and statistical abstracts of earlier selected DS divisions and other available secondary information especial reference to the production quantities of selected high potential underutilized crops to triangulate initial potential selections with available secondary sources. Both primary information and secondary data values were brought and discussed with Agricultural Instructors and Regional Agricultural Directors to recognize the most suitable DS division to conduct the data collection refers to the value chain component of the study. The most recent past field experience of the researcher refers to the data collection of the first and second objectives of the study and personal discussions with farmer leaders who identified during the first phase of the data collection also gave a good practical understanding on the ground situation where that high potential underutilized crop type is available up to the GN level within those DS divisions. After finalizing the DS division for the value-chain study, the same GN divisions of that researcher launched farmer household survey and value chain actor survey under phase one of data collection was given the priority. However, in-depth discussions were completed with ground-level agricultural officials (mainly such as Agricultural Instructors and Agricultural Research and Production Assistants) to understand their view on this and make if adjustments needed. After finalizing the GN divisions for the value chain study of the respective crop, discussed the survey plans with

the respective Agricultural Instructor of the area to identify the leading farmers who cultivate respective crops. In addition, information of lower stream value chain actors (primary and secondary collectors, local level processors, and village level retailers) was collected by mainly consulting leaders of different village societies, chief priests of temples, and local-level politicians. Information and contact details of the upper stream value chain actors (such as outside secondary collectors working with village-level agents, wholesellers, large scale processors, and outside retailers) were found by consulting local level business people, Agricultural Directors, Marketing officers of private companies, officers of the non-governmental organization working in the areas and some other identified well-wishers for my study.

4.2.2.2. Selection of sample for farmers' household survey, Focus Group Discussions, and Key Informant Interviews

Selection of sample villages, households, and data gathered

A mini farmer household survey, Key actor survey and Focus group discussions were conducted by covering selected GN divisions in each DS division in three selected districts for value chain study. The overview of the selected crop and geography of the sample selected for the value chain survey (Table 4.1). The total sample size of the crop-based mini farmer household survey covered 18 farmers from each district encompassing 54 farmers in the total sample (Table 4.2). The questions were structured type. The selection of farmers was done purposively based on the knowledge of farmer organization leaders and knowledge of the researcher based on previous survey experience. Researchers ensured selecting a more equal number of farmers from each representing GN division within selected DS division to maintain the rationality of the sample. This farmers' survey was mainly conducted to get a basic idea of resource allocation for the selected crop, special reference to lands and crop coverage in different farming systems. In addition, the survey attempted to get an overview of the economics of this crop in terms of input cost, production levels, different quantities selling under raw and basic processed forms. Finally, through the latter questions, the survey was encouraged to get a general overview of family and outside labour involvement in key practices of production and marketing while focusing on gender-based contribution and identifying an overview of different actors' involvement.

Table 4.1 Selected geographical locations for the detailed value chain study of high potential underutilized crops

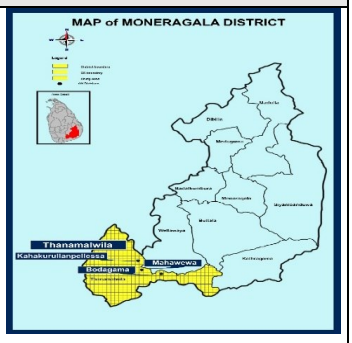
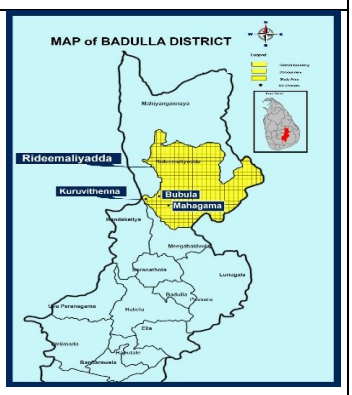
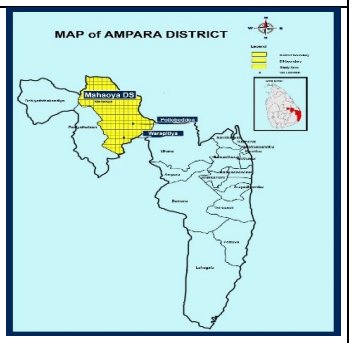
District	Selected Crop	DS and GN Divisions undertook	Geographical location
Monerag ala	Finger millet	Thanamalvila:Kahakurullanpelles sa,Mahawewa and Bodagama	
Badulla	Cashew	Rideemaliyedda:Kuruvithenna, Bubula, and Mahagama	
Ampara	Red Cowpea	Mahaoya: Pollebedda and Warapitiya	

Table 4. 2 Distribution of the survey sample for Value chain study of selected crops

District	Selected Crop	Producer Survey	Focus group discussion	Key Informant Interviews (Direct Value chain actors, actors in supporting services, and actors responsible for enabling an environment		
		Farmers	Dominated by farmers	Value chain actors	Supporting service actors	Enabling environment actors
Moneragala	Finger millet	18	2	6	1	1
Badulla	Cashew	18	2	6	1	1
Ampara	Red cowpea	18	2	6	1	1
Total Sample		**54**	**06**	**18**	**03**	**03**

Value chain actors: *farmers, collectors (Primary and/or secondary), primary processors, wholesalers, retailers;*
Supporting service actors: *input providers (seeds, fertilizer, and agrochemicals), extension officers*
Enabling environmental actor*s: Research firms, agricultural officers*

Key actor interviews targeting lead farmers, collectors, processors, whole-sellers, and retailers. The questionnaire was a semi-structured type that mainly collects different activity involvement of those actors, price, and quantity handled, their business partner channels, and changes or value additions by them to the raw products. However, the latter part of the questionnaires focussed more on the constraints and limitations of their involvements. The researcher attempted to explore the constraints and root causes behind those causes and get their opinion on suggestions to improve their business environment by adopting feasible coping strategies

4.2.2.3. Data and methods

The farmer household survey was conducted by visiting the purposively selected farmer households based on well-planned pre-appointments. The survey covered only farmers who have been cultivating the selected crop for the last consecutive five years based on the information of AIs and Farmer Society leaders. I adopted this approach since I need to interview farmers who have a thorough and established knowledge of this selected crop especially regarding production information as well as marketing. The survey took around forty-five-minute maximum and selected late morning time and continued up to late afternoon. During the survey period, farmers frequently visit their Chena land in the

early morning and late evening mainly to control damages by birds. More often, appointments of collectors, processors, wholesalers, and retailers were taken early morning, late evening, and sometimes night based on their choices. One key informant interview session took an average of one hour but sometimes it exceeded more than one and a half hours based on the situation. In most cases, wholesalers had to interview while they were engaging in the business activities which took a long time to finish the surveys. Few wholesalers, especially outside the village, rejected participating surveys since they were busy with their selling and buying activities. In most cases when I visited large-scale business people such as collectors and wholesalers I visited with the Assistant Agricultural Director or local political leader to motivate them to participate in the survey at a higher level of motivation.

Both quantitative, as well as qualitative information, was collected through a producer survey, key informant interviews, and focus group discussions. The quantitative data mainly collected through farmer household surveys, about land use, labour use, labour distribution patterns, yield levels, input cost, and income were entered into raw data tables develop using Microsoft Excel package. Basic descriptive statistical analysis was done to calculate mainly mean values of the respective raw data sets. The inferential statistical applications such as Analysis of variance (Single-factor ANOVA) and Chi-square tests were performed to check the significance of the means of the different data sets. The collected qualitative information was mainly reflected in crop cultivation cycles. The crop management cycles were developed in the way by reflecting key activities involved against several month periods as well as existing general climatic conditions. In addition, the qualitative information derived from key actor surveys and focus group discussions reflected by the development of the value chain structure of each crop by properly identifying key actors and their roles. The price information of different levels was also reflected in value chain structures to reflect changes in the prices along the different chains. The software package of SPSS and MS Excel was used to calculate the significance of differences.

4.3. Results

4.3.1.Land and labour utilization pattern of the selected high potential underutilized crops

Farmers cultivate red cowpea in both irrigated and rain-fed farms as well as all three farming systems. Cashew is prominent in home gardens by covering around half extent of home gardens. Finger millet is mainly available in Chena farming by covering more than 75% of land area and interestingly not available in other farming systems (Table 4.3).

Table 4. 3 Land resources and land-use patterns by high potential underutilized crops growing farmers in studied provinces

Farming system	Mean area of the farm (ha)	Mean land allocation (ha) for each high potential underutilized crops			Remarks
		Finger millet[a] (n=18)	Cashew nut[b] (n=18)	Red cowpea[c] (n=18)	
Irrigated farm	1.85	-	-	0.21 (33%)	
Rain-fed farm	5.22	0.58 (39%)	0.98 (41%)	0.45 (33%)	p=0.00056,F=8.7,Df=2
Home garden	2.43	-	0.60 (49%)	0.13 (23%)	
Chena	2.76	0.59 (78%)	0.31 (29%)	0.43 (46%)	p=0.0196,F=4.25,Df=2
Off-season paddy farm	1.23	-	-	0.25 (40%)	

Note: P-P value of the one-sided Anova Test
a-This crop information is for Thanamalvila DS division in Moneragala district
b-This crop information is for Rideemahaliyedda DS division in Badulla district
c-This crop information for Mahaoya DS division in Ampara district

The farming of high potential underutilized crops significantly depends on family labour compared to hired labour. The use of family labour remains above 90 percent overall in three crops where cashew farming almost depends on family labour. However, family labour utilization in harvesting practice in finger millet and red cowpea is around 15 percent and 50 percent respectively. Male labour contributes significantly in terms of gender (above 87 percent) in the overall farming of these crops. However, female labour contribution exceeds 50 percent in the case of harvesting practice.

4.3.2.Existing crop management cycles of high potential underutilized crops

Farmers cultivate Cowpea in two main seasons in January-April under the rain-fed (received from North-east monsoon) and July-October dry season. The majority of the farmers (approximately 95%) prefer the rainy season for their cultivation. Few of them (approximately 25%) cultivate in the dry season and limited their farming to the low-lying lands. Farmers receive around750-1000 kilogrammes per 1.6 acres in the rainy season but it drops up to 500-600 kilograms per 1.6 acres in the dry season.

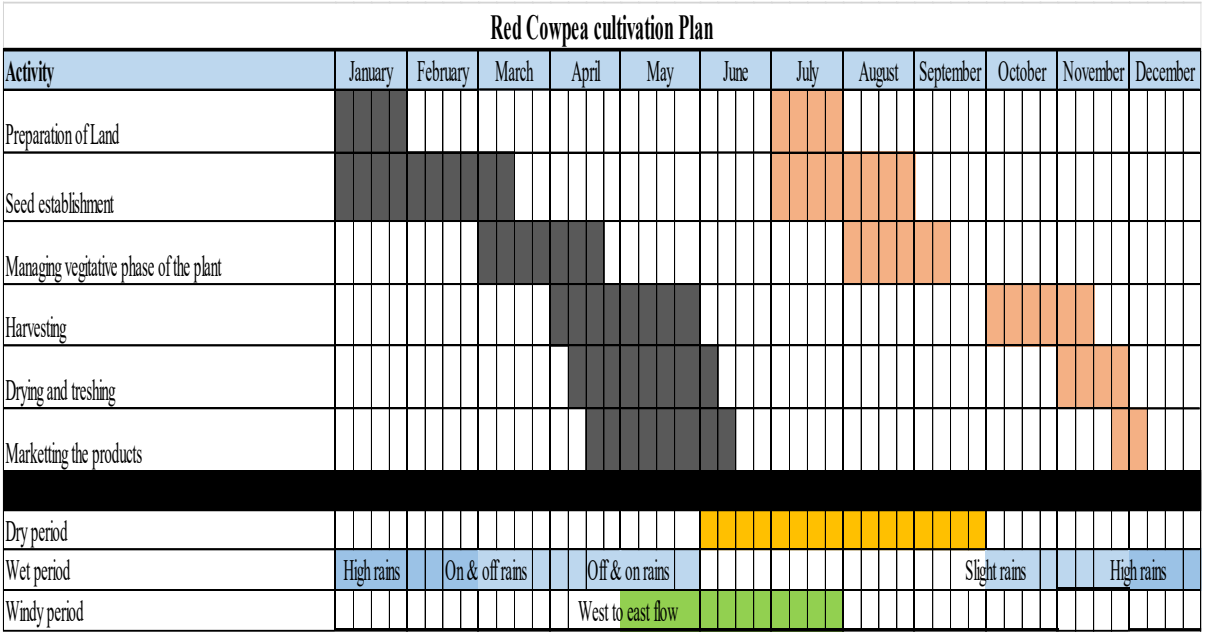


Figure 4. 1Current Red cowpea cultivation plan in Ampara district

The farming starts with cleaning the lands. Farmers use both tractor and cattle power to loosen the soil. After seed establishment, farmers do extensive field presence (especially morning and evening) for the first 14 days followed by the flowering period (2-3 months after seed establishment) to control peacock attacks to seedlings and flower buds. After harvesting they dry the pods for 3-4 days. Small-scale farmers put pods into a gunny bag and crush to separate seeds while large-scale farmers use threshing machines. Farmers sell their products as soon as to traders mainly to avoid the risk of pest attacks during storing time and address their financial pitfalls.

Finger millet predominantly available in Chena lands. Farmers recognize Finger millet as their “hungry manager” since it fills their food need when other foods are not available.

Small-holder farmers cultivate finger millet mainly in their Chena lands by mixing with mainly Gingerly or Thana. In general, farmers clean the lands in July-August dry period and establish seeds in September. However, some farmers start land preparation slightly later by using their tractors and establish seeds in October with the onset of slight rains. The growing period of finger millet falls from October to early January where croplands receive a substantial amount of rain. Farmers apply a few amounts of urea to increase the growth of finger millet and practice a few rounds of weeding or application of weedicides to control weed growth.

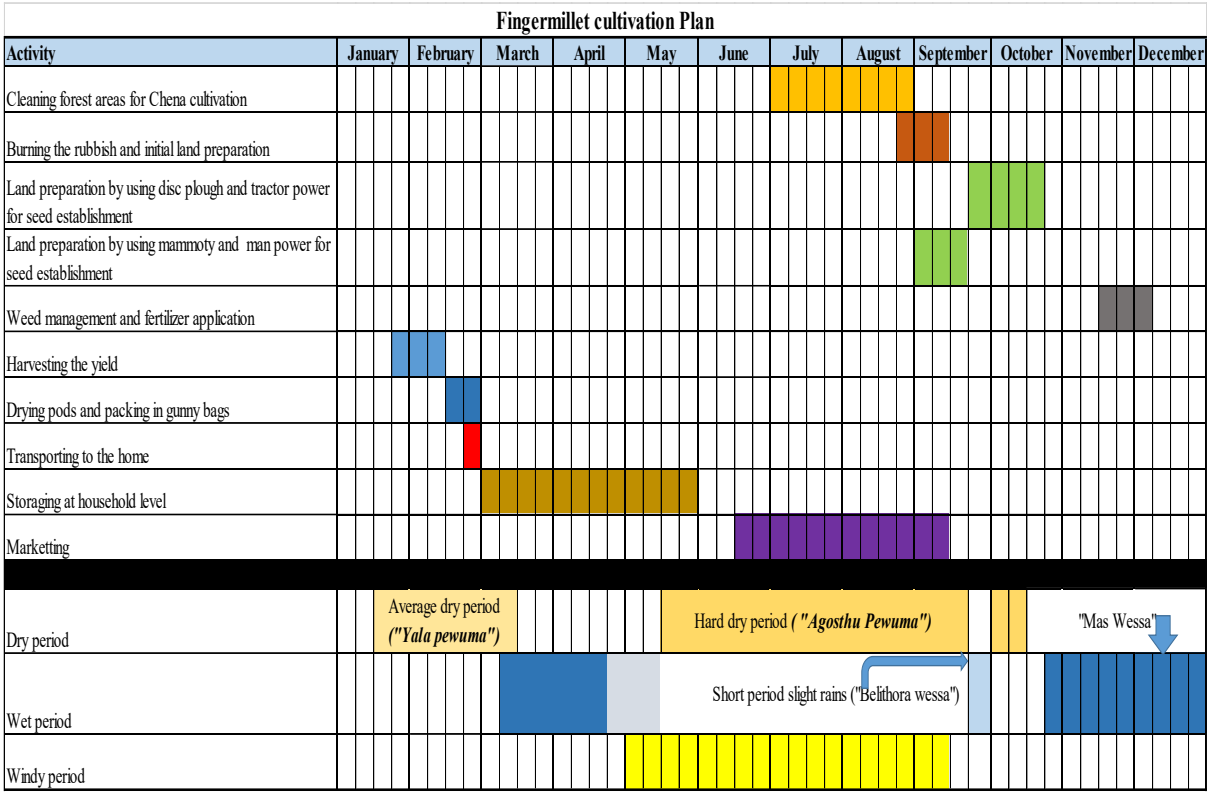


Figure 4. 2 Current Finger millet cultivation plan in Moneragala district

Farmers start harvesting finger millet in late January with the start of the dry period. They get an average of 2250 kilogrammes of finger millet seeds per acre which can go up to 4500-5000 kilograms under optimum conditions. They dry finger millet pods at their farm fields and transported them to their houses by filling in gunny bags before starting the next rain period in March. Finger millet has a long storage capacity without pest attacks and farmers use it to store 3-4 months and sell in July August when prices are high under normal conditions. In general, 1.5 kilograms of dried finger millet panicles yield one kilogram of finger millet seeds after threshing. Farmers produce a number of traditional

foods and sweets using finger millets. A typical farming household needs 300-400 kilograms of finger millet for their annual consumption.

