Public-Private Partnership Prospects for Quality Seed Potato Production in Sri Lanka

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Research Report No: 232 February 2020

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First Published: February 2020

Final typesetting and lay-out by: Dilanthi Hewavitharana

ISBN: 978-955-612-263-3

FOREWORD

Public-private partnerships are vital to modernize the agriculture sector in developing nations and to deliver multiple benefits that could possibly contribute towards the pursuit of the goals of sustainable development. Public-private partnerships could bring together all actors across the value chain to improve productivity and growth in the agriculture and food sector. In Sri Lanka, the local seed industry still lacks capacity and capability to produce adequate quantities of high quality seeds.

The cost of seed accounts for more than 50 percent of the total cost of production of potato due to scarcity of locally produced quality seed potatoes and high cost of imported seeds. Further, costs of the seeds of the OFCs are lower than that of potato, imposing a burden on the local farmer community. It is inevitable that both producers as well as consumers suffer due to the poor profit margin or loss. However, this could possibly be mitigated by a proper collaboration between government and private entities. These collaborations can open up barriers related to finance, technology and even lead to structural modifications in the value chain.

This study presents a valuable review of the current seed potato production programme of the government, its capacity, mechanism of seed potato importation, Seed Act practices and the need for private sector investment in producing pre-basic seeds. Therefore, I believe that the findings and recommendations of this study would be immensely beneficial to policymakers and the key stakeholders in the seed potato industry and the academic community, in general.

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ACKNOWLEDGEMENTS

We express our sincere gratitude to Mr. K. W. E. Karalliyadda, Mr. K. Udage and Mr. Keerthi B. Kotagama, former Directors of HARTI for their support and assistance to make this study a success. Further, special appreciation goes to Mr. R. L. N. Jayatissa, former Additional Director of HARTI and Dr. W. A. R. Wickramasinghe, Additional Director (Cover-Up) and Head - Marketing, Food Policy and Agribusiness Division of HARTI for their immense support by providing valuable insights to improve this report.

We convey our gratitude to the external reviewers - Dr. Wasanthi Wickramasinghe, Senior Research Fellow, Gamani Corea Foundation and Dr. D. V. P. Prasada, Senior Lecturer, Department of Agricultural Economics and Business Management, Faculty of Agriculture, University of Peradeniya for providing valuable comments to improve the structure and presentation of the report.

We acknowledge Mr. H. M. S. Jayaratne, Statistical Officer, Marketing, Food Policy and Agribusiness Division of HARTI for facilitating and conducting all field arrangements according to the work plan. Also, we thank Mr. M. D. L. Senerath, Senior Analyst Programmer, Statistics and Data Processing Unit of HARTI for his cooperation in coding, data tabulation and presenting necessary analysis required for the study. Further, we thank Mr. J. P. C. Udakumbura, Ms. A. D. L. Amarasingha, Ms. A. P. I. Mendis, Ms. U. Aththanayake and Mr. S. A. K. B. Senerath, Casual Investigators of HARTI for conducting the questionnaire survey of the study.

We extend our deepest appreciation to Ms. Chandrika Dahanayake, Assistant Registrar (Programme) and all her staff for making the administrative facilitation throughout the study. We are also grateful to Ms. Suharshi Perera, Editor of HARTI for language editing and Mr. S. A. C. U. Senanayake, Senior Information and Publication Officer of HARTI and all the staff of the Publication and Printing Unit of HARTI for their support in publishing the report. We acknowledge all the public and private entities that directly and indirectly supported in making this study a success.

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EXECUTIVE SUMMARY

Among various inputs, seeds play a critical role in successful crop production, farm productivity and profitability while reducing the cost of other inputs. Potato is largely a profit oriented crop grown in both Badulla and Nuwara Eliya districts. Despite farmers' market anticipations the net return is lessened by high cost of production and low yield. The main reason for this has been identified as the inferior quality seeds and high cost. Only the seed accounts for more than half of the total cost of cultivation due to scarcity of quality seed potatoes.

Forming viable Public-Private Partnerships to strengthen the quality seed potato production in Sri Lanka emerged a plausible measure in this context. Despite many rewards such as financing, initiating technical know-how, researching, and many other aspects in agriculture little attention was directed towards forming such partnerships throughout history. The World Food and Agriculture Organization also highlights policies of developing countries should direct towards fostering strong Public-Private Partnerships to enhance agriculture sector. Hence, the general objective of this study was to determine the prospects in initiating Public-Private Partnerships to improve quality seed potato production in Sri Lanka through a comprehensive and broad examination of all actors in the potato cultivation sector in the country.

Structure-conduct-performance paradigm was used as the conceptual framework to assess the behaviours of both public and private entities. It is grounded that success of Public-Private Partnerships depend on structure-conduct-performance and moderated by the environmental factors. Both primary and secondary data was collected. Above 30 key stakeholders were examined via key informant interviews and focus group discussions. Furthermore, 276 farmers were surveyed via a pre-tested structured questionnaire using multi-stage sampling technique. Badulla and Nuwara Eliya districts were selected for the study. Both descriptive and inferential statistics were used to analyze the data. ANOVA was deployed to compare each system namely pre basic, basic, imported and other seed types with respect to cost components such as seed, fertilizer, chemical, labour and any other potato cultivation related costs. Furthermore, Post Hoc Test was carried out to assess the statistical significance of different seed systems. A SWOT analysis was also carried out to exploit possible strengths, weaknesses, opportunities and threats for seed potato production sector in the country.

Report explores the overall review of seed potato production mechanism in public and private sectors, overall review of farmer seed potato production systems, past and present Public-Private Partnerships for seed potato production and future prospects for viable Public-Private Partnerships for the sector. It is envisaged that partnerships are required for long term and sustainable solutions. Presently, production of G_0 is inadequate and mainly carried out in the government farms. However, G_0 production could be further strengthened if it is properly introduced to a selected farmer base under continuous monitoring and supervision.

Private companies are the main bodies which import seed potato into the country. Average annual importation from 2013 to 2017 is approximately 1762mt. Generally, imported seeds are recommended to cultivate only for consumption. G_0 production is not economically feasible for commercial level private companies. However, commercial level private entities could engage in the process of multiplying G_1 while, importing a portion of seeds to retain the varietal diversity. G_1 production could be carried out in poly tunnels under geophonic system.

Build-Operate-Transfer approach is an option for the government to outsource public projects to the private sector. In this approach private entity receives concession for a fixed period from the public party for the development and operation of a public facility. The development consists of the financing, designing and constructing of the facility, managing and maintaining the facility adequately, and making it sufficiently profitable. The private entity secures return of investment by operating the facility and, during the concession period and also as the owner. At the end of the concession period, private entity transfers the ownership of the facility free of liens to the public entity at no cost. This approach is very much useful to share risk between the parties which considered as a vital aspect of a Public-Private Partnership. However, one should understand that this strategy does not imply 100 percent production or self-sufficiency level in seed potato in Sri Lanka.

Facilitating functions such as storage facilities are required to hold buffer stocks and surpluses. Study revealed cold storage facilities should only be constructed for large scale and active farmer groups. However, maintenance including utility cost should transfer to the specific farmer group to make it a realistic investment. The study also, proposes a subsidy or financial aid system under the partnership programme to increase facilitating functions to ensure uninterrupted supply of quality seed potato.

In conclusion, it is must to understand all partnerships share mutual benefits and risks. Strengthening the current Seed Act is another major emphasis which facilitate Public-Private Partnerships in Sri Lanka. However, this is a matter which must be worked out through a proper legal agreement. Therefore, the time has come for Sri Lanka to take necessary steps to establish viable Public-Private Partnership in relation to agricultural inputs.

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ABBREVIATIONS

A/L	-	Advanced Level
ALDMCS Ltd.	-	Agricultural Livelihood Development Multi-Purpose Co-operative Society Ltd.
ANOVA	-	Analysis of Variance
ASC	-	Agrarian Services Center
BOT	-	Build-Operate-Transfer
$C_1 – C_2$	-	Consumption Potato 1 – Consumption Potato 2
COP	-	Cost of Production
DOA	-	Department of Agriculture
DS	-	Divisional Secretariat
DZLiSP	-	Dry Zone Livelihood Support & Partnership Programme
FFS	-	Farmer Field Schools
$G_0 – G_9$	-	Generation Zero – Generation Nine (Seed Varieties)
GN	-	Grama Niladari
HORDI	-	Horticultural Crop Research and Development Institute
IFAD	-	International Fund for Agricultural Development
ISTI	-	In-service Training Institute
NVQ	-	National Vocational Qualifications
O/L	-	Ordinary Level
OFC	-	Other Field Crops
PPP	-	Public-Private Partnership
RRDB	-	Regional Rural Development Bank
SCP	-	Structure-Conduct-Performance
SCPPC	-	Seed Certification & Plant Protection Centre
SPMDC	-	Seed & Planting Material Development Centre
SWOT	-	Strengths, Weaknesses, Opportunities & Threats
UNICEF	-	United Nations International Children's Emergency Fund

CHAPTER ONE

Introduction

1.1 Research Background

There is no universally-accepted definition for the concept, "Public-Private Partnership" (PPP); however, this can be simply identified as a long term, contract-based agreement between public and private sectors. PPP is defined as a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance (World Bank Group , 2018). Public-private partnerships aim at improving delivery of goods and services to the civil society through sharing of skills and assets of each sector (i.e., public and private sectors) (Asian Development Bank, 2008; Food and Agriculture Organization , 2016; The National Council for Public-Private Partnerships, 2017). Public partners include the government, ministries, departments, publically funded education and research institutes and public banks, whilst private partners include mainly businesses (Asian Development Bank, 2008; Food and Agriculture Organization, 2016). An effective PPP recognizes the potentials of each partner relative to the other and allocates tasks, obligations, challenges, and risks among the partners in an optimal way (Asian Development Bank, 2008).

A sound partnership allows the public sector to regulate and supervise the PPP mechanism, while allowing the private sector to play the operational role, which is provision of improved goods and services to the society. The private sector enters into partnership with the aim of maximizing profits, which are generated by increased efficiency of the partnership operation. With increased operational efficiency, goods and services provided to the society become better, cheaper, and economically sustainable (Asian Development Bank, 2008). Public-private partnerships that were commonly seen in infrastructure, health, information and technology, education, and transportation sectors are now being increasingly promoted as a mechanism for ameliorating agricultural growth and productivity, thereby improving agricultural sustainability (Asian Development Bank, 2008; Food and Agriculture Organization, 2016).

Unlike traditional PPPs, agricultural PPPs, widely known as Agri-PPPs, are either informal or formal agreements between partners that may range from community organizations to non-governmental organizations. Agricultural PPPs have been initiated in developing countries in African, Latin American, and South Asian regions aligning their aims with the priorities of governments; consequently, national macroeconomic issues are addressed via agri-PPPs. For example, in these countries PPPs generate employment, facilitate economic recovery, and pave way to achieve national food security (Food and Agriculture Organization, 2016).

Many of the agri-PPPs initiated in Asia are aimed at assisting joint agricultural research, innovations, and technology transfer. Past studies showed that these

partnerships increased farmers' access to quality inputs, introduced new technologies, increased yields, improved seed quality, and enhanced the growth of the seed sector. Countries, especially, Uganda, Pakistan, China, and Indonesia have attempted to develop and commercialize certified seed varieties of staple crops such as rice, maize, and wheat through agri-PPPs. In addition, countries such as Kenya, Zambia, and Argentina have established agri-PPPs to support production and multiplication of seeds and quality enhancement of potato, which is a staple food crop grown in those countries (Chalwe, et al., 2015; Food and Agriculture Organization, 2016; Wageningen University and Research, 2015).

Potato is the fourth most important food crop worldwide, and is daily consumed by more than a billion people (Food and Agriculture Organization, 2009; International Potato Center, 2017). The annual requirement of potato is 228,000mt. in Sri Lanka; however, approximately, 35 percent of the annual requirement is fulfilled via local production (Department of Census and Statistics, 2017; Department of Census and Statistics, 2015). Seed potatoes provided to farmers are categorized mainly into two groups based on their origin: 1) locally produced seeds by government organizations, private companies, and farmers and 2) imported seeds from Netherlands, France, Germany, and the United States (Babu & Merz, 2011). To meet this local production, approximately, 15,000mt. – 20,000mt. of seed potatoes are required annually, which is provided through informal production by farmers, formal production by government and private farms, and importation. Around 1,000mt. – 2,000mt. of seed potatoes are produced in government farms, while another 1,000 – 1,500mt. are imported.

The rest, (i.e., 80 percent of the seed potato requirement) is produced by farmers themselves. Though the quantities of produced in government farms and that of imported are largely similar, the prices vary greatly. For example, the retail price of locally produced certified seed potato is Rs.8,000 – 9,000/50kg; the retail price of imported seed potato is Rs.14,000 – 15,000/50kg (Babu, 2017; Nandasiri, 2017; Department of Agriculture, 2016).

1.2 Research Problem Statement and Justification

Potato is considered as one of the major food crops, and more importantly, it is the principal livelihood of farming communities in the Badulla and Nuwara Eliya districts in Sri Lanka. Thus, farmers anticipate high net returns; however, the net return is lowered due to high production cost of potato and low yield (Department of Agriculture, 2017; Department of Agriculture, 2016; Wang, 2008). Potato requires inputs intensively in comparison with other field crops. For example, only the seed accounts for more than half of the total cultivation cost due to scarcity of quality seed potatoes at a reasonable price (Fernando & Premasiri, 2006; Wickramasinghe & Jayasooriya, 2012). Seed potato production is initiated with minitubers and then by producing $G_{0.}$ Since this is a technical aspect as well as capital intensive majority farmers could not be part of this. Therefore, farmers have to depend on low quality potato seeds. Of local seed production systems, farmer based informal seed systems are generally unable to maintain the expected quality, and seeds produced through

such systems are easily prone to diseases. Therefore, the ultimate result could be the reduction of total productivity at national level, thereby creating an adverse environment for local potato farmer communities. Hence, a combined approach of both public and private stakeholders should be adopted.

Agricultural PPPs play a pivotal role in the economies of developing countries. These partnerships are designed to mediate significant barriers related to financing, initiating technical know-how, researching, and many other aspects in agriculture. Sri Lanka has entered into 73 PPPs between 1990 and 2014; however, these partnerships were mainly limited to three sectors: electricity, information and communication technology, and ports (United States Agency for International Development, 2016). Few concerns gave rise to establishing of PPPs for quality seed potato production in Sri Lanka, while maintaining an affordable price for the local farmer. Also, sustainable continuation of those partnerships is another critical challenge.

In light of this, (Food and Agriculture Organization, 2016) has highlighted that policies of developing countries should be directed towards fostering strong PPPs to address issues related to finance, technical know-how as well as institutional arrangements. Subsequently, (Sri Lanka Council for Agricultural Research Policy, 2017) has emphasized on PPP prospects in quality seed production considering it as a priority research area under agriculture inputs, marketing, processing, and value addition. Interestingly, strategic PPPs could be used as an instrument to eliminate existing barriers in potato seed production in Sri Lanka and to maintain the expected production capacities.

1.3 Research Objectives

1.3.1 General Objective

- To determine the prospects in initiating PPPs to improve quality seed potato production in Sri Lanka.

1.3.2 Specific Objectives

- To study prevailing formal and informal seed potato production systems and PPPs for seed potato production in Sri Lanka.
- To propose strategic guidelines for a viable PPP model for quality seed potato production in Sri Lanka.

CHAPTER TWO

Literature Review

2.1 Factors Leading to the Involvement of Private Entities in the Services Sector

With the view to overcome challenges and provide better services to the public, one of the most realistic attempts is to initiate PPPs (Asian Development Bank, 2008). In general, the term PPP, describes a range of possible relationships among public and private entities established to improve the delivery of goods and services to the society (Asian Development Bank, 2008; Food and Agriculture Organization, 2016). Though there is no universal definition for a PPP, three key features are apparent in a successful PPP: 1) a contract between public and private entities defining their roles and responsibilities, 2) sensible risk sharing among the above mentioned partners, 3) profits to private partners depending on achieving the objectives of the PPP. Currently, PPPs are established in sectors such as infrastructure, construction, transportation, agriculture, education, health, and information technology (Asian Development Bank, 2008). In general, public partners of a PPP include national governments, whereas private partners include profit-oriented businesses that are not owned or operated by governments. Intermediary partners, such as non-government and community based organizations (at times categorized as private partners) are also a major sector in a partnership (Asian Development Bank, 2008; Food and Agriculture Organization, 2016).

2.2 Main Roles of Public and Private Entities Engaged in PPPs

Types of public and private partners in partnerships may vary by country. Public partners often seen in partnerships are ministries, regional-level government representative offices, state banks or funds, state-owned enterprises and publically funded research institutes. Private partners may include multinational and large domestic companies, smallholder enterprises, non-governmental organizations, charities not operated by the government, and community based organizations (Asian Development Bank, 2008; Food and Agriculture Organization, 2016).

Each sector, either public or private, has relative advantages over the other when performing tasks in a PPP. Thus, these relative advantages should be taken into consideration when allocating different responsibilities among these sectors (Asian Development Bank, 2008). The public sector usually involves in, but does not limit to, establishing a supportive regulatory environment, investing, coordinating the partnership, and monitoring and evaluating the partnership. The private sector involves in funding, implementing the services provided through partnerships, providing technical assistance, and supporting the monitoring of the partnership activities (Asian Development Bank, 2008; Food and Agriculture Organization, 2016). It is noteworthy that roles of public and private partners may vary according to the given context. The following is an example from effective PPPs that have been carried out in Indonesia and Colombia.