Farmers use well-grown matured seeds from identified well-grown trees during the May-July period to produce new cashew plants. They fill suitable soil mixtures to polythene bags to establish seeds and keep them in shade place to grow for 40- to 50 days to produce plants for field establishment. They establish the plants in permanent fields in October. Cashew plants take 3-4 years to start flowing and delivering yield. Well-grown cashew trees start flowering in late March and April period and yield starts June onwards till August.

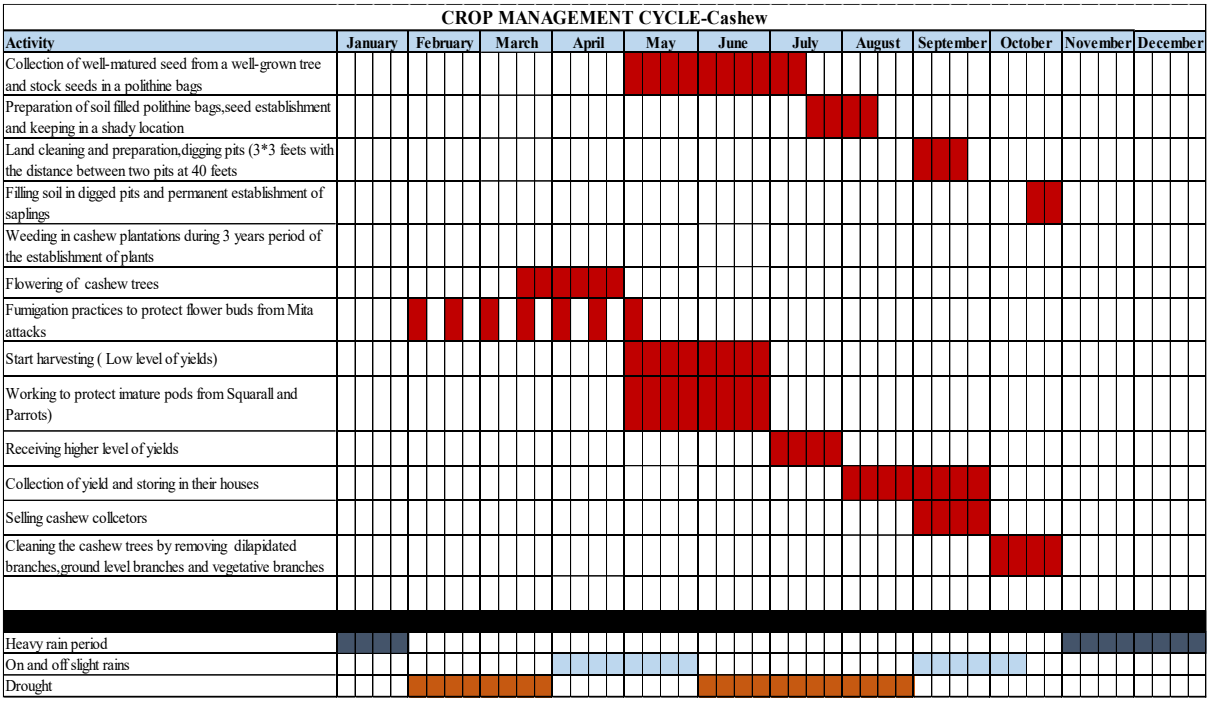


Figure 4. 3 Current crop management plan of Cashew in Badulla district

Farmers clean the land under the cashew trees during harvesting time and collect the fallen cashew nuts. The collected cashew nuts are dried by sunlight and store in gunny bags till selling those stocks. Farmers don't use the cashew apple and are just stuck in their cashew lands for decomposing to the soil.

4.3.3.Economic performances of high potential underutilized crops

The cost elements of finger millet, red cowpea, and cashew are reflected by a relatively low amount of input cost (for seeds, fertilizer, and agrochemicals) and significantly higher crop management costs mainly take-up by unpaid family labour. Both finger millet and red cowpea associate with a certain amount of cost for seed, fertilizer, and agrochemicals but farmers don't spend any cost for fertilizer and agrochemicals in Cashew farming. Both family labour and hired labour cost contribute to all three crops at all the stages of crop management and post-harvest management phases but at different levels. It is highlighted that low labour cost for Cashew farming compared to the other two crops. The value of family labour usage of three crops is very high but shows a significant difference among the three crops. However, the differences in the values of hired labour utilization by three crops are insignificant. The highest cost of farming and the highest income is recorded by finger millet followed by red cowpea and cashew. The cost of farming and income of farming among the three crops showed significantly different values. The important feature is that the net income values of both finger millet and red cowpea reflected minus values when considering the value of unpaid family labour in the cost calculation process.

Table 4.4 Cost & income of farming high potential underutilized crops in studied provinces

Variable	Finger millet	Cashew	Red cowpea	Remarks
Key Input Cost in Sri Lankan rupees (per hectare/per annum)				
Seed/Planting materials	2449	703	792	
Fertilizer	4661	0	3835	
Agro-chemicals	1441	0	2978	
Key labour cost categories in Sri Lankan rupees(per hectare/per annum)				
Family labour	287712	63139	222986	P=1.38E-38,F=752.9,Df=2
Hired labour	26982	6669	12775	P=0.08,F=2.59,Df=2
Distribution of labour cost among different agricultural practices in Sri Lankan rupees (per hectare/per annum)				
Crop management practices				
Land preparation	34257	34619	12762	
Crop management	249110	14919	200570	
Harvesting	16034	13135	12968	
Post-harvest practices				
Drying and basic processing	12089	5660	7444	
Storing	3204	1475	2017	
Cost & Income of farming in Sri Lankan rupees (per hectare/per annum)				
Cost of farming	323245	70511	243366	P=4.26E-40,F=866.7,Df=2
Income of farming	289539	135783	207342	P=3.52E-08,F=24.48,Df=2
Net income per hectare per annum (ignoring unpaid labour)	**254006**	**128411**	**186962**	P=1.08E-06,F=18.19,Df=2
Net income per hectare per annum(considering unpaid labour)	**-33706**	**65272**	**-36024**	P=0.00013,F=10.69,Df=2

Note: P=P value of the one-sided ANOVA test

4.4.4.Market environment of high potential underutilized crops

4.4.4.1 Input acquisition of high potential underutilized crops growing farmers

Red cowpea farmers use their own seeds to cover 75-80% of the seed requirements and the rest is purchased from suburb agricultural input sellers. The availability of seeds and quality of seeds is at a satisfactory level for farmers but prices (200 to 250 rupees per kilogram) are higher than their expectations. Farmers never use any kind of fertilizer on their cowpea farms in general. However, farmers know that their current yield levels can be increased by applying fertilizer. However, they discourage applying fertilizer due to

the higher prices of the chemical fertilizer, the low market price for cowpea in the last few years, and their belief in the nitrogen fixation capacity of the cowpea to the soil environment. Farmers use pesticides to control some pest attacks occasionally. They purchase pesticides from shops based on their recommendations and mostly apply based on the recommendations of the same shop owners. Farmers don't have any traditional methods to control pest attacks associated with cowpea farming.

Finger millet farmers use almost their own seeds for farming and apply a doubled amount of seeds to the field (two kilograms per one acre of land) to compensate for birds and ants damage at the field. They use four types of finger millet types (Mahagammora, Kiri, Idal, and Bala) and Mahagammora is considered as the original traditional type. An average value of one kilogram of seed is around 180 rupees in shops but farmers don't have the interest to buy those seeds mainly due to purity issues. Farmers buy urea fertilizer from non-branded franchise shops in their own village and apply it to accelerate the initial vegetative growth of their finger millet cultivations. Farmers have been facing challenges due to higher prices (2500-2700 rupees of 50-kilogram sack), and scarcity of urea fertilizer. Farmers buy fertilizer at ready cash and quickly apply it to the fields just after purchasing. They apply weedicide (M50) to control the weed growth after the application of fertilizer at the initial stage and use M60 to control worms in the panicle initiation period.

Cashew farmers use their own seeds for replanting or new planting of cashew lands by collecting seeds from well grown and well yielding few trees by taking as mother plants. They further selected well-filled and shiny seeds for planting purposes. They have enough seeds for planting purposes. Farmers never use fertilizer at all and confident in soil fertility and the natural nutrition management cycle of the soil environment of their cashew gardens. They never apply any kind of agro-chemicals to their cashew lands. They use fumigation by burning collected fallen cashew leaves underneath to control mite attacks during flowing periods.

4.4.4.2. Other supporting services for high potential underutilized crops

Farming of all three crops significantly depends on rainfall but farmers use their own agro wells to manage the dry spells to a certain level. Both finger millet and red cowpea farmers face difficulties to manage dry spells with the poor water yield of their agro wells. Farmers receive extension support mainly from Agrarian Service Centres (ASCs) but not

up to the expected level of farmers. In addition, cashew farmers are given support by the regional offices of Cashew Corporation. Farmers use part of their small houses mainly living rooms or one separate room inside the house to store cowpea for a short period till they sell their production. Finger millet and cashew farmers use a separate room for storage since they normally store for a longer period till market prices reach a reasonable level. Farmers don't use any advanced storage methods. Whole sellers use larger storage spaces to store their collections mainly locate behind their purchasing centres. They store different types of crops in the same place. They also face the capacity of storage problems during the harvesting period. Whole sellers face more challenges to store cowpea in harvesting time than the other two crops. Whole sellers use pesticides to control pest attacks during the storing period, especially for cowpea. There is no government or community-managed storage systems in study sites. Farmers' organizations are at a very poor stage and poor operation stage in study areas. Paddy farmers' association is considered as an only active institutional arrangement where most of the farmers are members. Paddy farmers' associations interfere with some critical issues of underutilized crops but are very limited. However, few finger millets farmers' associations are present at the grass-root level. The key role of such association is to share market prices among their peer farmers.

4.4.4.3. Key market actors and market channels of high potential underutilized crops

Around 75 percent of the total red cowpea production in the market is derived from Chena and the rest from home gardens and off-season paddy lands (Figure.4.4). Primary level collectors are not active in the market where farmers directly bring a major portion of their production (around 85%) to the wholesale shops in the close city at the rate of around 100 rupees per kilogram. The remaining amount is channeled to the market through outside traders and a few amount by roadside selling at the rate of 200 rupees per kilogram. The roadside selling directly moves to the hands of final consumers. The quantities purchased by traders move to capital Colombo wholesale shops located in the 4th cross street. These traders transport their stocks to traders in regional capitals (mainly Matara, Vavuniya, and Jaffna) and then to customers directly or via retail shops (Figure 4.4).

Farmers cultivate Finger millet only in Maha season by utilizing the rainwater. The total Finger millet production in the study area is around 600,000 kilograms with an average

yield of 1500 kilograms per acre. Farmers use around 30 percent of total production for their home consumption and to share with their relatives while remaining stocks are sold. Farmers channel more than half of their trading stocks (around 60%) through wholesale shops in close towns. Farmers use their own motorbikes, small lorries to transport their products to the towns. Those whole sellers transport their stocks to Colombo wholesale shops (located in the Manin market and Orormoor street market) and regional cities based wholesale shops (Tangalle, Matara, Weeraketiya, and Hambanthota) and then channel to final consumers. The rest of the stocks are channeled to final consumers by village level and outside collectors as well as via village level floor producers. Most of the outside collectors have their own grinding mills to produce finger millet flour (Figure 4.4).

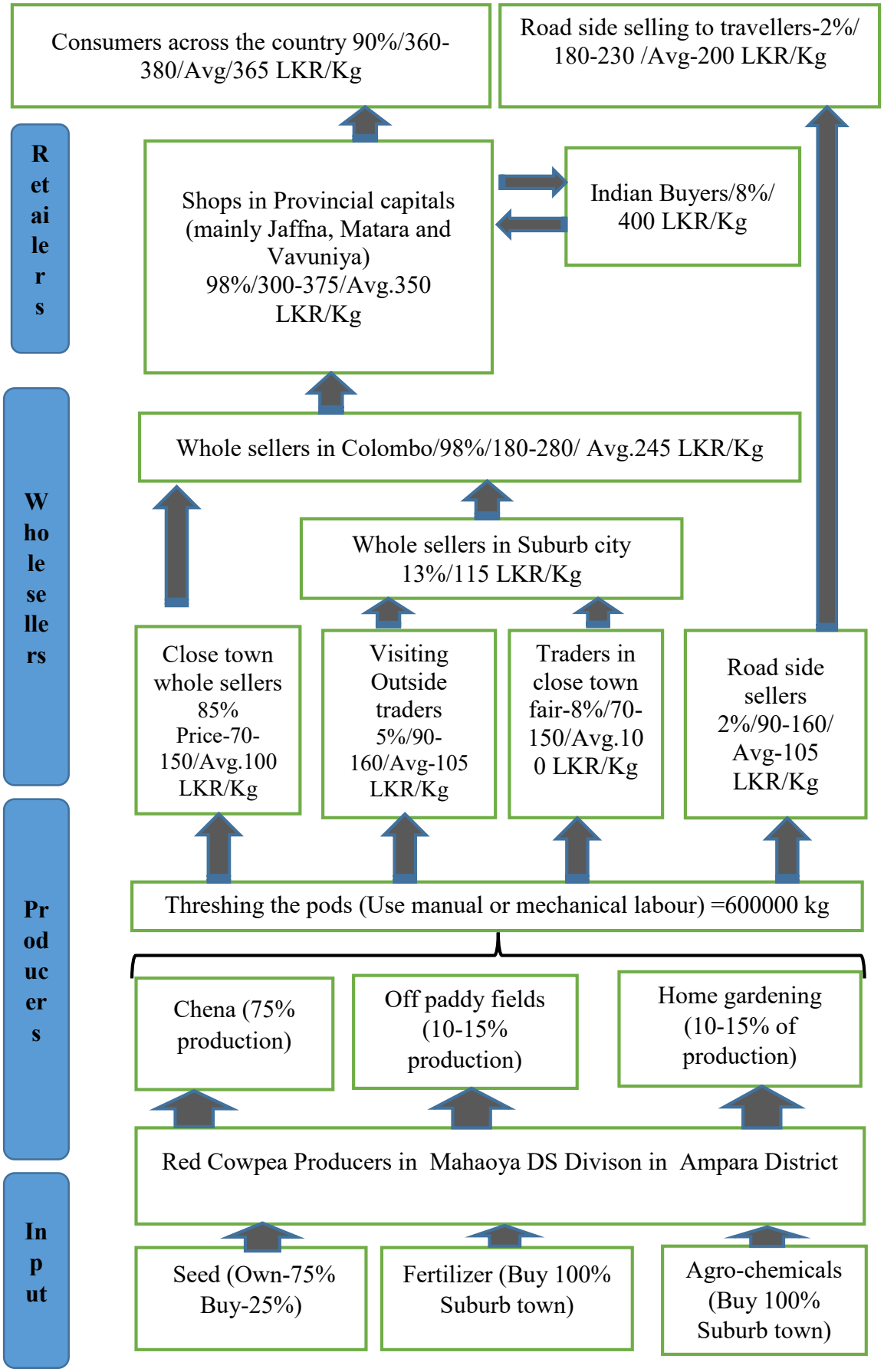


Figure 4. 4 Existing value chain map of Red cowpea in Ampara district

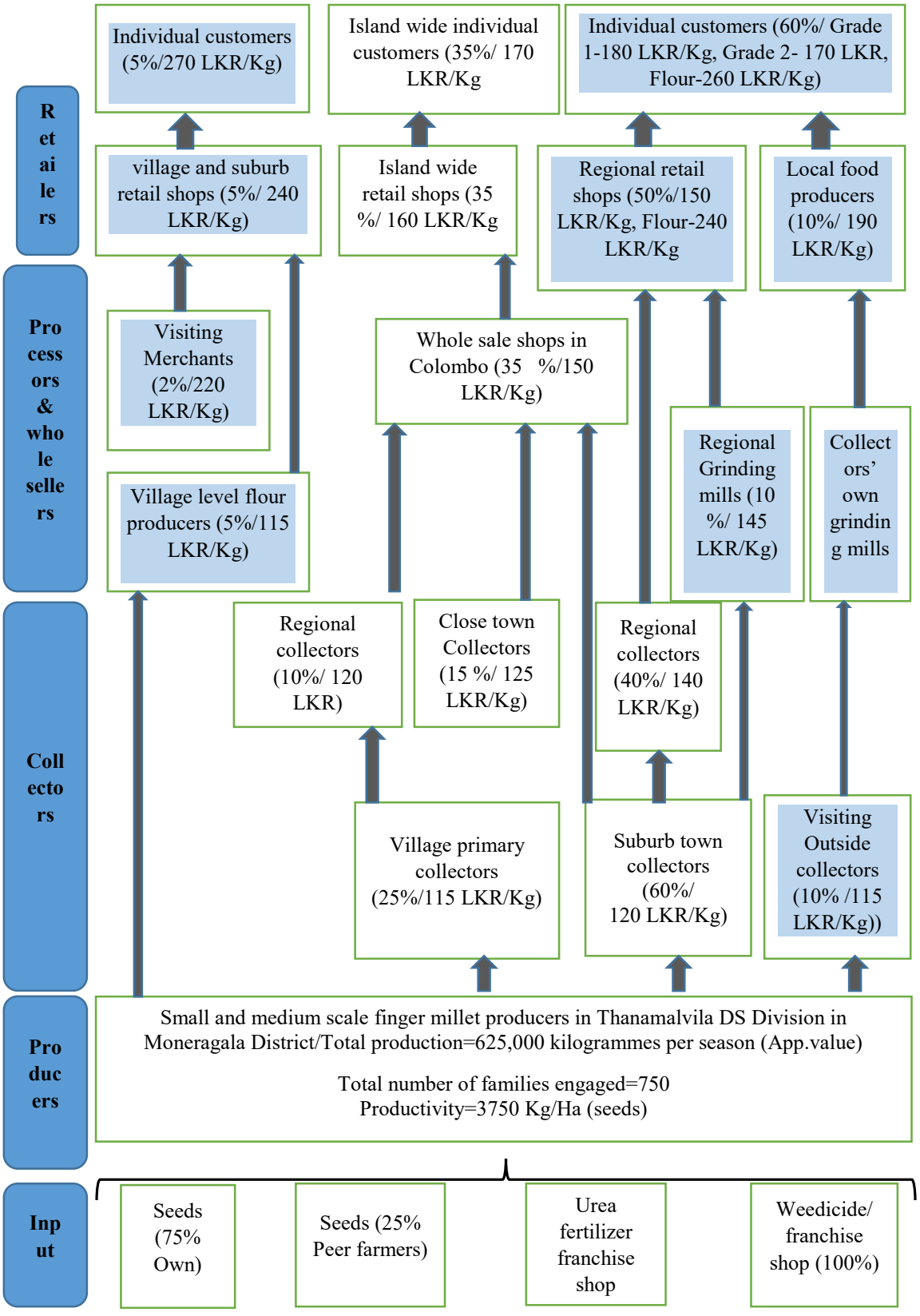


Figure 4.5 Existing value chain map of Finger millet in Moneragala district

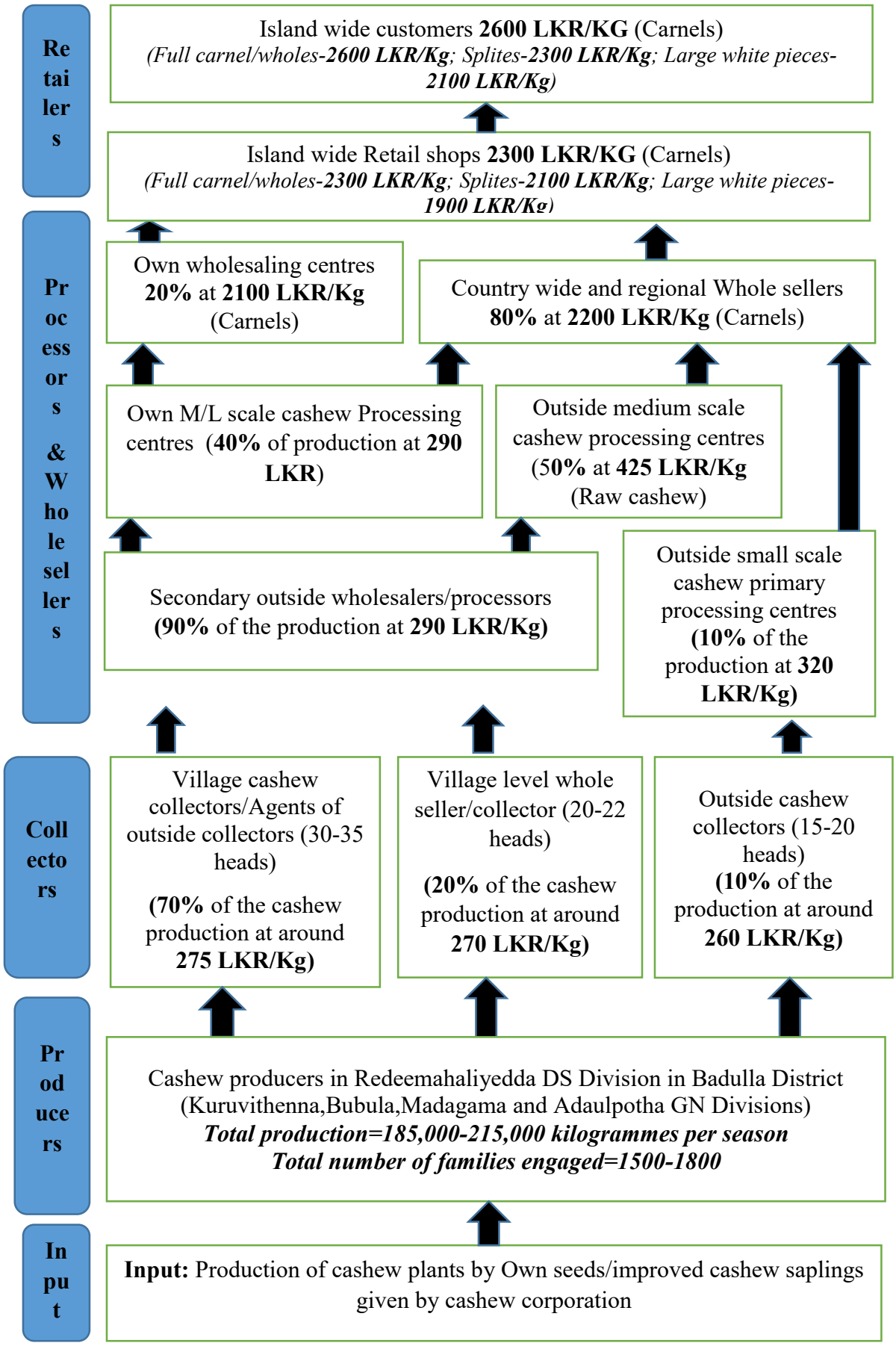


Figure 4. 5 Existing value chain map of Cashew in Badulla district

Cashew contributes around 40-45 percent of the household income of a typical cashew farmer in the study area. It is around 125,000 to 200,000 rupees per year/season (Only one season per year) but varies at the range of 50,000-60000 rupees to 500,000-600,000 rupees. The average yield of Cashew lands is around 250-375 kilograms per acre. The production cost of the cashew is at a very low level and a significant quantity of yield is produced by traditional cashew trees. Three kinds of buyers directly deal with farmers to purchase their productions. Village-level collectors are under two categories. One collector type is act as commissioned agents of the large scale of secondary collectors and other category use their own money to buy cashew. Both collectors purchase around 90 percent of cashew production and channel to large scale outside collectors/traders come to their villages. The third collector category approaches the cashew areas directly and buys farmers' production by visiting farmers' houses. Those collections are finally channelled cashew to processing centres followed by countrywide whole sellers and later retail shops (Figure 4.6).

4.4.4.4. The supporting activity environment of high potential underutilized crops (Service delivery and policy environment)

The main value chain actors (mainly farmers, collectors, whole sellers, and retailers) operate in a wider market environment. This wider market environment consists of institutions, rules, norms, and trends as well as key infrastructure facilities, input, and market support services. This includes supporting and policy context actors who influence the core value chain being away from the core market chain. The core value chain and interaction network of core value chain actors with such policy and support service actors are considered a market system. The efficient operation of the value chain and sustainability of the business highly depends on the productive interaction of key chain actors with others in policy and service delivery sectors (Adrian and Sue 2001; Nangole et al. 2011).

The study identified such actors are in three main categories the state, private, and non-estate where core value chain actors maintain average to below-average level interactions (Table 5.4). Farmers interact with Forest and Wild Life Conservation Departments to manage the issues of wild animal attacks on their farmlands. They get crackers (but very few numbers) from Wild Life Conservation Department to flee elephants but expect sustainable solutions immediately. The relationship of farmers with some banks, traders are mainly to get formal and informal credit and agricultural loans. Farmers maintain a

certain level of relationship with few non-governmental organizations where they work close to them by giving various individual and group support (Table 4.5).

Table 4. 5 Relationship of key-value chain actors with supporting service actors

Actors of service, supporting and policy context in the operating environment of high potential underutilized crops	**Level of collaborative and supportive relationship with value chain actors** *(1-Very poor or no relationship 2-Weak 3-Average 4-Good 5-Excellent)*		
	Finger millet	**Cashew**	**Red Cowpea**
State actors			
Department of Agriculture	**2**	**2**	**2**
Agrarian Service Department	**2**	**2**	**3**
Agricultural Insurance Board	**1**	**1**	**1**
Agricultural Extension service	**2**	**3**	**3**
Samurdhi Bank	**3**	**4**	**3**
State Banks (mainly people's	**3**	**3**	**3**
Janashakthi Bank	**3**	**3**	**3**
Sanasa Bank	**3**	**3**	**3**
Cooperative Bank	**3**	**3**	**3**
District/Divisional Secretariat	**2**	**2**	**2**
Cashew Corporation	**-**	**2**	**-**
Ministry of Economic	**1**	**1**	**1**
Ministry of Small Industries	**1**	**2**	**1**
Department of Irrigation	**1**	**1**	**1**
Department of Forest	**2**	**2**	**2**
Wildlife Conservation Department	**3**	**1**	**3**
Private sector actors			
Wholesale Agro input shops	**3**	**3**	**3**
Informal money lenders	**2**	**3**	**2**
Other actors (Non-state actors)			
Farmer organizations (Paddy)	**3**	**3**	**3**
World Vision International	**4**	**4**	**3**
Care International	**4**	**3**	**4**
Arthracharya Foundation	**3**	**3**	**3**

4.5.Discussion

4.5.1.Input utilization and current crop management cycles of selected high potential underutilized crops

Farmers in dry zone Sri Lanka are restricted with access to off-farm work and compelled to engage in agriculture. The farming systems identified as "Gangoda" (home garden), "Chena" (shifting cultivation), and "Welyaya" (low land paddy tract) are leading land-use systems that sustain the livelihood of smallholder farmers (Panabokke et al. 2001; Rupasinghe et al. 2017). Farmers in study sites have a considerable amount of land resources as irrigated and rain-fed farms as well as under the main three farming systems. All three crops are present in irrigated farms and red cowpea is available in both irrigated and rain-fed farms as well as three farming systems. The farmers cultivate those high potential crops with a number of other crop varieties.

According to Michalcheck et al. (2016), the space availability of the farming systems varies over time based on the production and consumption decisions. As viewed by the findings, red cowpea farmers cultivate the crop in all farming systems mainly due to the motivation by agricultural officers. It is clear that farmers select crops for farming systems based on their knowledge of farming systems but change with the motivations of external parties. The encouragement of government agricultural officers especially ensuring state interference to buy the production of farmers is the key to expand cultivations. In addition, the market price of the last season and farmers' climatic predictions decides the extent of crops to be cultivated. The selection of drought-tolerant finger millet to Chena and Cashew for home gardens can be considered as indicators of their crop selection capacities.

The labour utilization is reflected in the significant use of family labour for overall farming practices of three crops. Cashew farming almost depends on family labour. Since it is predominantly a home garden crop, they can use family labour easily. The usage of hired labour is limited overall in farming practices but significantly higher in harvesting especially in finger millet and cashew. Farming is dominated by male labour but female labour has become dominant in harvesting practices. Females seem to be specialized for harvesting practices compared to their male counterparts. According to the researchers, Marques and Ramos (2010) stated that family labour is the primary supplier of labour to smallholder farms. Small farms use a limited amount of hired labour and production resource utilization highly depends on the working capacity of families. The findings of

both researchers are consistent with the findings of this study. The families with more number members can discharge the labour cultivate large size of lands general. Sometimes they hire the lands of others and cultivate some marketable crops. However, the current trend of male labour migration to cities by searching for salaried jobs may be a huge risk for the growth and development of existing farming culture and especially the farming of high potential underutilized crops. As viewed by Hazell et al. (2007) the fundamental aim of traditional farming systems to produce foods for household consumption. This is fundamentally true with the findings of this study. However, farmers sell a major portion of high potential underutilized crops to cover their family expenses. However, farmers sell their red cowpea harvest as soon as due to storage problems but keep a considerable portion of finger millet for their consumption purposes. Farmers have a good understanding of the storage capacity of finger millet as well as food and nutritional security potential of it.

A number of researchers have stated that the nature of the relationship between the environment and rural farming systems. Farmers freely receive environmental resources for their farming activities through natural processes. However, rural farming communities prone to changes in the environment due to their weaknesses. Poor level of education, scarcity of relevant skills, negative attitudes, backwardness, social and economic discrimination, and poor social, as well as economic infrastructure facilities, are such weaknesses (Cavendish and Campbell 2017; Rupasinghe et al. 2017). For the study sites of this study, the farming cycle of crops is designed mainly based on rainfall patterns of the selected study sites. Farmers mainly use their own seeds to start farming cycles and use less amount of external inputs. Farmers practice seed establishments with the onset of rains in all study sites. The farmers in study sites also receive free rainfall to do their farming well. However, changes in rainfall patterns and cultivating off-rain time (eg: Second season of red cowpea) may cause huge yield losses. On the other hand, unexpected rains in flowing time (e.g. Cashew) may lead to huge yield losses.

4.5.2.Features of farm economics of selected high potential underutilized crops

In generally improved seeds, fertilizer and agrochemicals are the leading requirements to increase agricultural production. This is needed to enhance the living conditions of the smallholder farming communities. In developing countries context, farmers have shown low adoption especially for improved seeds and fertilizer (Hassan et al. 2015). The operation of high potential underutilized crop farming in study sites happens also by using minimum levels of key input cost (mainly refer to the fertilizer and agrochemicals). Farmers use their own seeds or seed shared by peer farmers and neighbour farmers for their cultivations. This operation brings a certain level of sustainability with their own mechanism for seed supply for the continuation of farming. In reference to selected high potential underutilized crops in this research, fertilizer and agrochemical usage remain at a minimum level. This is mainly because farmers trust the fertility of their farmlands and higher prices of chemical fertilizer. According to researchers (e.g. Mohammed 2019) even though having a number of negative impacts on the soil environment, the application of chemical fertilizer has become an integral part of modern agriculture. Same time soil quality is important to manage the productivity of farmlands within naturally managed biodiversity conditions.