Indonesia and Colombia established palm oil plantations via PPPs to trigger economic activities in remote or socially unstable regions. Both these contracts involved a national-level public partner to fund and monitor the partnership activities and a regional-level public partner to provide palm oil farmers with technical assistance and coordinate activities. Interestingly, international donors such as the United States Agency for International Development and the French Development Agency who were seemingly private partners were classified as public partners in both partnerships. The lead private partners included groups of or individual companies, whose responsibilities included providing technical and financial assistance to farmers and securing the markets. Other private partners included farmer organizations who assisted in distribution of raw materials (Food and Agriculture Organization, 2016).

2.3 Importance of PPPs in Agriculture Development

Globally, agri-PPPs are increasingly being promoted as means of improving agricultural productivity and developing sustainable agriculture (World Economic Forum, 2010). With the emergence of agri-PPPs, attempts have been made to address issues related to seeds, machinery, agronomic practices, pest and disease outbreaks, post-harvest losses, value addition, and food security and safety (Food and Agriculture Organization, 2016). Based on a study conducted by the (Food and Agriculture Organization, 2016), agri-PPPs are categorized into four typologies as follows:

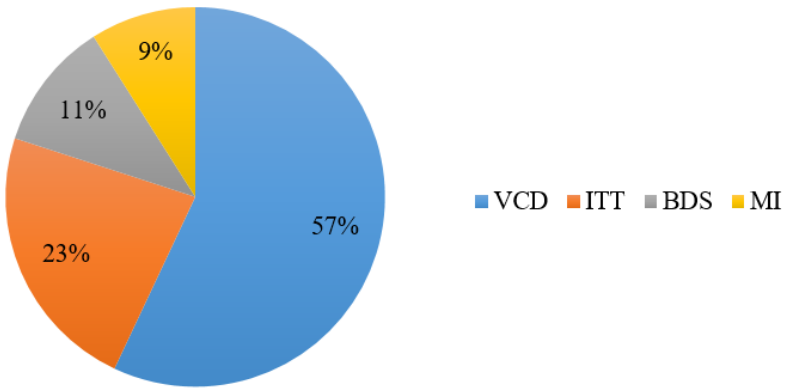
i. **Partnerships that develop agricultural value chains:**
Most developing countries are transforming their producer-based agricultural systems into market-based agricultural systems. In such systems, the increasing demand for food is highly important, and catering to such demands while ensuring food safety and environmental sustainability is highly based on developing agricultural value chains. While doing so, these partnerships focus on achieving quality certifications (e.g., good agricultural practices, fair trade and organic certification etc.) within value chains. These agri-PPPs have been carried out for industrial and food crops including oil-palm, sunflower, sorghum, rubber, sugar, and rice.

ii. **Partnerships aiming at agricultural research, innovation, and technology transfer:**
Sustainable agricultural development is a mere illusion for a developing country unless innovative research solutions and technology are incorporated into agriculture. Thus, PPPs are designed to commercialize innovative research findings and technology. For example, access to new seed varieties, plant-disease test kits, new machinery and equipment is improved through such partnerships. Agri-PPPs on improving seed quality have been implemented for food crops such as rice, maize, wheat, and sorghum. Simultaneously, PPPs are designed to deliver high-technology agricultural knowledge to farmers. For example, techniques for crop processing, environment control in poultry houses, waste management in slaughterhouses have been introduced via PPPs.

iii. **Partnerships that build and upgrade market infrastructure:**
Agricultural market infrastructure comprises both on-farm and off-farm elements; however, most PPPs falling under this category have focused on off-farm elements. Consequently, such PPPs have focused on the development of processing, storage, and transportation facilities as well as trading centers. More specific examples for this type of PPP are development and management of a flower exhibition and trading center, meat processing plant, vegetable market, and an industrial park for aquaculture in China and the Philippines. Establishment of trading centers enhances the market transparency via improved dissemination of price information of agricultural commodities.

iv. **Partnerships that deliver business development services to farmers and small enterprises:**
A broader term of business development services refers to not only the provision of knowledge and skills, but also, inputs, infrastructure, and finance (Lusby, 2004). Business development services are crucial for smallholder farmers, as they facilitate transition from subsistence to commercial agriculture. Partnerships that improve business development services increase the accessibility of these services to farmers, which in turn help realize the goals of PPPs that are aimed at developing agricultural value chains.

Of the agri-PPPs studied in the report by FAO, the majority (57%) of partnerships have been in operation to develop agricultural value chains (Figure 2.1). Moreover, the prominence of each typology varied from one region to another. For example, most agri-PPPs in Latin America and Asia were focused on developing agricultural value chains and delivering business development services to farmers and small enterprises. Most agri-PPPs initiated in Africa were focused only on developing agricultural value chains.



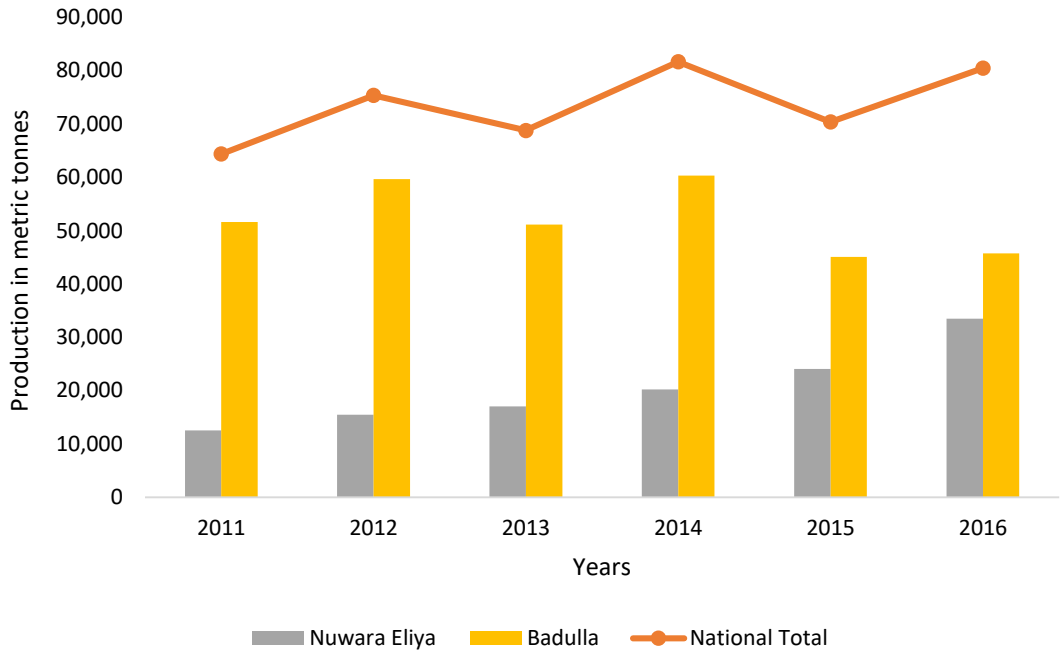
Note: (VCD = partnerships that develop agricultural value chains; ITT = partnerships that aim for agricultural research, innovation, and technology transfer, BDS = partnerships that deliver business development services to farmers and small enterprises, MI = partnerships that build and upgrade market infrastructure.
Source: Food and Agriculture Organization, 2016

Figure 2.1 Four Main Typologies of Agri-PPPs

2.4 Possibilities for PPPs in Seed Potato Sector in Sri Lanka

Potato is cultivated in Sri Lanka as a cash crop – a crop that is intended entirely for the market rather than for household consumption. The annual production of potato is approximately 80,000mt. and the highest production comes from Badulla and Nuwara Eliya districts. Interestingly, past five year-data shows that production of potato in Nuwara Eliya has increased contributing approximately 33,000mt. to the total production (Department of Census and Statistics, 2017) (Figure 2.2).

The annual land extent for potato cultivation is approximately 6,000ha, and to cultivate this extent, around 15,000mt. of seeds are required annually. Seed potato supplied to farmers can be categorized based on their origin. Of the total annual seed requirement only three percent (i.e., 1000mt.) is supplied by the Department of Agriculture and private farms each. Around 1500mt. – 2000mt. of seeds planted are imported through private companies such as Chemical Industries Colombo (CIC) Holdings PLC, Hayleys Agriculture Holdings Ltd., and Opex Holdings Pvt. Ltd. The rest (i.e., 9,000mt. – 13,000mt.) is classified as informal seeds, which are usually multiplied by farmers (Babu, 2017).