In study sites, farmers adapt their traditional methods to manage pests and diseases which involve very low cost. They showed a low level of adaptation even government agricultural officers trained them to use some new pest management techniques, especially for underutilized crops. The post-harvest cost is also at a minimum level since farmers sell their products quickly. The value addition application at the farmer level is minimum except for a few primary level improvements in the finger millet industry. Farmers showed weak interest to adopt technology to their underutilized farms. According to empirical evidence, technology adoption in developing countries identify three different groups of factors as characteristics of farmers, the performance of the technology and, program and institutional factors (Mohammed 2019).

Farmers get reasonable income by farming both finger millet and red cowpea with the massive engagement of unpaid family labour. Unfortunately, the net income value of both is negative with the consideration of the family labour value of farming. Family labour mainly uses to protect the farmlands from wild animals. Cashew is recorded as a positive

net income, contribute significantly to the farmers' household economy by consuming a lower amount of family labour.

4.5.3.Key actors, roles, and value chain structure of selected high potential underutilized crops

A market system identifies a value chain of a product where different actors organize to operationalize the respective business and their interaction with service delivery and policy environment (Verma and Patel 2013). The performance and operational efficiency of a value chain and its market system depend on how key actors are organized in the chain and to what extent the chain is supported by various business development services and favorable policy frame(Faye et al 2004; Lundy et al. 2007; Seville et al. 2011). The main activities explained as agricultural production, processing, storage, marketing, and consumption are required to bring farm products to the respective customers. In general, those structures are changing rapidly in developing countries in response to population growth, income expansion, urbanization and some other factors(Gómez et al. 2011). The nature of high potential underutilized crop value chains in study sites was average in length with a number of agents involved. The main agents are producers, collectors, whole sellers, and retailers. Downstream agents, farmers, and collectors (village level primary collectors and outside secondary collectors) showed distinguished marketing characteristics. Collectors' role just limited to collect the product of farmers and transfer the stock to whole sellers or processors. However, sometimes collectors sell their collected products on roadsides to commuters who travel on long-distance buses and travelers. Farmers sell a portion of their product and the remaining share with neighbors and friends in addition to home consumption.

Farmers bring their crop products to their homes after making initial cleaning and drying at their farms. The productions of farmers' channels to the market system through mainly three kinds of collectors. They are village-level independent collectors, village-level collectors operate as commission agents of out-side whole sellers, and out-side collectors approach farmers to buy their products. There are four kinds of whole sellers. They are whole sellers in a close town, whole sellers in a close city, whole sellers at fair and roadside traders. Roadside traders channel farmers' products directly to the consumers.

Farmers don't have any buyback agreement or our-grower systems with those sellers. However, most of the farmers take credit and loans from them and give their farm produce

to the whole seller to cover-up those credits. The value chain structures are illustrated a number of channels in the middle but finally heading to the whole sellers based in regional cities and capital of Colombo. Value addition at the village level is minimum except for finger millet floor producers at the village level. A certain level of value addition (removing feel, sorting, grading, packing, and labeling) happens in cashew at the whole sellers' level.

4.6. Conclusion

The selected high potential underutilized crops are shown different features of the availability in different farms and farming systems. Red cowpea is cultivated in diverse farming systems and farms but finger millet and cashew are dominant in Chena and home gardens respectively. The potential future threat on finger millet farming is very much higher since the crop is limited to the Chena farms and highly depends on family labour. Population growth, demarcation of forest lands, and labour migration to cities may seriously affect the future of finger millet farming. Cashew is a perennial crop and well-settled in home gardens in study areas. The requirement of low input, low labour requirement, and being in home gardens reduces future risk on the crop. In addition, the capacity of the crop to survive under marginalized condition bring advantageous position under climate change conditions. The expansion of red cowpea seems to be encouraged by government agricultural officers. The second season of the red cowpea farming associate risk of water for the crop growth and development.

The pest attack-free long storage capacity of finger millet is an important characteristic to address both the income and food security issues of the farmers. Farmers consume a considerable amount of the finger millet yield by keeping at their homes by preparing various kinds of foods. So the crop has already connected with their food culture. However, cashew and red cowpea are not linked with their food system strongly like finger millet. Both crops contribute to sell and generate income for the farming families. Cashew is in a strong position to generate more economic benefits to farmers due to the high market margin and storage capacity for a certain period. Farmers face challenges to sell their red cowpea yield during harvesting time due to low market prices. Traders are the price-setters and farmers' bargaining power is minimum mainly due to poor storage potential of the crop due to pest attacks. It seems to be important of adopting buy-back arrangements for the cowpea with solid state intervention to minimize the risk to farmers. Strong farmer organizations can play a key role when marketing cashew and finger millet.

So it is important to form farmer organizations for both crops and build the capacity of those institutions to experience group marketing their productions.

It is recommended that support and motivate farmers or groups of farmers to engage with primary value addition to a part of their productions instead of selling as primary products. It will enhance their profit margin and initiate rural agro-based industrial culture. Finger millet is in a strong position for such an initiative to start a value-added business with small investments. In both the finger millet and cashew market system, collectors play a strong role where they capture considerable profit generated in the business. The long storage capacity of both crops and low investment value addition potential should use to take-up part of profit at collectors' hands to farmers. In addition, existing marketing channels where farmers directly approach whole sellers and directly sell their products to final consumers (e.g. roadside stalls) need to be revitalized to enhance the more benefit to the farmers. It is a clear fact that the strengthening of farmers in the market system is the key to the sustainable development of the high potential underutilized crop business. Such initiatives slowly bring long term prospects to other actors in the upper-streams of the value chains. In this viewpoint, the role of the ground level agricultural officers is the key to the success of farmers to achieve competitive edges while the government should ensure policy support by controlling hap-hazard importation of those crop products from other counties.

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Chapter Five

Economic returns on key value chain actors, constraints, and development potentials of high potential underutilized crops

5.1. Introduction

Fundamental characteristics of agricultural value chains are similar to the other value chains. However, the agricultural value chain gives a higher level of emphasis on the quality of the product, safety concerns, and climate-related variabilities. Agro product-related characteristics such as short shelf life, frequent demand, and price fluctuations make those value chains are more complex and difficult to manage than other chains (Ahumada and Villalobos 2009; Opara 2003). Meanwhile, the changes happened in the retail sector in developed as well as developing countries in the last decades made considerable influences on the organizational structure of food supply chains, food processing, and even farm-based production. This change is demonstrated by modern retail outlets (mainly reflected by supermarket chains) affected farmers and their productions. The changes pushed farmers to produce quality products and create unfavourable bargaining power on them (Altenburg 2006; Berdegue and Reardon 2008; Coe and Hess 2005; Henson and Reardon 2005; Trebbin 2014).

However, some researchers (e.g Bijman 2008; Henson et al. 2005; Henson and Jaffee 2008; Hernandez et al. 2007; Moustier et al. 2010; Swinnen and Maertens 2007; Neven et al. 2009) believe that new changes bring challenges as well as opportunities to the smallholder farmers. The successful adaptation of farmers to the changing environment depends on a large scale of production and coordinated distribution along the value chain. The arrangements such as contract farming models, vertical integration, and farmer organization are considered as important institutional structures to face emerging market access challenges. As stated by Rondot and Collion (2001) and World Bank (2008) formation of farmer organizations is the first step to ensure farmers' competitiveness in the local market environment. Eaton et al. (2007), Omiti et al. (2007), and the World Development Report (2008) emphasized the importance of agriculture as an instrument for growth and development. They emphasized the challenges upon smallholder farmers in this context as well as the vital role them to play in the development of agriculture.

The world statistics showed that people living under less than US$ two per day is two billion where the majority of poor people engage in agriculture as their main livelihood. Applications of market-based solutions such as value chain interventions have gained great recognition as an approach to link this poor farmer to larger markets (Diao and Hazell 2004; Magingxa and Kamara 2003; Resnick 2004). Improvement of the overall performance of the value chain by placing actors at the most appropriate position is the broader objective of the value chain analysis. The right position of actors in the value chain may increase benefits for them as well as less exposure to the risk. (Bellon 2004; Fafchamps 2006; Isakson 2011; Lowitt et al. 2015; Rutherford et al. 2016)

This chapter mainly focuses on analyzing the market performance of selected high potential underutilized crops. In order to do so, the market margin of the different actors involved in each crop value chain is calculated. It is further explained by analyzing the profit distribution patterns of each value chain among the actors involved. The efficiency levels of value chains are hindered by various barriers within the main value chain structure as well as the way that main value chain actors interact with service delivery and policy context actors in the respective market system. This chapter attempted to illustrate constraints and limitations at different levels to understand the way those constraints at different levels as underlying causes and constraints leading to the visible symptoms of inefficiencies. In addition, this chapter tried to show the level of relationship between the key-value chain and other actors. In the last sections, this chapter discussed basic strengths weaknesses, opportunities, and threats in the system and potential interventions at different levels to upgrade the efficiency levels of the value chains.

5.2. Materials and methods

5.2.1.Sample selection

I collected the most important quantitative and qualitative information of farmers and other main value chain actors of the selected crops by conducting farmers' household surveys and key informant interviews (table 4.1 in chapter 4). The data collection refer to this chapter aims to fill the gaps in the information collected for selected value chain crops in chapter four. Since I understood that lack of information on upper-ends of the developed value chain maps developed as well as constraints associated with market channels, the emphasis was given to conduct dedicated FGDs and KIIs with selected large scale traders and processors (Table 5.1). In each selected crop, two separate focus group

discussions were executed. One focus group consists of whole sellers and retailers group with a number of 4-5 heads. The second focus group was done with a number of primary level processors who engage in certain level value additions which also consists of 4-5 participants**.** In addition, I conducted a few Key informant interviews and personal discussions with upper-end actors such as large-scale whole-sellers, processors who were in regional cities, and Colombo.

Table 5. 1 Distribution of focus group discussions and key informant interviews with traders of high potential underutilized crops

District	**Crop**	**Focus group discussion**	**Focus group discussion**	**Key Informant Interviews**
		Traders (village and close town)	Processors (Village and close town)	(Regional/national level traders and processors
Moneragala	Finger millet	1	1	2
Badulla	Cashew	1	1	2
Ampara	Red Cowpea	1	1	2

5.2.2.Data and methods

I organized both focus Group discussions with traders and processors in the early morning of the day. It ensured them in the discussion before they involve their day to day activities. Those focus group discussions were organized on the premises of the village temple with the support of the chief priest to ensure the participation of relevant actors.Those discussions took around one and a half to two hours. At the end of the discussion, I succeeded to finalize almost all key channels of the lower stream of the value chain with some top channels also. As the last phase of each focus group discussion, I made a clear brainstorming session on elements of SWOT analysis. I clearly explained to them about the contextual background of the strengths,weaknesses,opportunities and threats to enlighten them to get their inputs. Then I asked some hard questions to understand SWOT elements refer to the businesses and organized as individual facts by pooling different ideas derived during the discussions.

Evening time was allocated to meet the most important key informant actors who confirmed the appointments. In this time, I mainly met most upper-level actors such as

large-scale wholesalers, processors, and supporting service actors. Most probably I had to travel reasonable distances to approach them beyond the DS division sometimes beyond the district. I used some earlier developed contacts with school principals in the area and local politicians to approach this level of people and confirm their participation for the key informant interviews. In most of the cases, based on their busy schedules, I completed basic discussions during those physical meetings and further compensated by telephone conversations at a later date. However, few leading traders based in capital Colombo and hill country capital (Kandy) were interviewed only by phone discussions.

The qualitative information collected through focus group discussions and key informant interviews mainly included various causes that influence the current inefficiencies of the respective crop market system as well as the level of interaction of key-value chain actors with facilitating actors in policy and service delivery context. In addition, qualitative information included facts that refer to SWOT elements. Quantitative data such as the percentage of the quantity of products handled by different actors and price information were also collected.

I developed the maps basically following flow diagrams. The market environments of the selected crops were illustrated as flow diagrams and contents were analysed to understand their key practices. The quantitative data mainly refer to the quantities of crop products handled by different actors and price information was organized in the Microsoft Excel data table and used that information to analyze profit distribution and profit distribution rations. In addition, simple descriptive statistical applications such as mean values, ranges, and basic graphical illustrations were used.

5.3. Results

5.3.1.Market margin and profit distribution among primary actors of selected high potential underutilized crops

Market margin indicates the amount of profit earns by value chain actors involved in the market. Profit distribution shows the proportional distribution of the total profit generated by business among involving actors. The market margin and profit distribution values of the actors are presented below.

Table 5. 2 Market margin and profit distribution among value chain actors of selected high potential underutilized crops

Actors	Market Margin (Sri Lankan rupees per kilogram)			Profit Distribution (Percentage)		
	Finger millet	Cashew	Red cowpea	Finger millet	Cashew	Red cowpea
Producer/Farmer	56	213	67	64.37	13.41	25.87
Collector (General)	5			5.75		
Primary collector		20	12		1.26	4.63
Secondary collector		115			7.24	
Whole seller (General)		105	88		6.61	33.48
Whole seller (Village level)	5			5.75		
Whole seller (Town level)	8			9.2		
Processor		660			41.56	
Retailer	13	475	92	14.94	29.91	35.52

Cashew farming generates a reasonably higher market margin for farmers compared to the other two crops. However, the profit margin of processors and retailers in the cashew business is much higher than the farmers. The Finger millet business generates relatively

low profit compared to Cashew and red cowpea. However, farmers succeed to get the highest amount of profit margin compared to other actors in the Finger millet business. Red Cowpea gives higher profit margins for retailers and whole sellers. In the finger millet market, farmers secure a much higher profit share of the business where processors and retailers get the highest profit share in cashew and red cowpea businesses respectively (Table 5.2).

Table 5. 3: Producer share and market margin of high potential underutilized crops

Performances of the market system of selected underutilized crops			
Variable	**Red Cowpea**	**Finger millet**	**Cashew**
Producer share=producer price/Consumer price*100	27.78	67.65	11.28
Gross market margin/GMM=(Retail price-Farm gate price)/Retail price*100	72.22	32.35	88.72
Total gross market margin/TGMM=Consumer price-production cost/Consumer price*100	90.83	65.29	97.79

Finger millet shows higher producer share, high total gross market margin, and relatively lower gross market margin. However, both other crops show a lower producer share and a very high total gross market margin and gross market margin values (Table 5.3).

5.3.2: Existing constraints in the primary and supporting activity environment of high potential underutilized crops

The value chain and its operating environment are considered as a market system. It reflects value chain actors and their interaction with both policy and service environment. The study identified underlying causes effect on inefficiencies of the market systems of high potential underutilized crops. The high potential underutilized crop market systems have a number of common underlying causes (e.g. Lack of lands to expand production, wild animal attacks, scarcity of water, and poor government support) heading to some common constraints. In addition, there are some crop-specific underlying causes contribute to the inefficiencies of the market system.

In red cowpea farming, Peacock attacks are the main wild animal threats since it effects on vegetative, flowering as well as pod development period of the crop. Damage from peacocks happens during any time of the day except night time. In addition, the stoppage of the government purchasing mechanism for school meals and military camps drop the demand for red cowpea by reducing the bargaining power of the farmers.

Finger millet farming operates in Chena lands and has particular root causes heading to constraints of the market system. This farming involves a massive amount of family labour to look after their farmlands both day and night from animals and birds. The early harvesting to avoid wild animal attacks causes yield losses and a low-quality yield. In the market, local finger millet producers compete with imported products to get a reasonable price.

The low production and productivity of cashew is mainly influenced by maintaining old unproductive cashew trees by delaying replanting as well as felling productive cashew trees to sell for firewood at their financial pitfalls. Wild animal attacks on cashew are reflected by parrots especially at the early stage of pod development and bat at the final stage. The heavy rainfall during the flowering period damages flowers by dropping the yield. There is no market for cashew apple in Sri Lanka. Cashew farmers lose their bargaining power due to a lack of organized marketing. Prices of cashew even fluctuate morning and evening within a day by falling farmers in very difficult situations every year. Farmers expect quality and high yielding cashew plants from agricultural authorities yet to be realized.

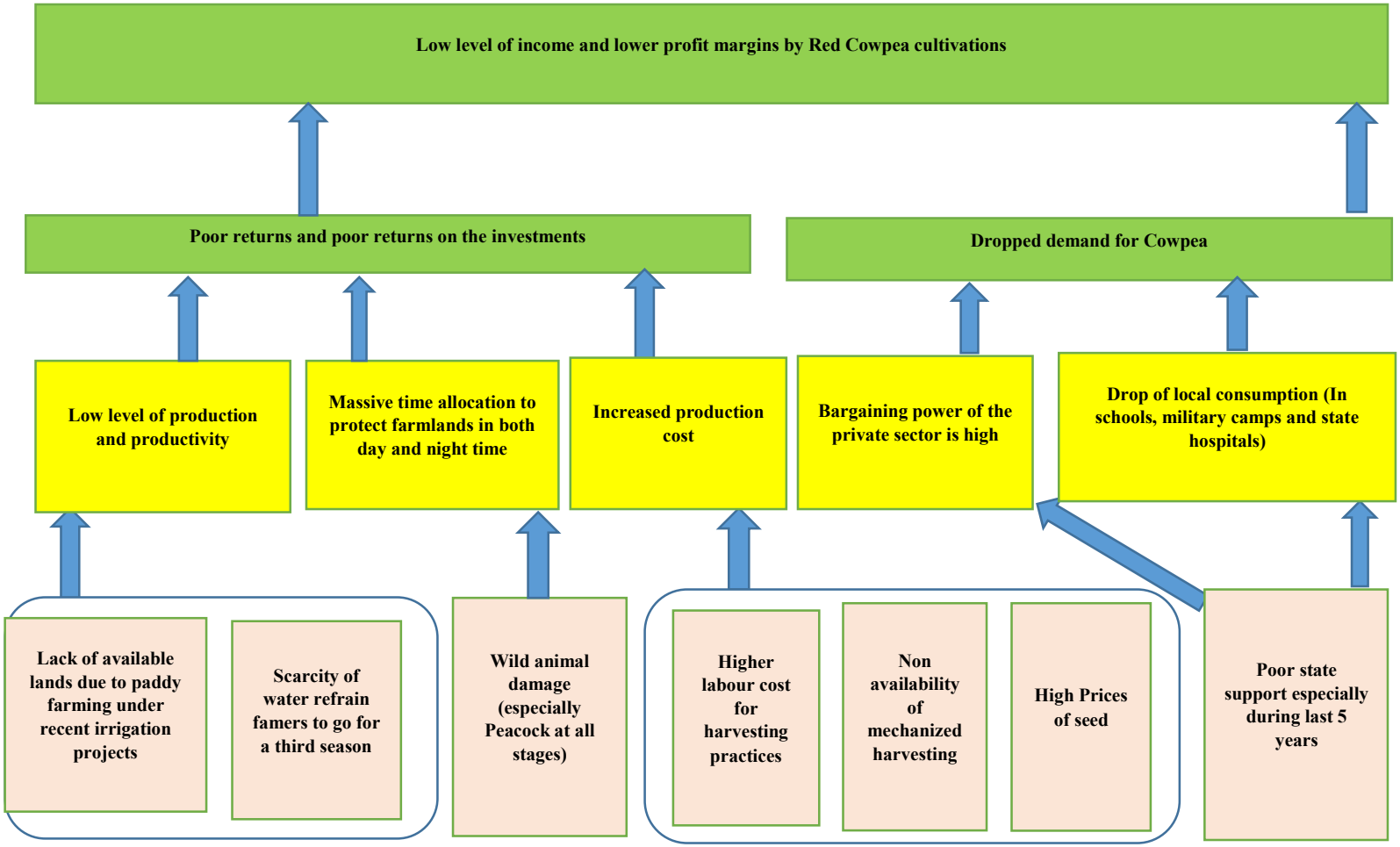

Figure 5. 1Constraints in the existing Red cowpea market system

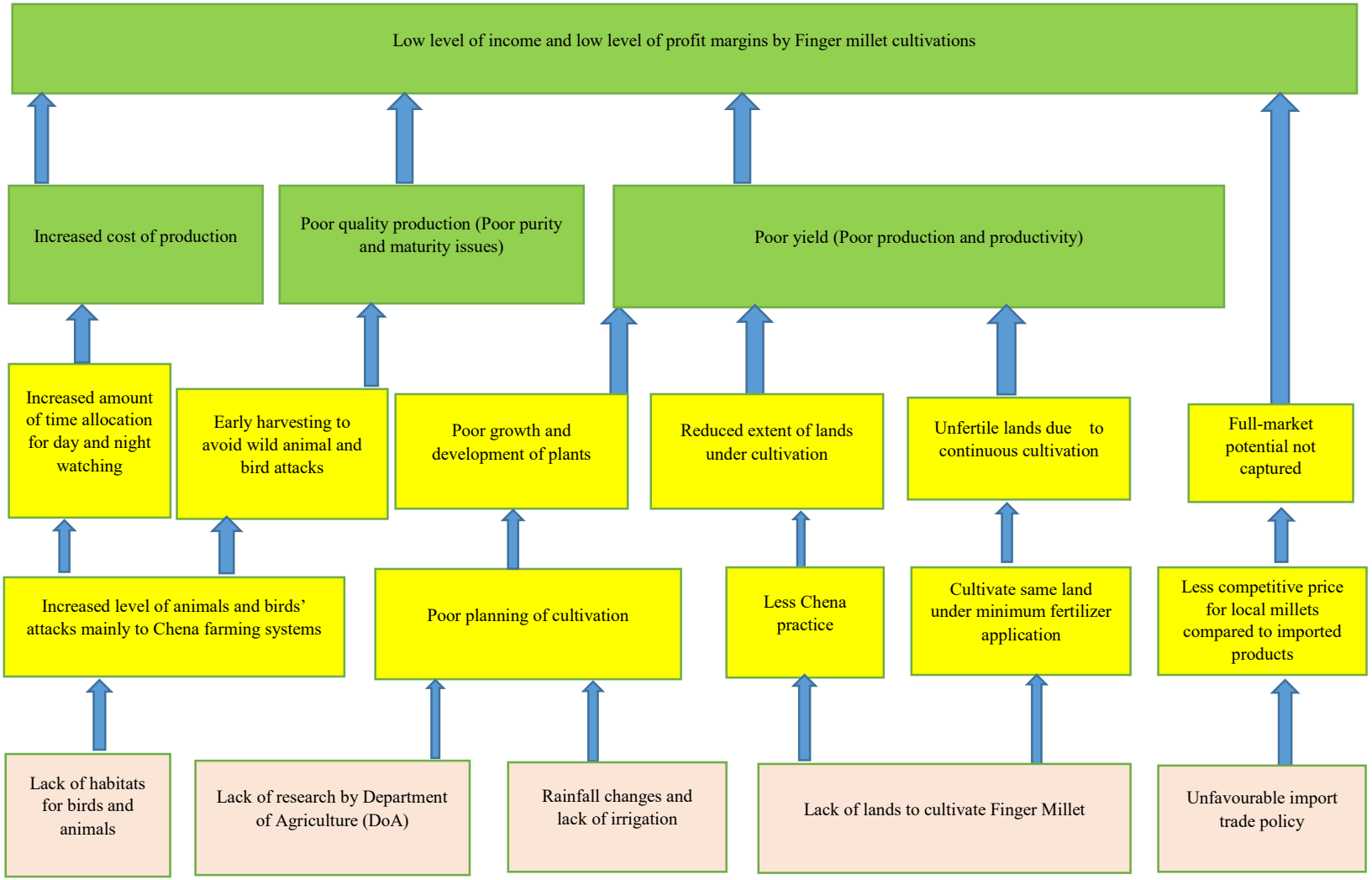

Figure 5. 2 Constraints in the existing Finger millet market system

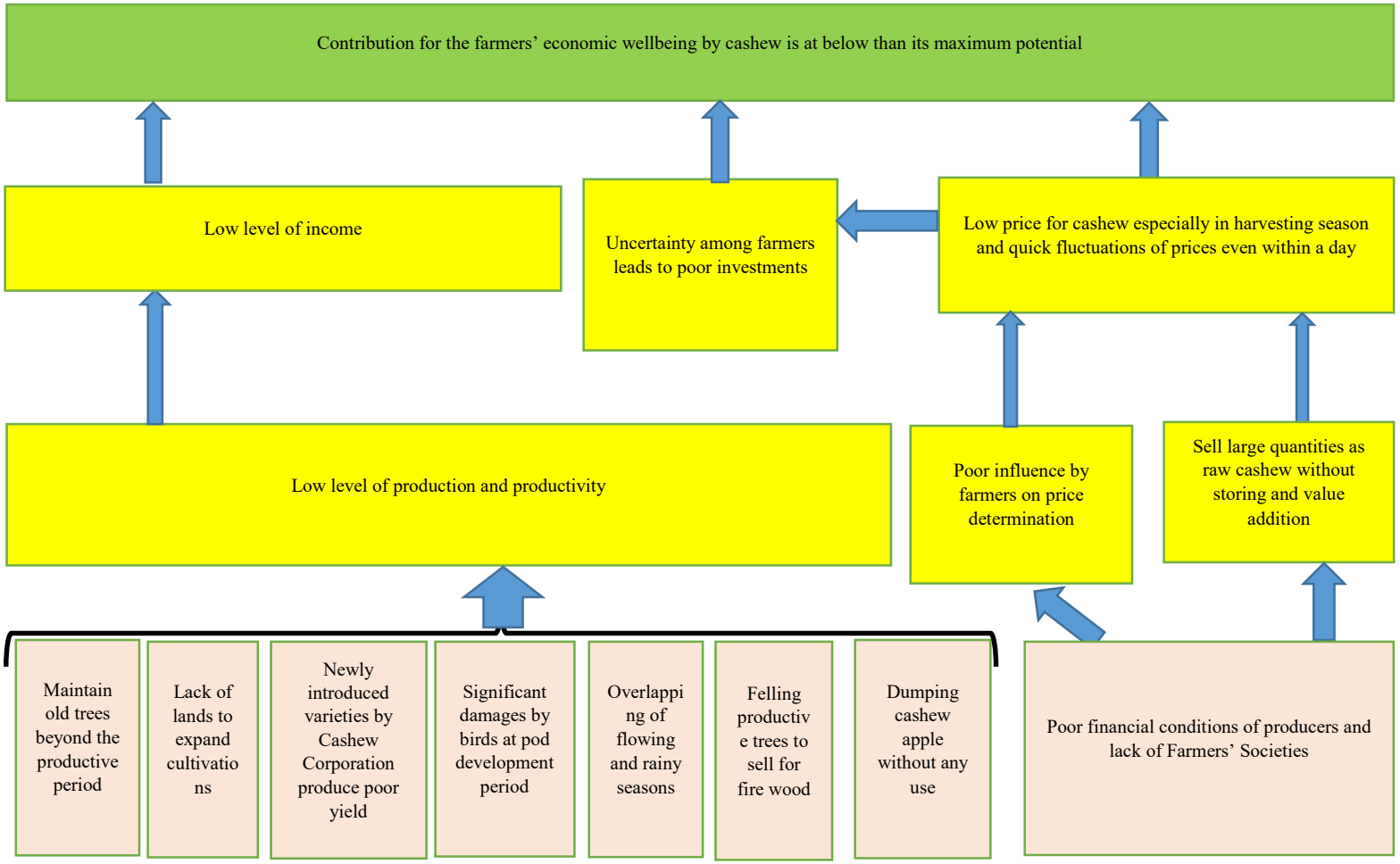

Figure 5. 3 Constraints in the existing Cashew market system

5.3.3.Scope of interventions to improve the value chain components of selected high potential underutilized crops

The value chain interventions understand mainly the development of market access conditions, finding out new opportunities, and upgrade existing opportunities as well as making some adjustments related to the distribution risk and benefits in favour of the producers (Pietrobelli and Staritz 2013). The value chain interventions may involve strengthening new linkages within the chain, increase the participation of target groups, controlling negative impacts by value chain operation to non-participants, and sometimes creating a completely new chain structure(Henriksen et al. 2010). This chapter earlier identified root causes associated with high potential underutilized crop farming systems and the way those causes lead to constraints and problems (Figure 5.1, 5.2, and 5.3). The study further identified specific interventional areas, broader activities, as well as potential partners, need to be involved to address the constraints and inefficiencies associated with potential underutilized crops. The specific interventions focus on number of areas related to legal ownership of farm lands, irrigation facilities, collaborative management, research on crops and mix cropping systems, strengthen farmers' organizations and developing productive linkages with private sector. (Table 5.4).

Table 5. 4: Insight of the issues related to the high potential underutilized crops and potential solutions

Root causes for constraints	Specific interventions	Broad activities	Potential partners
Animals enter farmlands since lack of habitats for animals and birds	Providing a legally defined land plot for the farmers with minimum irrigation facilities	Develop and maintain long-term programs to increase the food availability for animals within the forests	Department of Forest, Department Wildlife Conservation, Department of Agriculture, Agrarian Services Department
		Ensure water and foods for wild animals within the forest especially during dry periods	Land Development Ministry, Irrigation Department, Ministry of Mahaweli Development
Farmers clean border and sensitive forest patches for their Chena cultivations	Implement major irrigation program to ensure that farmers get irrigation water to their paddy lands during off-seasons	Sustainable management of buffer zones of forests by controlling illegal cultivation and encroachment of forest lands	Ministry of Economic Development, Land Development Ministry, Irrigation Department, Ministry of Mahaweli Development
		Promote farmers to cultivate underutilized crops in off-season paddy lands instead of Chena	
	Introduce a collaborative management strategy of forest areas with the active participation of host communities	Establishing and maintaining electric fences and provide incentives for private solar-powered electric fences	
Susceptibility of crops for long spell dry periods and especially elephants and bird attacks	Research on mixed cropping models having resistance to wild animals and conserving soil environment	Incorporation of modern technology to the farmers' coping strategies adopted to protect their farmlands	
		Control human infiltration to forest areas and making critical damages by politicians, hunters, and firewood collectors	

Root causes for constraints	Specific interventions	Broad activities	Potential partners
	Promote and provide necessary facilities to farmers cultivate drought-tolerant crop types (Eg: Red Cowpea)	Introduce buy-back arrangement and state intervene to buy their products and use for the government institutions)	Ministry of Economic Development, Department of Agriculture based "Hela Bojun" program, Ministry of Education, Ministry of Defence
Lack of research on underutilized crops	Design good researches to identify un-tapped socio-economic potentials of highly preferred underutilized crops	Identifying the hotspots of human-animal conflicts and strategic shifting of human habitats to safer locations	Regional universities with the collaboration of agrarian service centres, independent researchers, and local funders
		Design research programs can be easily implemented with the support of villages	
		Develop a pool of researchers for underutilized crop development programs	
Uncontrolled importation of some crops (especially Cowpea and Finger millet from India)	Facilitation of farmers to cultivate Cowpea for the third season by ensuring sustainable market opportunities for product	Introduce buy-back arrangement for the farmers' product with the sponsor of the government	Ministry of Economic Development, Department of Agriculture
	Introduced high taxes on imported selected crops at the raw form	Improve the status of storing facilities of the local government of the crop growing areas	
Unavailability of farmers' organizations	Form a formal farmer organization of underutilized crop-growing farmers and register those organizations	Develop those farmers' organizations and trained them to deal with input purchasing and marketing activities as a group	Ministry of Economic Development, Ministry of Agriculture
Exploitation of high profit margins by middlemen	Develop strong, sustainable direct links between farmers and key buyers of their products	Strengthen farmers' organizations and their capacity to doing marketing	

5.3.4.Existing potentials and challenges of farming of high potential underutilized crops

Strengths

- High potential underutilized crops make a considerable contribution to income and food security at the household level
- Understanding among farming communities on the nutritional value of high potential underutilized crops
- Existing willingness among farmers to cultivate those crops if market ensured
- Farmers have a certain level of seed regeneration and peer sharing system
- Famers bear fair knowledge on key underutilized crops

Weaknesses

- Lack of land resources with legal rights
- Water scarcity and lack of irrigation to key farming systems
- The increasing level of wild animal and birds and farmers spend significant family labour to safeguard their farmlands
- Poor market prices at harvesting time
- Lack of community-based storage and value addition options at farmers' level
- Low yield parameters compared with recently introduced hybrid varieties

Opportunities

- Creation of strong farmer organizations
- Develop a link between potential private sector partners and farmer organizations for buy-back agreement/out-grower farmer network
- Growing health consciousness among the middle class and even among farmers
- Possibility to cultivate under low input agricultural practices

Threats

- Promotion of hybrid varieties
- Increasing human-elephant conflict
- A higher level of damages by fast-growing peacock and parrot populations
- Change of climate and weather patterns
- Poor state support at field level and policy level
- Demotivated young generation towards the farming

5.4. Discussion

5.4.1.Market performances of high potential underutilized crops

In general situations, middle men's behaviour is recognized as a reason for making considerable losses to both producers/farmers as well as consumers. This kind of presumption is mainly based on the that intermediaries push farm gate prices down when they buy products from farmers while raising the price when selling the same products to the consumers. However, in the technical viewpoint middlemen contribute to expanding the market margin of most of the agricultural products (Pedagang and Timur 2016). However, the results of this study showed that the value of the market margin is comparatively low in Finger millet compared to the other two crops were selected. Interestingly, Finger millet farmers acquire a significantly higher market margin as well as a share of the profit compared with other actors involved in the finger millet value chain. This is mainly because farmers cultivate finger millet with both consumptive and marketing perspectives. They don't hurry to sell their products quickly and store at their houses and consume when needed. As this crop can store under minimum conditions for a long time with zero pest attacks, farmers are in a position to capitalize on favourable market times to sell their products under high bargaining powers. It is needed to emphasize that the calculation of the production cost of farmers has been excluded extensive family labour (unpaid labour) involved to safeguard their farmlands in both day and night times. The favourable market margin and profit share towards Finger millet farmers within the value chain are considerably compensated by this unpaid hidden cost involved. Both cashew and red cowpea provides a higher amount of profit margins and profit distributions are highly favourable upper stream actors of the value chains (including wholesalers, processors, and retailers) compared to producers. It is more similar to the general situation. As viewed by Pedagang and Timur (2016), in general situations, governments attempt to ensure that farmers receive a reasonable price for their products at the farm gate level while consumers get those products at the bearable price at retail sales outlets. Such an effort is launched by setting price policies and improvements in marketing efficiencies. This kind of effort can reduce both instabilities of prices and market margins. As found by the study, the producer share of red cowpea and Cashew is low because of the high level of market margins were taken by intermediaries. This value is further consistent with the higher gross market margin and total gross market margin values of both the aforementioned crops.