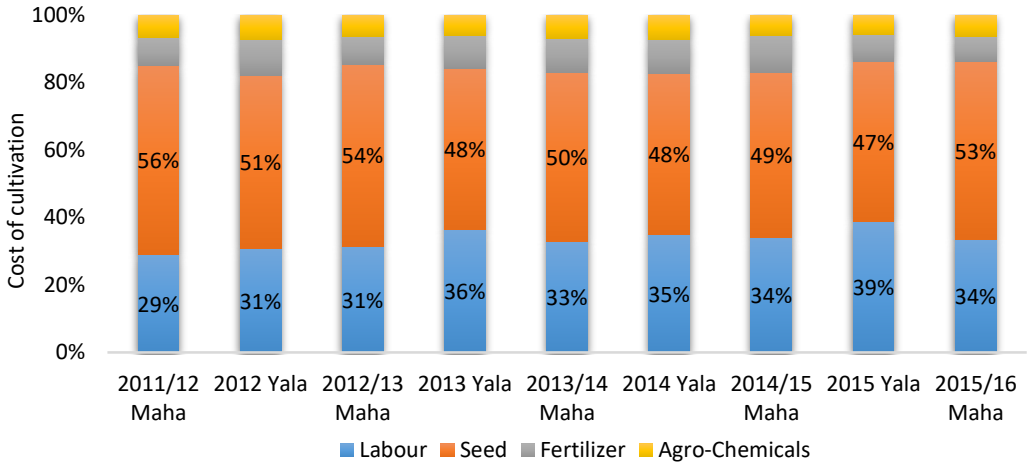


Source: Department of Census and Statistics, 2017

Figure 2.2: Potato Production in Sri Lanka in Major Potato Growing Districts from 2011 to 2016

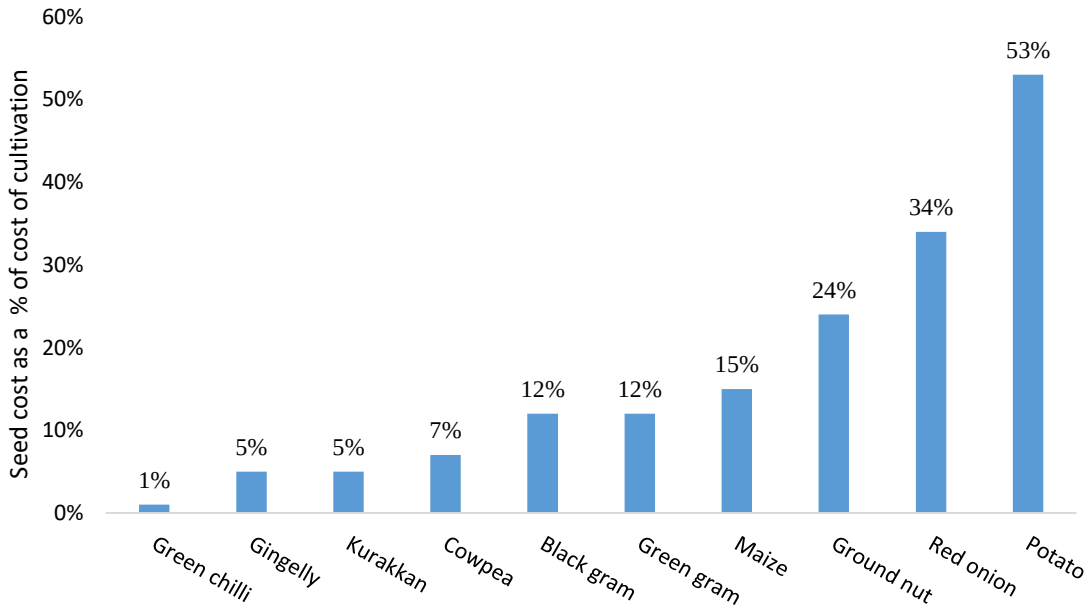
Currently, one of the most severe constraints faced by potato farmers is the unavailability of high quality seed potatoes at an affordable price. Seed potatoes account for more than half of the cost of cultivation. Interestingly, seed costs of rest of the OFCs is lower than that of potato, thus causing lower costs of cultivation. (Department of Agriculture, 2017; Department of Agriculture, 2016) (Figures 2.3 and

2.4). On the one hand, seeds imported via private companies are highly expensive; the cost of 50 kg of such seeds ranges between Rs.13,500 and Rs.15,000. On the other hand, seed produced at government farms are sold at a comparatively lower price (approximately at Rs.9,000.00); however, plants arising from those seeds are vulnerable to diseases such as brown rot wilt. Consequently, farmers are compelled to purchase imported seeds despite of the high price. Thus, farmers anticipate any means of intervention by the government to resolve this issue (Organization, 2017).



Sources: Department of Agriculture, 2017

Figure 2.3 Different Segments of Cultivation Cost in Potato from 2011 to 2016



Source: Department of Agriculture, 2017

Figure 2.4: Seed Cost as a Percentage of Cost of Cultivation in OFCs Grown in 2015/2016 *Maha* Season

2.5 Structure-Conduct-Performance Paradigm

SCP paradigm is a main element in Industrial Economics. A typical SCP paradigm is an approach that postulates the relationship between the structure, conduct, and the performance, especially, in markets (Ferguson, 1988); however, it is plausible to understand about PPPs using a SCP paradigm. It is an analytical approach that describes overall mechanisms and consequently the effect towards welfare of the country as a whole (Wijesooriya & Priyadarshana, 2013). Simply, the term, structure can be used to describe the composition of the PPP and the characteristics of public and private partners. The term, conduct may refer to the behaviour of the public and private partners. The term, performance may be used to measure outcomes of the PPP with respect to efficiency, effectiveness and profitability. As demonstrated in Figure 2.5, the structure of the PPP determines its conduct; conduct in turn determines the performance of the PPP.

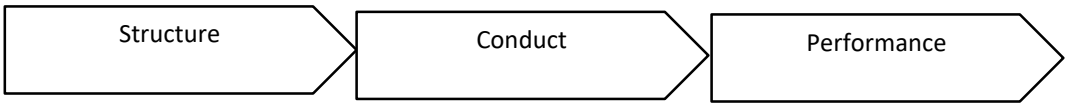


Figure 2.5: Structure, Conduct and Performance Paradigm

This approach is not confined to describe the mechanism of markets, but also could be extended to understand the mechanism of public and private partnerships. Hence, the ultimate objective is to demarcate the possibilities and boundaries of these partnerships in the process of serving at the national level. More importantly, this approach illustrates the most beneficial mechanism. Interestingly, relationship among the elements of the model does not have a unidirectional flow; it could be in the reverse direction as well. Therefore, it influences own conduct on its structure and ultimately, its performances. Therefore, approach is useful to develop as well as in revising of current mechanisms. Nevertheless, performance of a particular partnership positively relates to its efficiency, because generally low cost structure increases profits by reducing prices and expanding market share (Edwards, et al., 2006).

2.5.1 Structure

Structure of a mechanism consists of relatively stable features of the environment. It directly influences the behaviour of that mechanism. Structure mainly signifies through the number of buyer and sellers in a particular market, number of firms or entities in the market, barriers to enter and exit the market and homogeneity or heterogeneity of the product. For example if products are relatively homogenous competition may decrease while if it is heterogeneous it would be the contrary. Likewise, if barriers for entry (e.g. high capital requirement, high risk etc.) are high then there may be only few firms in the market. This results whether market is competitive or otherwise. If market is non-competitive it leads to monopoly market situation where predatory price setting behaviours may exercise (Talpur, et al., 2016).

Ultimately trade becomes unbalance and unfair. This situation could be experienced in many agricultural commodity markets.

According to the (United States Agency for International Development, 2016) success of PPPs heavily depends on contractual agreements and therefore, proper policy support is essential. Otherwise, lack of legal framework may discourage long term PPPs. Both entities should work under a clear legal and regulatory framework to properly allocate the benefits, risks and responsibilities associated with such projects. In general, private entities provide design, construction, financing, operation and maintenance services and also technical know-how and managerial expertise in certain cases. Government role is to lead the project by conducting feasibility studies, mobilizing resources, risk sharing, monitoring and regulation. Identifying and allocating such roles and responsibilities prior to PPPs are important (United States Agency for International Development, 2016).

2.5.2 Conduct

Simply, conduct refers to patterns of behaviour derived from the change in the market mechanism. Conduct signifies the price setting strategy of the market, productivity, risk taking ability and partnering. Performance of any particular market is decided via conduct; however, as mentioned earlier these components do not have a unidirectional flow. If numbers of sellers are relatively high then, stationed price determined by the market could be observed for a standard commodity in most of the time. Therefore, structure inherently influences conduct. Especially in agricultural markets, cost structure plays a pivotal role in determining the final price. Hence, marginal cost is crucial in agriculture. On the contrary, if there are few sellers in the market, those sellers could change the behaviour of that particular market by unfair intervention.

Further, (United States Agency for International Development, 2016), mentioned that operations and maintenance should be governed by strict standards to ensure a high level of service to user. Further it highlights that, government need to intervene in the event of default by the concessionaire or in national interest. Also government should support and guarantee to provide or facilitate some key elements necessary for the project. In this case, success factor or the element would be the land owned by the government. One of the factors of production which deters private sector is the land. Hence, this is the place where rules and regulations come into the play. Hence, in the absence of a legal structure private entities may not actively engage in forming of partnerships.

2.5.3 Performance

Performance refers to the results or outcomes demanded by the society. However, results or outcomes should achieve targets. Generation and provision of daily food requirement is a desirable outcome which is benefited for the society. However, mere supply of food commodities does not imply the desirable outcome. Hence, food should be provided through proper channels while observing certified standards.