5.4.2.Constraints and limitations in current market systems of high potential underutilized crops

The agricultural policies in the last decades showed a severe shift from state intervention to business focussed market globalization. This nature of change failed to manage the fundamental role of the agro-food businesses over the business interest (Hawkes et.al 2012). The argument of Gomez and Ricketts (2013) emphasized that the transformation of different food chains in response to evolving new policy context and changing business environments have diverse types of influences on various categories of social groups.
The findings of this study emphasized that lack of support or delivering poor quality support by state institutions in both production and marketing perspectives. The agencies with a mandate to support the agriculture of rural farmers are in poor performance to address the need for farming communities. They mainly expect solid support from them by providing inputs (mainly seeds) when needed as well as their timely support to face pest and disease attacks. The long-standing issues of lack of land, wild animal attacks, and irrigated water are key issues that farmers expect sustainable solutions from the government. State involvements in purchasing their productions in peak harvesting periods and develop expand storage facilities are expected to minimize critical exploitation of their products by private sellers during harvesting season.

The liberalization of trade and globalization enhanced and integrated world markets. Though this implies that local farmers are increasingly connected to the international rich markets finally local farmers face greater market competition even in local markets. Agricultural markets are transformed into vertically coordinated structures to face this challenge (Reardon and Barrett 2000). As found by this study, farmers are at a disadvantageous level in local markets when marketing their products. Regarding underutilized crop products, markets are not connected to the export level. It is visible that few Indian buyers involve in business at the upper level. The role of such buyers is not clear but seems to be that they mix local and Indian products together and send back to the local market during the off-season. This area needs to be studied comprehensively to understand the ground situation. In general, farmers sell their products at a low price due to their financial difficulties at the price where traders proposed.

However, some adjustments in agricultural markets were introduced by both state and private sectors in view of facing competition due to market changes. Though such policy

changes are oriented in favour of smallholder farmers, they still need to face competition to achieve safety needs, lack of skills, and highly rely on middlemen (Jari and Fraser 2009).

As recognized by this study, state-sponsored strategies to minimize the input cost is the key to escape farmers from strong financial pressures at harvesting time. Simultaneously, the provision of state-sponsored or community-managed storage facilities and the formation of farmers' organizations can develop a certain level of favourable environment towards farmers. Farmers expect some training to enhance their product qualities, skills on mechanized harvesting options yet to be realized by mainly state institutions. In general, value chains of high potential underutilized crops engage a considerable number of middlemen. Farmers in the Finger millet value chain enjoy higher profit share due to fewer involvement middlemen compared to the other two value chains.

5.4.3.Potential capacities of selected underutilized crops and upgrading opportunities of the value chains

The concept of the value chain is considered as an analytical concept that explores different linkages of the market system (Poole 2013). The value chain interventions are a kind of development activities apply to a section of the value chain or the entire value chain by expecting to achieve certain identified social and or economic objectives (Zuberi et al. 2016). The value chain structures of selected underutilized crops in this study showed different actors involved in key functions such as input acquisition, production, processing and value addition, marketing, and consumption. Those core value chains operate in the market environment where those actors are supported by some other actors who do not directly involve but engage in service delivery and policy environment.

The past value chain studies didn't make consistent attention to the way poor people are connected to the value chains and the influences of value chain interventions on them. The influences on value chain interventions are mainly considered to refer to poverty, gender, and the environment. Most of the post studies focus on studying the changes in livelihood dynamics and the way those dynamics affect poverty, gender, and the environment. Those studies didn't focus on how different issues are shaped by value chain dynamics (Bolwig et al. 2010).

The constraint maps diagrammatically reflect underlying root causes and leading constraints which affect the poor efficiency and effectiveness of the market system as well as mainly operationalization of value chains. The root causes are related to

production-related issues as well as marketing related issues. Farmers tend to cultivate underutilized crops (especially Chena farming) in encroached border forest areas having a high risk of wild animal infiltrations. They must adapt to dramatic structural changes in the Chena farming system to face the key challenges farmers are being faced in the current context. It is important that shifting farmlands to safer locations by clearly demarcated boundaries for the forest areas as wildlife habitats. It is important that enhancement the food availability in forest areas for wild animals and well as water availability in the forest during dry spells. The common approach of constructing electric fences has a certain level of the short-term impact of protection but ineffective in terms of ensuring sustainable solutions to the issues.

From a biological viewpoint, farmers have to cultivate farmer-friendly, crop varieties having resistance to the drought conditions as well as having resistant qualities for wild animals and birds. It is important to conduct long and short-term research programs on biological and agronomic aspects of the selected crops as well as specialty socio-economic aspects of those crops. Farmers' bargaining power needs to be enhanced by organizing them as collective groups. And need to develop community managed crop storage system to help farmers to store their product till favourable market conditions realize. The potential partners identified to introduce and implement the interventions are mainly government institutions. It is very much important of the leadership and commitment of officers to do those identified interventions to ensure sustainable development of underutilized crop farming systems, production, and marketing to the next level of development.

5.5. Conclusions

Finger millet has a relatively low capacity to generate a higher amount of profits for all the actors in the value chain compared to Cashew and Cowpea. However, the crop having the potential to ensure that farmers get more than half of the total profit generated by the business. Even though, the reflection as such the higher amount of unpaid family labour is the matter of consideration to assess the real value of this visible advantage of Finger millet for the producing farmer. In this viewpoint, the role of Finger millet is much important for farmers' food security perspective rather than an income-generating business. Thus the ability of farmers to keep store their finger millet stocks under normal conditions further opens spaces for them to store their productions at their homes till

market conditions are favourable. Red cowpea generates higher profits compared to Finger millet. However, the highest amounts of the market margin go to the whole sellers and retailers. Wholesalers have the capacity to stock for a certain period and distribute stocks through their retail networks. Farmers have to sell their red cowpea harvest as soon as harvest due to pest attacks on the crop. This limits farmers, ability to store red cowpea for a certain period pushes them to release their stocks under unfavourable market conditions. Thus this poor storage feature loses the value of the crop to address food insecurity issues of the farming societies. Cashew is the crop with a greater capacity of generating profit among all the value chain actors. The crop provides significantly higher profits for mainly processors and sellers while ensuring a reasonable amount of profits for the producing farmers. The amount of the profit and share of the profit taken by cashew farmers is much worth due to less involvement of unpaid family labour for the crop.

It is clear that selected high potential underutilized crop value chains have few leading relatively short channels which ensures heading farmers' products to the market. As per the previous discussions also, it is clear that the crop like finger millet ensures considerable profit share to the farmers out of total profit generated but it is not much larger amount of profit. On the other hand, Cashew ensures considerably higher profit value for farmers compared to finger millet but it is a small share of the total profit generated by all actors. Since farmers are the starting point of the value chains it is important that strengthening this lowest point of the value chain to ensure sustainable operation of the chain as well as market structure. It is much emphasized that constraints existing in the value chains mainly because of limitations effect on farmers rather than other actors involved in the operation. The issues of the farmers need to address immediately and state agricultural bodies have not taken this matter up to the required level. The poor linkages of state agricultural institutes as well as officers with farmers need to develop to the next phase and ensure their frequent support and guidance to the farmers. It will help to drop the existing production cost of farmers which included a higher portion of hidden cost main come as unpaid family labour. Facilitation to initiate farmer societies to organized the same crop-growing farmers together and make those bodies are formally registered is important. Those organizations need to be strengthened in different perspectives and develop their capacities to deal with collectors as well as whole sellers with a high bargaining advantage. The storage capacities of the crops need

to be developed at a suitable level and management of those storage centres can be transferred to the farmer societies. It is important to develop alternative income sources to enhance their family income especially off in the season. This will support reducing the indebtedness of farmers which pushes farmers to sell their product just after harvesting at lower price regimes.

Underutilized crop value chains have a great potential to enhance the economic wellbeing as well as the social wellbeing of the poor category of farmers in rural areas of the study sites. The development of the underutilized crop farming sector is a strong representation of the poor category of farmers in both Uva and Eastern provinces. The interventional focus needs to pay a higher level of emphasis on the reduction of the cost of production (mainly the unpaid family labour) as well as the introduction of efficient harvesting and community-based storage systems. In addition, strengthening farmers' organizations is a vital need to enhance their bargaining power when marketing their products. Even though a certain level of market systems are operating regarding main underutilized crops, it is needed to see the interventions to connect farmers directly to best private sector buyers in agreed price conditions for their products. The out-grower farming model with buy-back model forward agreements may be a sound application in this regard. Simultaneously the quality of farmers' products needs to improve to allow the agreed buyer to purchase the products without any unnecessary risk. This is important to expand the profit share of the farmers. Chena farming is the leading production source of both Red cowpea and finger miller. However, this is an illegal and highly unstable farming system that needs critical transformation by ensuring the safety of farmlands and land ownership issues. The connection of individual farmers, as well as farmers' organizations, have a poor and fragmented relationship with state agricultural institutions. It is needed to improve urgently in the process of developing the underutilized crop sector. The corporation of farmers and the private sector (mainly wholesale buyers) need to improve to an advanced collaborative platform both parties receive mutual benefits.

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Chapter Six

General discussion and conclusion

In the preceding chapters (chapters three, four, and five), I have undertaken a comprehensive analysis and discussion based on the primary data collected from two study regions. In those primary data chapters, I have elaborated on the underutilized crop farming systems, crop profiles in those farming systems as well as the economic contribution of those systems and underutilized crops for the economy of farmers. Identification of high potential underutilized crops opened the path for comprehensive value chain analysis of selected underutilized crops for those regions by identifying market actors, value chain structures, and positioning of those key actor value chains in the broader market system. The insight of the market systems is further elaborated by the look into the interactions of core value chain actors with other collaborative actors in service and policy context. The assessment of market performance as well as identification of the underlying factors contributes to the weaknesses of production and marketing pave the path to recognize potential broader development areas and possible interventions. In this chapter, I do a number of important discussions in light of the structure of the dissertation. Firstly, the discussion creates key findings of the study refer to the farming system as well as the market system. In this discussion, I make a special emphasis on key issues for the sustainable farming of underutilized crops. Secondly, the discussion is focussed on conclusions and recommendations of the study based on the findings and limitations of the study.

6.1Key findings of the study

6.1.1 Underutilized crops, farming systems, and economic contribution

The communities of study locations commonly face a lack of alternative livelihood options and significantly engage traditionally endowed agriculture. It is considered an easy choice for them and having perception as a part of their life. Their agriculture is highly influenced by changing rainfall patterns mainly in terms of lack of water to their farmlands as well as wild animal damages at increasing rates. Farmers adopt self-provisioning coping strategies to ensure consistent water supply to their farmlands mainly by constructing agro-wells and rainwater harvesting ponds. However, poor attention was given to soil and soil water conservation techniques and prioritizing drought-tolerant crops. There is a large pool of underutilized crops in their farms fallen mainly under

cereals, pulses, vegetables, fruits, and yam varieties. Chena is the main source for cereals and pulses while home gardens mainly produce vegetables and fruits. Off-season paddy fields consist mainly of Maize at a commercial scale with few underutilized vegetables. These underutilized crop farms follow mix cropping and ensure a greater level of contribution for income as well as food security of farming households. The selection of crops mainly depends on farmers' future climatic predictions, food security, and nutritional and health values than economic factors. However, the household income of farming families is significantly contributed by underutilized crops despite having a certain level of household income diversity. The key actors including farmers and traders involving in this sector have a considerable understanding of the concept of underutilized crops and priority crops are to be developed for their socio-economic development. As reflected by the perception of a wide range of involving actors highlighted economic marginalization, Poor demand in the local market, marginalized under hybrid crop culture, lack of knowledge and familiarity, ability to prevent non-communicable diseases, nutrition, and healthy are the key features of underutilized crops. This is considered as a local definition for underutilized crops which is very much important in the context of global definitions on underutilized crops are very much diluted. When prioritizing high potential underutilized crops, cost of production, market potentials, options for value addition, private sector involvement, and feasibilities to expand the cultivation was given the highest priority by actors.

6.1.2 Crop management, the economics of production and marketing of selected high potential underutilized crops

Finger millet, Cashew, and Red cowpea were selected as high potential underutilized crops for socio-economic development. Availability of quality seeds and planting materials is the key to the success of any crop. Farmers face issues of adequate quality seeds at the onset of farming cycles but manage with their seed stocks and sharing by peer farmers. They use minimum quantities of external inputs (especially fertilizer) leads to a drop in the soil fertility of their farmlands in the long-run. This soil fertility management is further aggravated by shorter or absence of fallow periods, especially in Chena farming.

Farmers attempted to align the key events of crop farming cycles (Such as land preparation, planting, pod development, and harvesting) in line with dry and rainy periods

based on their traditional knowledge. However, current climate changes denoted by long drought spells as well as unexpected rains made considerable disturbances for their farming practices.

The distribution of selected crops in underutilized crop farming systems showed some special features. Red cowpea is available in all three main farming systems in selected areas while Finger millet and Cashew dominates Chena farms and home gardens respectively. The crop management significantly depends on family labour irrespective of the farming system where male labour is the main contributor overall. A significant amount of male labour is allocated to protect their farms where female labour contributes equally to certain activities such as weeding and harvesting of the yield. Farming of selected potential crops brings reasonable gross profit for the farming families but becomes unfavorable in the case of both Finger millet and Red cowpea when considering the monetary value of unpaid family labour. However, both crops ensure food security as well as nutritional requirements of the farming families which seems to be the emerging interest and high considerations among farmers.

The market structure of high potential underutilized crops is characterized by a large number of scattered farmers, numbers of intermediaries (mainly village level and outside collectors), wholesalers, and retailers. Farmers practice individual marketing of their products instead of collective marketing under organized farmers' groups or associations. This kind of situation drops their bargaining powers compared to organized group marketing under formal agreements (such as out-grower models supported by buy-back or forward sales agreements). Individual marketing discourages options of potential value addition opportunities beyond cleaning and drying of their primary products. The majority of village-level collectors act as commissioned-agents of a large buyer. This relationship brings farmers further disadvantage in terms of the farm gate price for their products through it ensures a certain level of stable demand for the products. Unfortunately, outside collectors approaching farmers are not on a competitive edge to generate a certain level of competitive demand for farm products, especially at the peak seasons. However, farmers succeed to connect a considerable amount of their production directly to whole sellers (eg. Finger millet) by-passing collectors which brings higher profit margins for them. The role of middlemen (especially collectors) is very important for the farmers to sell their products at the peak of harvesting time and to ensure quick cash-flow back to them to re-start next cultivation season.

As reflected by the market margin and profit distribution along the value chain bring valuable insight into the distribution of benefit among different actors. Finger millet generates average profit along the value chain but farmers succeed to capture a significant portion of it. It is mainly because of the growing demand for the Finger millet as well as long storage capacity with minimum pest attacks under minimum storage conditions. The above features of the crop open spaces to smart farmers to keep their yield till market prices are favourable for them. Easy land preparation associated with minimum cost further enhances the advantage towards farmers. Cashew farmers receive reasonable profit against low cost of production but high-profit share headed toward whole sellers and retailers in the marketing context. However, cowpea farming sustains mainly due to the encouragement of agricultural officers and high demand created in the past by direct government purchasing of their product. The sustainability of cowpea farming will face critical issues in the future without the state-led demand and irregular importation of Cowpea to the country.

6.1.3. Constraints in selected high potential underutilized crops, potentials, and interventions for the improvements

The overall performance of selected high potential underutilized crops is determined by mainly production and marketing related factors. As I illustrated in chapter 5 low-level production, poor productivity and the low market price at harvesting season are the common issues for all high potential underutilized crops. Even though Chena farming is the major source of underutilized crops as well as high potential crops, limitations of lands to practice Chena, increasing rates of animal threat drop the production capacities. Long drought spells and lack of irrigation water discourage farmers to increase the scale of the economics of farming. The effectiveness of their coping strategies is debatable due to the inefficiencies of those strategies and marginal results. As interventions, the emphasis is given to improve the functionality and capacities of the farmers' organizations to face emerging challenges. Farmers ‘organizations need to work proactively to develop and strengthen their relationship with the ground level agricultural officers. Both study sites need a sustainable year-round irrigation scheme which is the necessary factor to keep the young generation in the agricultural sector in the long-run. The strengths of underutilized crop farming are highly related to the traditional knowledge available, easy farming practices, and growing demand in urban middle-class markets. It is important that adjusting the crop farming calendar according to the climatic

changes based on scientific evidence to minimize adverse environmental impacts. Farmer organizations need to move collective marketing of their products can be motivated by promoting community-based storage and processing mechanisms.

6.2. Limitations of the study

The limitations of a scientific study are characteristics of design or methodology that set parameters on the application or interpretation of the results of the study (Allen 2017). The most obvious limitation would relate to the ability to draw descriptive or inferential conclusions from sample data about a larger group (Wiersma 2000). Limitations are usually beyond the control of the researcher which are affected by the results of the study or control the way how results are interpreted by the researcher. It is clear that limitations are not merely mistakes but support the readers to understand real reflection of the results and scope of generalizability of the research findings. (Connell et al. 2011; Trevi 1999).
The researcher defines the boundaries of the study explicit by the scope are delimitations. Delimitations are boundaries that are set by the researcher in order to control the range of a study (Allen 2017; Simon 2011; Trevi 1999).
This study selected divisional secretariat divisions (DS Divisions) from each district by considering the diversity of agro-climatic variability. The Gramaniladari divisions (GN Divisions) within each DS division were selected based on the availability of underutilized crops. However, the study didn't cover all DS divisions and all GN divisions within each DS division. The study selected underutilized crop-growing farmers by following initial information given by government Agricultural Instructors and farmer society leaders followed by snowball sampling techniques. It is difficult to adopt random sampling techniques since the exact population of underutilized crop-growing farmers is not known.

Most of the farmers who cultivate underutilized crops live in marginalized locations where Chena cultivations are prominent. It is a challenge to reach them due to poor access roads, poor phone mobile signals and the threat of wild elephants in farming locations. I always travel with experience farmers to avoid those challenges.

Some farmers as well as traders reluctant to spend a long time to provide information to the researcher. This is mainly because of their busy work schedules. I always get the easiest time for them and use phone and cloud technology for distance meetings.

6.3. Recommendations

The recommendations are developed based on the consideration of findings of the research as well as by considering emerging contextual developments in the country. I organized my recommendations under three main areas. First, the study attempts to identify a set of recommendations to ensure sustainable farming practices. Second, recommendations are focused on expanding the contribution of underutilized crops for the household economy and livelihood environment. The third set of recommendations are focused on supporting the business and enabling the environment of underutilized crop products followed by interventional scope as final directions for the overall development of the sector.

6.3.1.Ensuring sustainable farming practices

The mixed cropping culture in all three farming systems needs to be further strengthened by motivating farmers to cultivate drought-tolerant crop varieties and crops having resistance to wild animal attacks. Such crops need to be identified clearly with strong scientific evidence.

Chena lands in high sensitive forest borders should move to safer locations. Simultaneously farmers should motivate to cultivate lands under their ownership, currently an abandoned stage instead of expanding Chena towards forest areas. Promotion of home gardening and especially farming in off-season paddy fields may discourage Chena farming to a certain level. Off season paddy fields need to ensure with irrigation for off-season farming. Food and water availability for wild animals in the forests need to improve to reduce animal movements to farmlands

Home gardens need to drive from subsistence to commercial level to some extent by optimizing the family labour utilization. Farmers should motivate to cultivate key crops in Chena (Cereals and pulses) in the peripheral locations of the home gardens by facilitating legal ownership of home gardens. Adopting new agricultural practices, rainwater harvesting, soil water conservation, soil improvements are some good and practical adoptions to make the system stronger and sustainable than current.

6.3.2. Household economy and livelihood environment

The significant amount of household income of farming families depends on underutilized crop sources as well as other farm products. This income is pretty much vulnerable to environmental and market risk and uncertainty. These risk factors needed

to minimize by introducing value addition at the producers' level as well as diversifying non-agricultural income. Same time productivity of male labour utilization should improve by controlling the massive time consume to protect farmlands from wild animal threats. The reasons contributing to increasing wild animal threats, the effectiveness of coping strategies as well as returns of the investment of such high-cost strategies need to be studied. Some massive investments may lead to unstable household economic resilience.

6.3.3. Business environment and underutilized crop value chains

The organizational capacities of farmers are at a very poor stage. It is recommended to execute a capacity assessment of existing farmer organizations and potentials to form new farmer organizations by linking farmers who cultivate identified high potential underutilized crops. The capacity of farmer organizations needs to be improved based on the scientific evidence of the capacity assessment. The priority should be given to improve the acceptance of the quality of their production processes (using the techniques like Participatory Guarantee Systems) and reduce market risk (by adopting out-grower models and forward agreements). Farmer associations move towards initial value addition options than just selling their primary products to traders. Community-based storage facilities need to be provided to stock their products till market prices are favourable to them.

The existing market linkages between farmers and especially village level collectors and village level primary value-adding actors need to be supported to strengthen the relationships and expanding the scopes. This will cartelize the local economic development in a circular economic context and manage the bargaining power of the outside business people approach farmers. As a long term strategy to increase the income of Cashew farmers, need to explore potential pathways to use especially cashew apple to enhance their income by experimenting with new product development as well as finding emerging market opportunities. Same time market linkages need to be developed to connect farm products to emerging urban markets (such as Good market Battharamulla, Colombo) as well as international markets. This process needs careful facilitation by the responsible agency till the relationship reached an optimum operation stage.

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Appendices

Appendix. 1 Questionnaire for farmers' household survey (Underutilized crop-growing farmers)

1-Preliminary Information on Location of Household Survey

Name of the Interviewer		Home Address			
Date/time					
Form Number					
District	DS Division		GN Division		
Mobile No of the interviewee		Landline No of the interviewee			

2-Basic Demographic Information of the household:
Total No of persons living in the house:...

ID	Name of the family members (Do not include visitors)	Sex (M/F)		Age	Education Status	Occupation	Relationship of the respondent to index person
1		M	F				
2		M	F				
3		M	F				
4		M	F				
5		M	F				
Herself -1,Mother-2,Father-3,Husband-4,Brother-5,Sister-6,Son-7,Daughter-8,Other relative (male)-9,Other relative (female)- 10,Outsider (Male)-11,Outsider (Female)-12							

3: Dynamics of the household land resources and key underutilized crop farming systems

Lands (Availability/ownership/Accessibility/Manageability/etc..)							
Total land available(Ac)		Irrigation		Rainfed		Abandoned	
No of land blocks		Less than 1AC		1 AC-2AC		Larger than 2AC	
Distance from home to closed land (m)				Distance from home to distanced land(m)			
Farming systems contains underutilized crops						**Size of land allocated (Ac)**	
Home Gardens							
Chena cultivation/Shifting cultivation							
Off-season paddy lands							

4-Composition of main farming systems with underutilized crops availability

Farming system	**Leading common crops available (First 10 priority)**	**Potential underutilized crops available (First 10 priority)**
Home gardening		
Shifting cultivation/Chena		
Offseason cultivations in Paddy		
Special case: Wild collections		

5-Different income sources including farming systems and economic contribution to the household economy (Changes during the last 10 years' period)

Income sources and Farming system	Household economic contribution(05 years back)-LKR Per Year	Household economic contribution (Current) LKR Per Year
Government employment/s		
Private/NGO sector employment/s		
Self-employment (Non-Agricultural)		
Casual labor work		
Small production units		
Providing services(Transport, repairing, etc..)		
Small businesses (Retail, Wholesale and		
Any other non-farming income		
Paddy farming		
Commercial Agriculture		
Commercial vegetable and fruits		
Paddy lands (Offseason)		
Home gardening		
Chena/shifting cultivation		
Any other		

6-Position and contribution of underutilized crops in underutilized crops available farming systems

The farming system having underutilized crops	Total land size (Ac)	The land covered by UUCs	Total income per month or year or season by UUCs	The percentage contribution from UUCs
Offseason paddy				
Home gardening				
Chena cultivation				

7-The most vulnerable non-major crops of last decade and reasons for the vulnerability (Maximum 5 crops)

The crop	The extent of cultivation (Ac)		The income per year		Reason/s for the
	10 Years back	Current	10 Years	Current	

8. What are the challenges of farming systems and particularly of cultivating UUCs?
9-How can these challenges be tackled?
10-What are the supports, farmers, getting from the different government and non-government agencies to solve the above challenges?
11-What farmers exactly expect from different government and non-government agencies?
12-Do farmers like to continue growing UUCs in their farming systems? If so what are the driving factors?

Appendix. 2 Semi-structured questionnaire for the Key Informant Interviews with leading farmers (Position holders of farmers' societies), Agricultural Instructors, Sellers

Basic Information about the event and Participants			
Interviewer		DS/GN Divisions	
Interviewee &Position		Postal address of the interviewee	
Date and time		Phone number	

1. **What do you mean by underutilized crops? What are the criteria you like to propose to identify or recognize underutilized crops?**
2. **How do you understand the term "Common underutilized crops" and "potential underutilized crops"?**
3. **What were the dominating/common underutilized crops observed in *home gardens, Chena and off-season paddy fields in 5-10 years back?* (Get a list of crops separately refer to each farming systems and additionally wild collections)**

Common underutilized crops in home gardens	Common underutilized crops in Chena cultivations	Common underutilized crops in off-season paddy fields	Wild/forest collections (Optional)

4. **What are the crops dominating/common in the same farming systems now? (Get a list of crops separately refer to each farming systems and additionally wild collections)**

Common underutilized crops in home gardens	Common underutilized crops in Chena cultivations	Common underutilized crops in off-season paddy fields	Wild/forest collections

5. **What are the main reasons for some crops lost their position in mentioned farming systems during the last decade? *(Probe for socio-economic, environmental, climatic and any other very specific reasons)***

Key farming system	Main reasons for the loss of some crops during the last decade (Socio-economic, climatic, environmental and very specific reasons)
Home gardens	
Chena cultivations	
Off-season paddy	

6. What are the common underutilized crops and potential underutilized utilized crops in your DS division and GN division wise?

DS	GN1(……	GN2(……	GN3(……

NB: Please note "p" within bracket in front of the potential crops," C" within the bracket of common crops and "PC" within the bracket of potential and common crops

7. Can you mention any high potential underutilized crop/s suitable for your area which is not currently existing at a reasonable level? Please mention key facts to justify your suggestion?

The proposed crop	Justifications to mentioned as high potential crop type

8. According to your understanding, what are the different reasons behind the above mentioned potential crops not existing in farming systems?

The proposed crop	Reasons for not existing though justified as high potential crops

9. What are the best crops that can improve the well-being/livelihood of the farmers in your DS division in general? (This may include both common and potential underutilized crop types and any type not existing in current farms. Please mention five crops)

10. How you give a score to your potential underutilized crops based on a set of selected criteria mentioned below? (Maximum score 5)

No	Criteria	Details	Crop A	Crop B	Crop C	Crop D	Crop E
01	The crop is cultivated by a large number of farmers in the selected geographies in the district	There should be a significant number of farmers engaged in the crop. They need to be cultivating at a reasonable level. Farmers should available in all the selected GN divisions for the study.					
02	The crop needs to have an existing reasonable marketing network	The crop products should have existing marketing links beyond the village level boutiques and suburbs small shops					
03	Potentials of the VC to increase the income of smallholder farmers	In the targeted geographic region the mentioned crop is cultivated by a significant majority of farmers who interested on underutilized crops					
04	Presence of Willing Private Sector	Availability of any existing or potentials with Private Sector Companies who engage in some value-added products based on the selected crop					
05	The interest of government agricultural officers	Increased interest by state agricultural officers to promote the selected crops as recognized by its potentials and some provisions for the development					
06	Local resource (Raw materials, support services, climactic situation, etc.) availability	Land, Raw material, climatic situation, skills, heritage, expertise, experience					
07	Favourable Market Demand	Unmet demand, high growth potential, potentials in local/regional/national/export market					

08	Scope for Value Addition	Scope for creating a new product, reduce the cost of production, improve an existing product, improve efficiency, etc.					
09	Input requirement level	Ability to cultivate the crop with minimum inputs. This includes the potential of the crop to cultivate under organic farming methodology to get higher prices on growing urban/semi-urban markets					
10	Outreach/Scalability	No. of People that can be engaged (both current farmers and the wider population in the region)					
11	Sensitivity to low-cost interventions	To what extent the value chain of the proposed crop can enhance by doing poor farmers' friendly interventions.					
12	Favorable Regulations and Policies	Government's policy to stimulate market; Environmental sensitivity; Cultural and norm sensitivity					
13	Adaptability to the climatic changes	The potential of the crop to survive under extreme climatic conditions such as heavy rains and droughts. And the potential of the crop to cultivate by making minimum environmental impacts					

(Interviewee is asked to give marks at 0.5 slots up to the maximum marks proposed.)