Otherwise, effectiveness of that performance is questionable. In addition, financial aspects (e.g. costs and benefits) should also be considered. Conduct influences the performances. Hence, if price is determined by the market, benefit may automatically be transferred to the society without a hitch.

CHAPTER THREE

Conceptual Framework and Methodology

3.1 Introduction

This chapter illustrates the conceptual framework and research methodology of the study. Accordingly, important variables in the conceptual framework are separately elaborated. SCP of a PPP is identified as the most essential element. Effective combination of these three elements would drive PPPs in a more efficient manner. Lack of coordination of either element would result more fragmented partnerships rather than a long lasting ones. Furthermore, this chapter describes key research methodologies adopted in the research process including the study areas, sample and sample selection criteria, data collection methods, tools and the data analysis process.

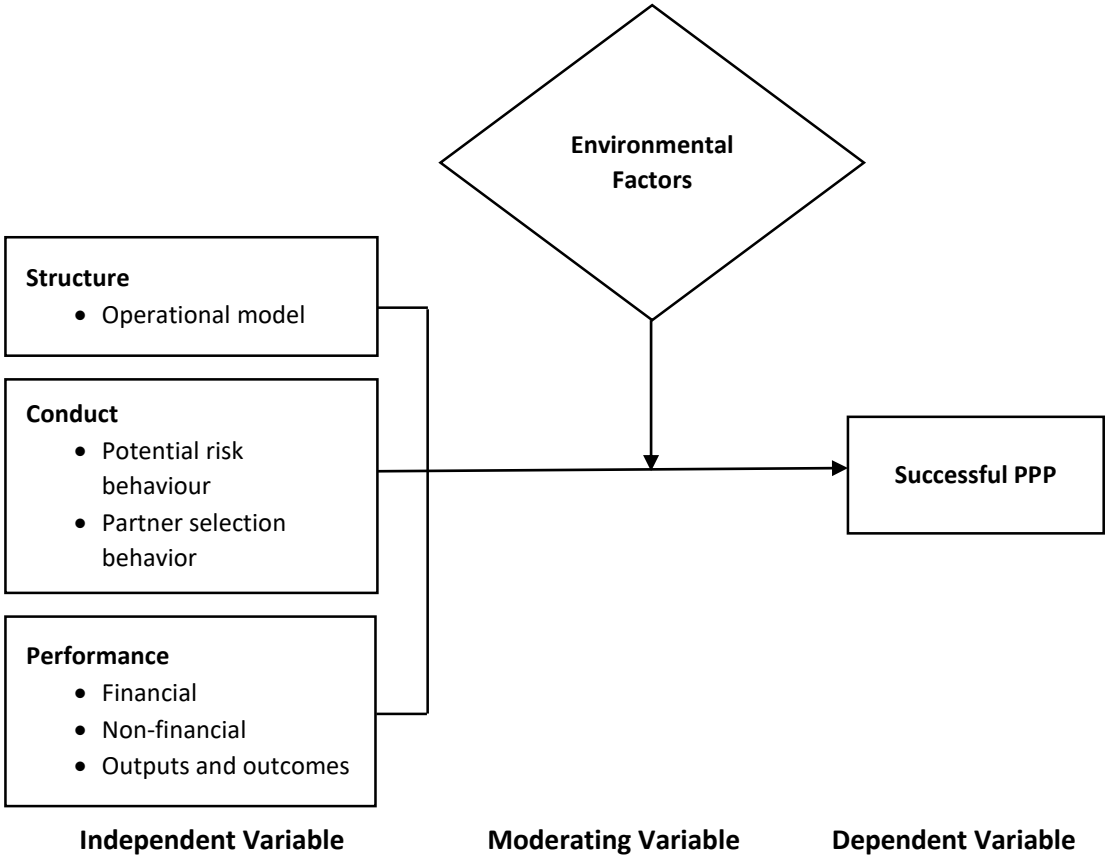
3.2 Framework for Viable PPPs on Seed Potato Production

Therefore, analysis of three elements: structure, conduct and performance are paramount, not merely to evaluate current system, but also to develop viable seed potato production model. SCP will be critically analyzed to explore key driving forces in a successful PPP model for a quality seed potato production mechanism in Sri Lanka. Subsequently, structure, conduct and performance variables have been identified as independent variables that affect the success of PPP, which is considered as the dependent variable. Further, environmental factors are considered as moderating variables, which affect the relationship between dependent and independent variables (Figure 3.1).

The key aspect of a structure is its operational model. Operational model simply refers to how partnerships execute operations and activities to its partners. It describes people, processes, and technologies. It allows to identify clear cut roles, responsibilities, and main functions of engaging partners. In addition, it demonstrates the governing mechanism and the operational structure of a partnership. Establishing a common interest between public and private entities related to seed potato production is the foremost point and this would determine the level of formality of the partnership. Generally, these types of partnerships are formalized legally. Afterword, stakeholders to the partnership, beneficiary group and the process either seed production or facilitation should be decided. This demarcates roles and responsibilities of each party such as oversight mechanism, resource contribution and other required services. Duration of the partnership either short term (less than three year) or long term (more than three years) is also vital.

The second key independent variable is conduct. Conduct refers to the behaviour or actions of the PPP. It includes, especially, potential risk behaviour and selection criteria of partners. Under this element, it is important to identify how stakeholders work towards achieving a common goal, special legal and non-legal terms and agreements, levels of transparency and willingness to partnering. Also, conduct reflects how a partnership derives its margins (e.g., setting prices). In most Agri-PPPs

government role is facilitation and mediation of forming partnerships with private entities. Facilitation of key resource or resources is essential in the public perspective. Usually, resource allocation is carried out by the private sector after acquiring the key resource such as financing, design and construction of the facility, managing and maintaining the facility adequately and making it sufficiently profitable.



Source: Authors' Compilation

Figure 3.1 Conceptual Framework for Viable PPPs

The third independent variable is performance. Performance could be assessed through specific outputs and outcomes with respect to financial and non-financial aspects. Thus, it is necessary to determine the sources of funds and cost components of partnerships as well as to identify the non-financial contribution of each party if provided. Most importantly, specific outputs such as cost reduction of seed production and benefited stakeholders via the PPP should be identified to assess the performance. Within the time duration of the partnership private entity should yield profits to cover their costs and public sector should pay attention to the sustainability of the partnership. When predetermined timeframe has elapsed, continuation is useful if original interest have been broadened and consolidated. In this case expansion of G_1 to G_3 seed production is a possible fact to be considered. Also, seed potato cost benefit should be transmitted to the farmers.

Apart from these independent variables, it is also important to understand the environmental factors which affect the partnership. For example, there could be many opportunities and challenges in establishing partnerships. These environmental factors could differ according to the context in which the partnership operates;

simultaneously, the environmental factors could be inherent to the partnership. Hence, environmental factors may moderate the relationship between the independent variables and the dependent variable.

3.3 Data Collection Methodology

Both primary and secondary data was collected for the study (annexure 1). Primary data was collected through key informant interviews, focus group discussions, and pre-tested structured questionnaire survey. Both public and private sector key stakeholders related to seed potato production and provision was examined to elicit their perception and ideas related to PPPs on quality seed potato production. Secondary data was gathered from publications of DOA, Department of Census and Statistics, Central Bank of Sri Lanka, relevant national and international journal articles, periodicals, and reports. Detailed data collection approach is presented in Annexure 2.

3.4 Study Area/s

The highest number of potato cultivation extents are located in Badulla and Nuwara Eliya districts and both areas contributed 99 percent to the total extent in potato cultivation in average over the past five years, from 2013 to 2017 (Annexure 3). Therefore, Badulla and Nuwara Eliya districts were selected for the study. Three DS divisions (Welimada, Uva Paranagama and Bandarawela) were selected from the Badulla district, while one DS division (Nuwara Eliya) was selected from the Nuwara Eliya district based on the respective potato land extent. Potato farmers are scattered around many GN divisions across selected DS divisions and therefore, altogether 38 GN divisions were selected for the study covering 15 ASCs.

3.5 Sample and Sample Selection Criteria

The total sample was comprised of key stakeholders from both public and private entities and farmers who actively engaged in the process of seed potato provision and production. Altogether 35 stakeholders were interviewed during the study (Annexure 4). Key stakeholders were selected using a priority list according to their relative contribution and importance to the seed potato industry. A survey was conducted on independent farmers who cultivate and produce seed potatoes. From each DS division 69 farmers (representing nine percent from the total potato farmers in each DS division); total of 276 farmers were selected for the study. Multi-stage random sampling was deployed to select farmers (Annexure 5).

3.6 Data Collection Tools

3.6.1 Key Informant Interviews

Key informant interviews were carried out for the selected stakeholders using a key informant interview guideline. Key informant interviews were conducted to elicit the current PPP details, their success or failure, challenges and barriers faced within

partnerships, willingness of each parties for partnership prospects, special conditions, governance aspects (based on the SCP paradigm) and advantages and disadvantages of partnerships.