Appendix. 3. Questionnaire for farmers' household survey (Selected specific high potential underutilized crop cultivating farmers)

1-Preliminary Information of Location of Household

Name of the Interviewer	Home Address		
Date/time			
Form Number			
District		DS Division	GN Division

2-Land allocation for the crop and representation in farming systems

Type of the land	**Irrigation available**		**Rainfed**	
	Total land size	Land covered by crop	Total land size	Land covered by crop
Size of allocation				
Farming systems contains underutilized crop A			**Size of the farming**	**Land allotted for**
Home Gardens				
Chena cultivation/Shifting cultivation				
Farming in off-season paddy lands				

3-Sourcing Inputs

Input source	Quantity required for UUC per year	Price of a one unit
Seeds/Planting materials (Kg)		
Fertilizer(Kg)		
Agro-chemicals (kg/L)		
Family labour (labour day/8 hours)		
Hired labour (labour day/8 hours)		
Land preparation cost (LKR)		**Per acre**
Crop management cost (LKR)		**Per acre**
Harvesting cost (LKR)		**Per acre**
Drying and processing cost (LKR)		**Per acre**
Storing cost		**Per acre**

4-Production

Farming systems contains underutilized crop A	Size of production per year (kg)
Home Gardens	
Chena cultivation/Shifting cultivation	
Off-season paddy lands	
Any other lands	
Total production	

5-Marketing and Value addition

Production, consumption, and selling (At raw form and any value-added form)	Percentage of the total quantity	price per Kilogram
Own family consumption		
Sharing among relatives and neighbours/Barter system		
Selling to local HH level		
Direct primary/secondary collectors		
Direct whole /retail sellers		
Any other channels		

6-Involvement of men and women

Task of farming	Contribution of own family	Contribution of outsiders (%)	Contribution of Men (%)	Contribution of women (%)
Lad preparation				
Crop establishment				
Irrigation				
Weed management				
Fertilizer and				
Harvesting				
Storing, Processing				
Marketing				

7-Value chain actors and their information

Name of Respondent	
Company Name	
Address	
Phone Number	
Function and Role in Value Chain	
Interviewer (s)	
Date	

Name of the actor	No of actors	Avg value (Lkr/Kg)	Avg value (Lkr/Kg)	Total quantity handled
Input suppliers (Seeds)				
Input suppliers				
Input suppliers (Agro-				
Input suppliers (All)				
Producers				
Primary collector/s				
Secondary collector/s				
Whole sellers				
Retailers at village				
At Colombo Market				
At Dambulla Market				
Export Market/s				
Any other local or				

Appendix. 4 Semi-structured questionnaire to interview market Actors-Input suppliers (Seeds, Fertilizer and Agro-chemicals)

Question	Remarks
What is your sales coverage area?	Basically, get an idea of the size of the geography
Who are your main customers?	
What is the volume of seed that you sell to these customer segments	Kilo or Metric ton in each of
What varieties of seeds do you sell?	
What volume of seed from each of these varieties is being sold every	Kilo or Metric ton from
What is the price of one Kilo of Seed for this crop?	If there is a difference due to variety, mention the price of each variety in Rs/Kilo
Which customer segment is predominantly increasing over the last three years?	
Can you indicate any percentage of increase in demand for seed from this customer segment?	
Was there any price fluctuation of Seed over the last three years? If	
What do customers demand from you?	E.g. low price, good quality,
Do you provide information on how to sow seeds to your customers?	
Where do you get such information?	
Do you sell branded seeds or non-branded seeds as well?	
Which companies seeds do you sell?	
If you sell non-branded seeds, then where do you get these seeds	

Do you provide seeds in cash or credit?	
How many seed retailers are working in this area as you?	
Is the production of this crop, increasing in your area?	
If it is increasing then can you mention the percentage of increase that	
What is the major use of this crop now a day - Raw form or processed form? Please mention what is the processed version of this crop	
Which variety of the crop is getting more preference?	
Have you seen women in your area being engaged with this crop?	Asked if your feel requires in view of finding some pathways to develop the respective value chain to the next level.
If yes, then in which areas - production, processing, marketing, etc.	
Is the engagement, increasing or decreasing? Please mention a percentage, at which it is increasing/decreasing	
What is your sales coverage area?	Basically, get an idea of the
Who are your main customers?	Get an idea of underutilized
What is the volume of fertilizer that you sell to these customer	Metric Ton
What type of fertilizer do you sell?	
What volume of fertilizer from each of these types is being sold every	
What is the price of each type of fertilizer in terms of Rs/Kilo	
Which customer segment is predominantly increasing over the last	
Can you indicate any percentage of increase in demand for fertilizer	
Was there any price fluctuation of Fertilizer over the last three years?	
What do customers demand from you?	E.g. low price, good quality,
Do you provide information on how to use fertilizer to your	
Where do you get such information?	
Which companies fertilizer do you sell?	
Do you provide fertilizer in cash or credit?	
How many fertilizer retailers are working in this area as you?	
What is your sales coverage area?	
Who are your main customers?	
What is the volume of Pesticide that you sell to these customer	Metric Ton
What type of Pesticide do you sell?	
What volume of pesticide from each of these types is being sold every	
What is the price of each type of pesticide in terms of Rs/Kilo	
Which customer segment is predominantly increasing over the last	
Can you indicate any percentage of increase in demand for pesticides	
Was there any price fluctuation of Pesticide over the last three years?	
What do customers demand from you?	E.g. low price, good quality,
Do you provide information on how to use Pesticide to your	
Where do you get such information?	
Which companies Pesticide do you sell?	
Do you provide Pesticide in cash or credit?	
How many Pesticide retailers are working in this area as you?	
Can you mention the reasons for such an increase/decrease?	Question for only Eastern

Appendix. 5 Semi-structured questionnaire for the focus group discussions with farmers who cultivate selected high potential underutilized crops

Contact Information Collection of the Participants			
Name/Nickname of the participant	**Any position in the village**	**Home Address**	**Phone contacts**

Input Acquisition	
Question	***Remarks***
Where do you get seeds/planting materials from?	*E.g. Branded retailers, non-branded retailers,*
How much do you have to pay for a kilo of seeds/planting materials?	*Mention the payments in terms of Sri Lanka rupees*
Do you pay cash or credit?	
If credit, then what are the modes and conditions of	*E.g. partial, full and buyback*
Do you get any support from the seed/planting material retailer?	*E.g. information on seed sewing, using other inputs, credit facility, etc.*
Are seed/planting materials widely available in your	
Is there any issue with the quality of the	
What challenges do you face in sourcing seeds/Planting materials?	*(Please probe for problems and underlying causes)*
How did you try to tackle these challenges?	
Who do you think can help you in tackling the	
After purchase, do you have to do any further	
What are those processes?	
Do you need transport support in sourcing seed?	
Where do you arrange transport from?	
How much do you cost of transport? Who bears the	
What are the storage methods you follow for	
What is the cost of storage?	
Where do you get fertilizer from?	*E.g. Branded retailers, non-branded retailers,*
How much do you have to pay for a kilo of	
Do you pay cash or credit?	
If credit then what are the modes and conditions of	*E.g. partial, full and buyback*
Do you get any support from the fertilizer retailer?	*E.g. information on fertilizer usage, using*
Is fertilizer widely available in your area?	
Is there any issue with the quality of the fertilizer?	
What challenges do you face in sourcing fertilizer?	*(Please probe for problems and underlying*
How did you try to tackle these challenges?	
Who do you think can help you in tackling the	
Do you need transport support in sourcing fertilizer?	
Where do you arrange transport from?	
How much do you cost of transport? Who bears the	
What are the storage methods you follow for	
What is the cost of storage?	
Where do you get pesticides from?	*E.g. Branded retailers, non-branded retailers,*
How much do you have to pay for a kilo of	
Do you pay cash or credit?	
If credit then what are the modes and conditions of	*E.g. partial, full and buyback*
Do you get any support from the pesticide retailer?	*E.g. information on pesticide, using other*
Is pesticide widely available in your area?	

Is there any issue with the quality of the pesticide?	
What challenges do you face in sourcing pesticides?	*(Please probe for problems and underlying*
How did you try to tackle these challenges?	
Who do you think can help you in tackling the	
Do you need transport support in sourcing	
Where do you arrange transport from?	
How much do you cost of transport? Who bears the	
What are the storage methods you follow for	
What is the cost of storage?	
Where do you get an irrigation facility from?	*E.g. Natural, from a service provider, etc.*
If it is a service provider then who is she/he?	
How do you pay for the service?	
How much do you need to pay?	
Is the irrigation service widely available?	
Do you face any constraints regarding availing	*(Please probe for problems and underlying*

Production

Question	Response	*Remarks*
What is your primary source of income?		
What percentage of your annual income comes from Crop A		
What volume (in terms of Kilograms) of crop A do you produce		
What are the different forms of crop A do you sell- What volume		
What is your average yield?		
What constrains you in achieving your yield targets?		
What major technologies did you adopt in recent years for		
How do you think you can increase yield?		
What is your average cost of production?		
What constrains you in controlling the cost of production?		*(Please probe for*
Who provides you the knowledge, information, and skills		
How do you collaborate with other farmers in your locality for		
What constrains you in acquiring knowledge, information, and		*(Please probe for*
What do you do after harvesting?		*E.g. drying, etc.*
Where do you store your product before selling?		*E.g. Own storage,*
How long do you store before selling?		
Do you perform sorting or any other processing before selling? If		
What is the volume of crop A that is usually waste during storage?		
How many farmers in the area are engaged in crop A production?		

Marketing

Question	Response	*Remarks*
Do you sell the entire production volume or use a portion for your		
What percentage of your production do you sell?		
Who are your major buyers?		
What price do you get from the buyers?		*E.g. Rs. per Kilo*
How do you transport the product to the buyers? Who pays the		
How do the buyers pay- in cash or in credit?		
What are the modes and conditions of credit?		
What quality of products of Crop A do you think attracts the		

Are the buyers satisfied with the quality?		
Is there any particular variety of crop A that your buyers like?		
What percentage of your production is wasted during marketing?		
How did you try to reduce wastage?		
Who provides you the market information on price?		
Who provides you the market information on quality?		
How do the buyers help you in marketing?		
What other support do you receive for marketing and from whom?		
What are your major challenges in marketing?		(Please probe)
How did you try to tackle the challenges?		
What issues do you need to address to increase your sales?		
Who can support you to address your market-related constraints?		(Please probe
Access to Finance		
Question	**Response**	***Remarks***
How much working capital do you need for every production		
How much of the working capital is sourced through credit?		
From whom do you source your credit?		
What interest do you need to pay for credit?		
What challenges do you face in sourcing funds?		*(Please probe)*
How did you try to tackle the challenges?		
What challenges do you need to address to source funds?		
Involvement of Women and Men		
Question	**Response**	***Remarks***
In which kind of activities women/Men involvement is significant		E.g. drying,
Are the women/Men able to involve those activities as per		
What challenges do women/Men face in involving those		
How do you think you can tackle the challenges for women/Men		
How are women/Men involved in the production?		
Do the women/Men have the necessary knowledge and skills for		
How much do you pay the women/Men for production?		
What challenges do women/Men face in production?		
How are women/Men involved in marketing?		
Are the women/Men able to play their role in marketing?		
What challenges do women/Men face in marketing?		
How are women involved in sourcing finance?		
What role can women/Men play in sourcing finance?		
Extension and Training		
Question	**Response**	***Remarks***
Do you have any training on Crop A production, processing or		
Who are the major providers of training for you?		
Do you get any support from the Government Departments? If yes		
What support do you get from local NGOs/ Projects for training?		
What other supports do you get from local NGOs/ Projects?		
Do you pay for training?		
What was the last training that you attended?		
What knowledge/ information did you get from the training?		
To what extent farmers apply their training knowledge in the		
If apply what kind of outcomes and impacts are visible?		

What knowledge do you want to gather from future training?		
Associates		
Question	**Response**	***Remarks***
Do you have any association/ farmers cooperatives?		
What role does the association play for input procurement?		
What role does the association play for production?		
What role does the association play for marketing?		
What role does the association play for access to finance?		
What other roles does the association play?		
What support do you want from the association?		
What are the major challenges for the association?		
If you do not have an association, do you think it is needed?		
Did you try in forming an association? What has been your		
Disasters		
Question	**Response**	***Remarks***
What are the major disasters in your region?		
How do disasters affect the production/ marketing of the product?		
What did you do to adapt to disasters?		
Who has been supporting you to adapt to disasters?		
What production technique did you embrace/ change to adapt to		
Future		
Question	**Response**	***Remarks***
Do you think Crop A farming is a profitable venture?		
Do you want to continue it in the future?		
With the policies of the new government, do you see any		
How can you avail of these opportunities?		
Do you require any assistance?		
What sort of assistance are you thinking of?		

Appendix. 6: Semi-structured questionnaire for the key informant interviews with traders (Collectors, Whole sellers, and Retailers of both raw and processed forms) of selected high potential underutilized crops

Nick Name of Respondent			
Company Name			
Address			
Phone Number			
Function and Role in Value Chain			
Interviewer (s)			
Date			
Question	**Response**		**Remarks**
	Collectors/Wholesalers/Retailers		
	Raw form	***Value-added form***	
What is your geographic coverage of business?			i.e. is it the whole
From whom do you buy Raw crop A products?			
Which form do you buy it?			

Do you make any changes in the form after you buy it?			
What is the volume of crop A that you purchase in one			
What is the price at which you purchase?			Rupees per kilograms
Is there any particular variety that has more demand?			
Have you found any constraints in sourcing crop A? What are those constraints?			
Do you conduct any processing/Value addition to the Raw			i.e. storing,
Who do you sell? If there is more than one type of			
What is the percentage of demand for each segment of			
What is the total volume of crop A that you sell per			
What is the average price at which you sell?			
What are the constraints that you faced in the last three			
After the new government came to power any change in			
What were the changes? i.e. has the business decreased or			
What are the reasons for such a change?			
Do you see crop A business as a profitable venture in the			
Tentatively, what percentage of business growth in this crop have you experienced so far in the last three years?			

Appendix. 7 Semi-structured questionnaire for the key informant interviews with regulatory actors (Departments and Institutions) of selected high potential underutilized crops

Name of Department/Division/Ministry:	
Name of Respondent	
Designation:	
Phone Number	
Interviewer (s)	
Date	

Question	Response	Remarks
Which one of the following sectors is a more priority sector for your		
Do you have any program to develop these sectors? Can you explain		
What is your target expansion regarding these sectors? E.g. certain		
What you can especially say about programs to develop underutilized crops?		
What is your target expansion regarding this Underutilized crop sectors?		
What activities have you done so far to materialize that plans to develop		
Do you have any future plans regarding Underutilized crop sectors?		
Do you support the farmers in these sectors under your existing		
Have you collaborated with any NGOs/private companies previously for		
Is there any special plan for your department/division/ministry regarding		

Appendix. 8 Semi-structured questionnaire for the key informant interviews with service providing actors (Departments and Institutions) of selected high potential underutilized crops

Name of	
Name of Respondent	
Resignation:	
Phone Number	
Interviewer (s)	
Date	

Question	Response	Remarks
What type of service do you provide? (e.g. training, extension, storage,		
Who are your main customers? (small farmers, medium farmers, large		
How many customers do you serve a month? Can you segregate the		
How do you charge for your service? What is the rate?		
How the payment is completed? In Cash or in Credit?		
6. Are you meeting the requirement of the customers? If not what else the		
Are the customers happy with the price? Are they asking for a price		
How many service providers are there in the locality like you?		
What are the inputs for your service provision? (Vehicles, human		
What is the cost for you in the provision of such services?		
Was there any change in your business in the last three years? If yes what		

Appendix. 9: Ethical Approval document

UNMC Ethics Committee Reviewer
Decision Form (version 3, June 2017)

The University of Nottingham
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Ethics Committee Reviewer Decision

This form must be completed by each reviewer. Each application will be reviewed by at least two members of the Ethics Committee. Reviews should be completed electronically and emailed to the **Ethics Administrator** (Vanitha.Singaram@nottingham.edu.my) from a University of Nottingham email address.

Applicant full name: HAMBANGE DON AROSH CHAMIKARA BANDULA

Application identification number: HDACB260517

REVIEWED BY:

Reviewer ID: BB

Date: 25 JULY 2017

Outcome: Approved Awarded - but you must make the changes requested below

Major amendments required:

Minor amendments required:

The applicant has included a consent form and a briefing document for the participants. It would seem the applicant will be going through different authorities to gain access to participants and will be getting proper permission and consent.

The plan for storage and handling of data was submitted late (last Thursday, 20th of July 2017). Although data security and protection of participant identity was given. However, there was no indication how long data will be stored and what will happen to the data after that (See Code of Research Conduct and Research Ethics item 4. 2 Research Data). Applicant need to be aware that UNMC researchers are legally bound by the Malaysian Personal Data Protection Act (PDPA) 2010. If there are any discrepancies between the laws in UK, Sri Lanka or Malaysia, it is expected that researchers adhere to whichever Act that has the most stringent requirements applicable to their area of research.

Comments:

Applicant will need to make sure he or she can obtain all necessary permits and permission from Sri Lankan government and follow guidelines by UNMC and the Malaysian government.

Applicant will need to submit a risk assessment (SEREC) for health and safety while working out of Malaysia. Please obtain sufficient insurance coverage for him or herself and those who will be helping him with the work. Also, please refer to the university guidelines for lone working and good practices for conducting research overseas.

UNMC Research Ethics Committee Reviewer Decision Form (version 3, June 2017)

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

Please note:

1. The approval only covers the participants and trials specified on the form and further approval must be requested for any repetition or extension to the investigation.
2. The approval covers the ethical requirements for the techniques and procedures described in the protocol but does not replace a safety or risk assessment.
3. Approval is not intended to convey any judgement on the quality of the research, experimental design or techniques.
4. Normally, all queries raised by reviewers should be addressed. In the case of conflicting or incomplete views, the ethics committee chair will review the comments and relay these to the applicant via email. All email correspondence related to the application must be copied to the Faculty research ethics administrator.
5. You have the right to appeal against a decision by the Research Ethics Committee. To do so please complete the appeal form (available on the Moodle Page) and submit it to Vanitha.Singaram@nottingham.edu.my

Any problems which arise during the course of the investigation must be reported to the Research Ethics Committee