3.6.2 Focus Group Discussions

A total of three focus group discussions were conducted with the selected farmer groups. The GN divisions, in which focus group discussions held, were selected based on the total number of potato farmers available in the area. Both office bearers and members of farmer organizations were included in these focus group discussions.

Main aspects which examined through focus group discussions were;

i. Structure of the partnership
ii. Potential risk factors for partners
iii. Partner selection
iv. Financial and non-financial contribution of partners
v. Performance and outcomes of the PPP
vi. Challenges and opportunities in potato seed sector

3.6.3 Structured Questionnaire Survey

A pre-tested structured questionnaire was administered to collect data only from independent farmers who produce seed potatoes and cultivate potato in selected GN divisions. Following key elements were assessed through the questionnaire from each respondent:

i. Geographical information
ii. Social and economic status of the respondent
iii. Current crop production status
iv. Current seed potato production system/s
v. Characteristics of seed potato producing lands
vi. Institutional contribution towards seed potato production and provision
vii. Seed potato production prospects

3.7 Data Analysis

To fulfill the first specific objective, intensive descriptive analysis using tables, pie charts and frequency distribution was executed to explore the prevailing seed potato production mechanism in Sri Lanka. Next, cost comparison was conducted for different seed potato production systems. Furthermore, ANOVA was deployed to compare each system: pre basic, basic, imported and other seed types with respective to cost components such as seed, fertilizer, chemical, labour and any other potato cultivation related costs. Post hoc test was carried out to assess the statistically significant of different seed systems. Primary data was used for the analysis.

To fulfill the second specific objective, a SWOT analysis was conducted for seed potato production in Sri Lanka. Both primary and secondary data was utilized to derive the second specific objective of the study.

CHAPTER FOUR

Socio-Economic Information and Seed Potato Production Systems

4.1 Introduction

Chapter four elaborates demographic, socio-economic characteristics of the studied sample along with their seed potato production aspects. Income and expenditure levels are also analyzed for eliciting possible associations between production of seed and consumption varieties of potato. Also, the chapter describes overall seed potato production mechanism and systems practiced by the local farmers with examples where necessary. Specific concern is given to different seed production systems and their productivity for each DS divisions by analyzing individual farm units. Further, the chapter illustrates yield potentials of seeds used in two districts. It also sheds light on farmers' reasons to adopt each system and common drawbacks and difficulties of those systems.

4.2 Demographic Information

It is important to understand different modes of socio-economic factors of the studied sample since those could either directly or indirectly influence the particular behaviour or set of a behaviours of farmers' cultivation preferences. Thus, socio-economic characteristics of the farmers play a vital role in either promoting or impending agricultural production in a country (Sebatta, et al., 2014). From the total sample majority (88%) of the farmers engaged in potato cultivation were males. Hence, potato cultivation is dominated by the male farmers in all four DS divisions. Only six percent of female farmers were engaged in potato cultivation in Nuwara Eliya. In terms of age, majority (32%) were in the age of 50 to 59 years. Only 19 percent of the farmers were below 40 years. On the contrary, the number of farmers above 60 years are higher than those below 40 years. It is observed that, only a limited number of younger people are engaged and remain in the potato cultivation.

In other words, potato cultivation is not overly attractive to draw new entrants into the field. None of the farmers in the sample was categorized under no schooling or uneducated. Majority (27%) of the farmers in the sample had studied up to grade six to eleven. Fascinatingly, 22 percent of the sample had studied up to O/Ls. Only two percent from the total sample had higher education. In the Nuwara Eliya district 43 percent of the farmers have passed A/L. Education level of the sample is average and many of the farmers possess satisfactory level of understanding on potato cultivation and its pros and cons. Nearly all farmers had a fair well understanding on potato varieties and pest and disease issues in potato cultivation. Also, in few cases farmers also had knowledge on generation types[1]. Therefore, conducting of basic training on potato cultivation techniques is suitable for the farmers in studied areas.

[1] Generation types refers to different types of seed potato varieties starting for generation zero to nine.

Table 4.1: Gender, Age and Education Levels of the Sample

Demographic Character	Category	Uva Paranaga % (n=69)	Welimada % (n=69)	Bandarawela % (n=69)	Nuwara Eliya % (n=69)	Total % (n=276)
Gender	Female	12	20	12	6	12
	Male	88	80	88	94	88
Age	20-29	-	3	-	4	2
	30-39	16	16	9	28	17
	40-49	25	32	28	32	29
	50-59	36	29	43	19	32
	60 or <	23	20	20	17	20
Education	Grade 1-5	4	16	6	7	9
	Grade 6-11	18	32	20	29	27
	Sat for O/L	13	28	26	14	22
	Passed O/L	14	14	13	6	13
	Sat for A/L	10	6	14	33	17
	Passed A/L	9	1	17	10	11
	Graduated	1	1	-	-	1
	Diploma / NVQ	-	1	3	7	1
Marital Status	Married	96	94	84	90	91
	Unmarried	4	6	16	10	9

Source: HARTI survey, 2018

In the total sample 91 percent of the farmers were married, the fact implies that those farmers have families to feed and look after. Therefore, making decisions on cultivation is critical for those farmers. Also it may have a direct implication on determining to hold on to the same crop or shifting to another crop or occupation. In general, majority (35%) of farm families consisted of four members (Table 4.2). The second (30%) highest consisted of five members. When considering labour usage in the cultivation process, most farm families do not get family members involved. As a result of their family members being engaged in non-agricultural occupations many farmers had to hire labour from outside. Hence, the labour cost plays a significant role in determining the total cost and ultimately affects the profit margins.

Table 4.2: Number of Family Members in a Household

No of Members	Uva Paranagama % (n=69)	Welimada % (n=69)	Bandarawela % (n=69)	Nuwara Eliya % (n=69)	Total % (n=276)
1	-	-	1	-	-
2	1	10	4	6	5
3	16	19	13	23	18
4	39	30	43	28	35
5	33	32	29	26	30
6	7	7	6	10	8
7	3	1	3	6	3
8	-	-	-	1	-

Source: HARTI survey, 2018

Due to the exorbitant labour cost in certain areas, farmers practice labour exchange methods to overcome the issue. Simply, a system of the mutual lending of labour is in operation among those farmers. This way the farmers could reduce the labour cost. However, in Nuwara Eliya this practice is not common and hired laborers are used. Normally, for a male labourer the daily wage is Rs.1,500 excluding meals and for a female labourer it was Rs.800. In some cases, transportation is also provided for those labourers.

Table 4.3: Experience in Potato Cultivation

DS Division	Gender	Count	Minimum Experience (Years)	Maximum Experience (Years)	Mean Experience (Years)	Standard Deviation
Uva Paranagama	Female	8	15	30	23.63	5.15
	Male	61	4	55	24.67	11.01
	Total	**69**	**4**	**55**	**24.55**	**10.48**
Welimada	Female	14	10	35	20.57	6.74
	Male	55	2	50	23.33	11.89
	Total	**69**	**2**	**50**	**22.77**	**11.05**
Bandarawela	Female	8	15	30	25.00	5.98
	Male	61	6	51	25.98	10.38
	Total	**69**	**6**	**51**	**25.87**	**9.94**
Nuwara Eliya	Female	4	15	40	26.25	11.09
	Male	65	2	50	21.91	11.14
	Total	**69**	**2**	**50**	**22.16**	**11.11**
Total	Female	34	10	40	23.00	6.87
	Male	242	2	55	23.95	11.14
	Total	**276**	**2**	**55**	**23.84**	**10.70**

Source: HARTI survey, 2018

In general, farmers engaging in potato cultivation had experience of two to 55 years (Table 4.3). Hence, new entrants for potato cultivation were noted in Nuwara Eliya and Welimada DS divisions. This implies that, there are positive prospects for potato cultivation in these two areas and this has been already proven in the past statistics as well. Nearly all farmers in Bandarawela had above five years of experience in potato cultivation, implying that new entrants are few in this area. Interestingly, female farmers in all DS divisions had over 10 years of experience in potato cultivation. Therefore, none of the female farmers have entered the industry recently. An equal average experience level was observed when comparing both genders and higher variation was noted for male farmers. Hence majority of male and female farmers have a relatively sound experience in carrying out potato cultivation for a reasonable duration.

Table 4.4: Types of Crops Cultivated

Crop/s	Uva Paranagama % (n=69)	Welimada % (n=69)	Bandarawela % (n=69)	Nuwara Eliya % (n=69)	Total % (n=276)
Paddy, Potato & Vegetable	64	70	22	-	39
Paddy/ Potato/ Vegetable & Tea	25	1	4	-	8
Potato & Vegetable	1	26	54	90	43
Potato/ Vegetable & Flowers	-	-	9	6	4
All Other Crops	10	3	12	4	7

Source: HARTI survey, 2018

The study revealed that, majority of farmers preferred to cultivate potato and vegetable combination. This is mostly prominent in Nuwara Eliya. (Dharmasena, et al., 2017) also found that, for its significant contribution to the vegetable production Nuwara Eliya stands out and is one of the production areas of upcountry vegetables. In most cases, farmers cultivated carrot, beet, leeks, cabbage, beans and tomato. Study also found that, potato farmers were well aware of not to cultivate *Solanaceae* family crops (e.g. eggplant, chili, tomato, bell pepper etc.) continuously along with potato. The second highest combination was paddy, potato and vegetables. This was a prominent practice in Welimada followed by Uva Paranagama. Farmers in these areas consider paddy cultivation is a vital factor for potato since it provides a successful fallowing conditions for potato. Importantly, farmers engaging in paddy cultivation utilize more than 60 percent of their paddy harvest for domestic consumption. Hence, those farmers do not cultivate paddy for commercial purposes.

In Bandarawela there is an increasing demand for cut flower cultivation. This is mainly due to exercise of irregular cultivation system, relative easiness of the cultivation and moderate income generation by the cut flower cultivation. Hence, there is a possible threat to production of seed potato in Bandarawela area in near future. Nevertheless,

vegetables, potato and paddy are the main crop types cultivated in these areas and always there is a rotation between these crops. Therefore, there is a clear possibility to promote public-private partnerships for seed potato production in these areas.

Table 4.5: Average Gross Monthly Income and Expenditure of the Households

Description	Uva Paranagama (Rs.) (n=69)	Welimada (Rs.) (n=69)	Bandarawela (Rs.) (n=69)	Nuwara Eliya (Rs.) (n=69)
Household Income	30,364	29,998	20,268	59,016
Household Expenditure	30,154	28,610	31,825	47,124

Source: HARTI survey, 2018

The survey considered household income as total income received by all the households from all the sources (both agricultural and non-agricultural income sources). From the total sample main occupation of more than 85 percent was farming. The rest were engaged in private sector, public sector, semi-government sector employment and also in private business activities. The lowest average gross monthly income was noted in Bandarawela DS division. Consequently, average gross monthly expenditure is higher than the average gross monthly income in the area. As a result of the deficit, farmers in those areas were not willing to take risks an important attribute in forming PPPs. However, in all other DS Divisions households were able to cover their average gross monthly expenditure from the average gross monthly income. According to the (Department of Census and Statistics, 2016), average gross income of Nuwara Eliya and Badulla districts were Rs.46,517 and Rs.53,236 respectively. These values are derived in general. However, it is envisaged that, some of the DS divisions within the Badulla district are well beyond the general average income levels.

Household expenditure consisted of three components: expenditure on food, expenditure on non-food and expenditure on any other household activity. When referring to the average gross monthly expenditure levels, the highest expenditure was demonstrated by the Nuwara Eliya DS division. In general, average gross expenditure of Nuwara Eliya and Badulla districts were Rs.44,059 and Rs.41,234 respectively. Findings revealed that selected DS Divisions in Badulla deviated from the overall income / expenditure figures. This may be due to the total sample being constituted of farm families. Hence, this implies majority of farm families are not up to the average income and expenditure levels. This is a crucial aspect when considering the sustainability of PPPs. Majority farmers expect fast and steady profit from the cultivation.

4.3 Farmer Contribution and Patterns of Seed Potato Production

Prominently both seed potatoes and consumption potatoes are cultivated by farmers in the Badulla and Nuwara Eliya districts in Sri Lanka. From the total sample (n=276) the purpose of majority (80%) of farmers was to cultivate potato for both seeds and

for consumption (Table 4.7). Therefore, it is evident that 80 percent of the farmers are engaging in self-seed production in Sri Lanka. In Welimada and Nuwara Eliya DS divisions above 90 percent of the farmers cultivated potato for both seed and consumption purposes. Hence, these two areas are identified as established seed production areas in the country. Nevertheless, the seed production systems and cycles are different in each area.

Table 4.6: Category of Potato Farmers

Cultivation Purpose	Uwa Paranagama % (n=69)	Welimada % (n=69)	Bandarawela % (n=69)	Nuwara Eliya % (n=69)	Total % (n=276)
Only for seed potato	-	1	-	1	1
Only for consumption	25	1	42	7	19
Both seed and consumption	75	98	58	92	80

Source: HARTI survey, 2018

On the contrary, in Badarawela DS division nearly half of the farmers produced potato only for the consumption purpose. Poor keeping quality of seeds is the main reason for this particular cultivation pattern in Bandarawela. Fallowing period is essential for crops such as potato. In most cases farmers in Bandarawela, have not maintained a proper fallowing period for potato and as a result quality of the next generation may significantly deteriorate. Therefore, output may significantly reduce. However, in Welimada and Nuwara Eliya regions farmers practiced a successful crop rotation system creating a favourable condition for potato. Specially, in Welimada soon after paddy harvest is reaped lands are prepared for potato cultivations. Hence, with paddy cultivation there is always a time lag around three to four months period. Another reason is that, farmers in Bandarawela shift their cultivation patterns more frequently compared to those of the others. With this behaviour less attention is paid to a single crop at a time.

District	Season	Month											
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Badulla	*Yala*												
	Maha												
Nuwara Eliya	*Yala*												
	Maha												

Source: HARTI survey, 2018

Figure 4.1: Cropping Pattern for Potato

In Nuwara Eliya potato cultivation is practiced in early January to mid-March and the second season from September to December. Second season in Nuwara Eliya is

relatively shorter than the first season. In Badulla, the main season starts from June to September. The peak harvest is recorded from August to September. The first season is initiated from October to early February and main objective of this season is to produce seeds required for the second season. This production season is also termed as "*kandu kannaya*" and cultivation is mainly practiced in higher elevations. Thus, there were some slight and trivial cropping pattern differences within the DS divisions in the same district. For each season seeds should be set aside for about three months to break the dormancy. Cropping cycle is aligned accordingly and between two cropping cycles a gap is maintained.

Table 4.7: Current Seed Sources for Seed Potato Production Adopted by Farmers

Seed Production Source	Uva Paranagama % (n=69)	Welimada % (n=69)	Bandarawela % (n=69)	Nuwara Eliya % (n=69)	Total % (n=276)
From Imported Seeds	62	48	49	78	59
From Other Seed Sources	13	54	9	35	27

Note: More than one seed source is noted in some cases. Hence, multiple responses are observed.
Source: HARTI survey, 2018

In general, majority of farmers (59%) in all DS divisions except in Welimada have used imported seed sources as their first cultivation source. There have been two entities who distributed imported seeds and those were retailers and direct agents of the particular company. However, most popular source was retailers due to convenience and reliability. In Nuwara Eliya more than two third of the farmers adopted imported seeds as their primary seed source. Therefore, it is clear that majority have adopted "Class A" seed types recommended for potatoes meant for consumption. Other seed sources referred to seeds that were purchased or obtained directly from:

i. Seetha Eliya or Boralanda Research Stations
ii. ASCs
iii. Ambewela Seed Farm
iv. Other farmers
v. Self-seeds (seeds produced by farmers themselves)

Notably, in Welimada more than half of the seeds were conjointly acquired through Seetha Eliya and Boralanda Research Stations and commercial level farmers in the area. Also, of all DS divisions government contribution for seeds was higher in Welimada. Farmers were also reasonably aware and connected with the government bodies to acquire quality seeds. This is another factor which rationalizes higher yields in the area.

Table 4.8: Current Seed Potato Production Systems Adopted by Farmers

Seed Production System	Uva Paranagama (n=69)		Welimada (n=69)		Bandarawela (n=69)		Nuwara Eliya (n=69)		Total (n=276)	
	%	Ext (ac.)	%	Ext (ac.)	%	Ext (ac.)	%	Ext (ac.)	%	Ext (ac.)
G0 to G1	-	-	-	-	-	-	10	6.79	3	10.14
G1 to G2	-	-	-	-	-	-	6	3	1	3.00
G2 to G3	1	1	-	-	-	-	7	11	2	12
G3 to C1	-	-	1	0.5	-	-	1	0.5	1	1
C1 to C2	1	0.5	35	19	3	1.75	3	3.75	11	25
C2 to next	4	1.75	12	10	4	1.75	4	1.48	6	14.98
Class A to next	67	36.25	46	25	49	23.58	75	88.59	59	173.42
Other Systems	3	1.75	7	4.75	-	-	6	4	4	10.5

Note: More than one seed production system is noted in some cases. Hence, multiple responses are observed.

Source: HARTI survey, 2018

From the total sample G_0 production was only noted in the Nuwara Eliya district. A considerable land extent was demarcated for G_0 cultivation and it was nearly seven acres. Both poly tunnels and open field G_0 cultivation was observed in the area. Pre-basic seed generation was practiced by few farmer groups and interestingly all systems were observed in Nuwara Eliya. Since majority of farmers have adopted imported seeds for their first cultivation, Class A seed types were used to generate seeds for the next phase. This was noted in all DS divisions. Relative cultivation extent was also high. Cost of an imported 50 kg of seed potato bulk was reported as Rs.13,000 to Rs.15,500 during the survey period and the local price was adjusted according to the world market prices and expected to increase further. Hence, it is inevitable that cost of cultivation may increase and in particular seed cost may take a major cost component. C_1 to C_2 was the second prominent seed production system observed in all areas especially in the Welimada DS division. Most of the time these seeds were released by the Ambewela seed farm and also a limited portion by the government seed farms.

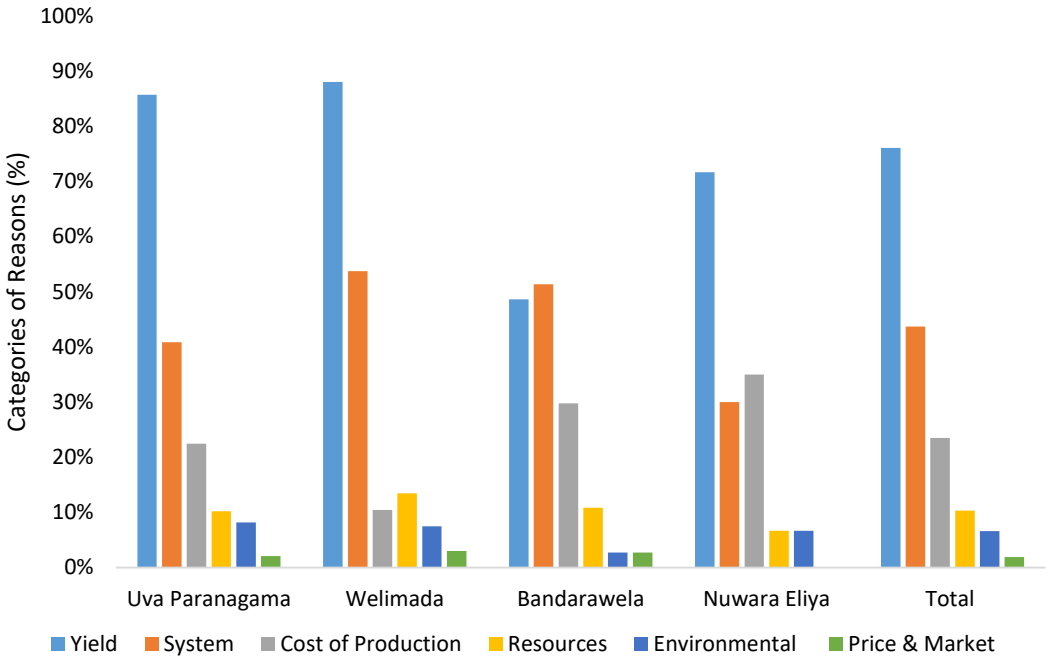
The third preference was placed on C_2 to next generation system. This system is not recommended as a seed production system. However, the worse scenario is the other systems of which origin of the seeds were not known by the grower. In general, when considering the total sample only six percent used pre-basic seeds, 12 percent used C_1 and C_2 seeds and majority (69%) used unqualified seed as their primary seed source for the second cultivation phase. It is evident that even with higher costs farmers ended up in low quality seed production cycles in the second cultivation phase. This implies non availability and high cost of seeds were grave challenges for farmers. Obtaining a good quality seed is critical thus it directly affects the physiological status of seed potato. Physiological status impacts the emergency, number of stems for the plant, number of tubers per stem, tuber size distribution and tuber yield of the crop.

Specific standard of a tuber ranges from 28 mm to 55 mm in diameter. However, large tubers are also planted by the grower. In Sri Lanka, for about 30 to 45 percent of total

potato production in a seed production phase are sold for consumption. Nevertheless, some growers retained large tubers as seeds for the next cultivation phase. The large size tubers are cheaper, and quality of seeds is very high. Planting large tubers are more expensive since more tubers are required to plant a unit area. Therefore, farmers tend to slice these large tubers to increase the number of seed pieces regardless of technical formalities.

4.3.1 Reasons to Adopt Current Seed Production Systems

There were several reasons why farmers adopted each seed production system. All these reasons are separately summarized in Figure 4.2. Main reasons why farmers engaged in seed potato production are broadly divided into six categories. Those six were identified as yield, system, cost of production, resources, environment and price and market related reasons.



Source: HARTI survey, 2018

Figure 4.2: Reasons for Farmers Engaging in Current Seed Production Systems

Amongst them farmers three DS divisions except Bandarawela, focused on yield aspect. Increased and marketable yield was determined through number of tubers from one seed, quality of the final output, seed production standards, size of the tuber, generation effect on yield. However, in most cases regardless of the seed generation majority relied on imported seeds and its yield prospects, predominately on yield meant for consumption rather than the seed yield. If the size of the potato is relatively large, then those potatoes are sold as that for consumption and the rest is retained to be used as seed. Hence, the potatoes which are small in size are preferred as seeds and for those the demand is high. In few cases quality of the second generation was also considered and therefore, utilization of pre-basic seeds were observed. This is considered as the proper seed cycle.

Potato seed production system related aspects were identified as the second reason in most of the DS divisions. One such reason under this was resistance to pest and diseases. Specially, in Bandarawela more emphasis was placed on the system related reasons. With irregular climatic pattern spreading of disease such as bacteria wilt was noted in all studied areas. Interestingly, locally produced seeds were able to withstand bacteria wilt and other soil borne diseases to a certain extent. This is considered as an important characteristic in quality seeds. Another concern was convenience of locating and procuring seeds in the adopted seed production system. Even though several potato varieties are available in a particular season in the market uncertainty in continuous supply of those varieties was a limiting factor. Also, in few cases adopting to a new system was not willingly practiced by the farmers due to their reservations towards the adopted system. The factors such as high recommendation given to imported seeds and less availability of local seeds have retained local farmers in their current seeds production system.

Third reason was identified as the cost of production of potato seeds. Aligning with above two reasons, farmers are compelled to retain in the same production system. As mentioned earlier price of imported seeds are relatively expensive and roughly accounted for about 50 to 60 percent of the total cost of production. If the cost of production is not covered in the first cultivation season, through self-seed production farmers tend to cover the cost of production in both seasons. This has been the case with regard to imported seeds. Apart from these three prominent reasons resources, environmental and marketing related aspects were cited as other points by the farmers respectively. In terms of resources, the main concern was related to insufficient and less availability of quality seeds. Adaptability of selected seeds to the cultivation environment was considered under the environmental aspect. Over the years utilization of seeds that belonged to the same varieties was also observed in the studied area. Hence, farmers were used to that system. Interestingly, last reason was related to marketing of seeds. Majority of farmers cultivated seeds to use those as self-seeds in the next season.

Even farmers have practiced self-seed production in most of the time, some did not reserve 100 percent of those produced seeds for the next season. They had two options with the produced seeds: to retain it for the second season or to sell a portion to an outside party. Selling of seeds is prominent in Nuwara Eliya and Welimada DS divisions since those areas generate higher yields. Hence, small scale farmers had won confidence of those sellers. Selling of seed potato is solely based on trust and not on legal procedures. Hence, there is a greater risk due to less guarantee.

It is clearly observed that, in all four DS divisions self-seed production for the subsequent season is being practiced using the production systems such as C2 to next, class A to next and other systems. Interestingly, in all four areas more than three quarter of imported seeds have been used as seeds in the next season (76% in Uva Paranagama, 82% in Welimada, 75% in both Bandarawela and Nuwara Eliya). Over 90 percent of the seeds obtained for the first season cultivation were certified and verified as quality seeds. However, situation is worse with regard to the second or subsequent cultivation season. The results revealed that more than 95 percent of self-

seeds were not certified through a proper channel as quality seeds. Therefore, proper intervention is essential in the second season to ensure quality and standards of the seeds. Table 4.10 also reveals that only a very small proportion from the sample cultivates and multiplies pre-basic seeds. Hence, this highlights a critical issue in the Sri Lankan seed potato cycle, since the most vital attribute 'quality' is not fulfilled in the current production system.

Table 4.9: Utilization of Seed Potato by Farmers in the Studied Areas

Seed Production System	Uva Paranagama (n=69)				Welimada (n=69)				Bandarawela (n=69)				Nuwara Eliya (n=69)			
	Cultivated Quantity (kg/ac)	Harvested Quantity (kg/ac)	Used as Self-seeds (%)	Used for selling (%)	Cultivated Quantity (kg/ac)	Harvested Quantity (kg/ac)	Used as Self-seeds (%)	Used for selling (%)	Cultivated Quantity (kg/ac)	Harvested Quantity (kg/ac)	Used as Self-seeds (%)	Used for selling (%)	Cultivated Quantity (kg/ac)	Harvested Quantity (kg/ac)	Used as Self-seeds (%)	Used for selling (%)
G0 to G1	-	-	-	-	-	-	-	-	-	-	-	-	1168	7062	100	
G1 to G2	-	-	-	-	-	-	-	-	-	-	-	-	533	1783	75	25
G2 to G3	1000	3500	100	-	-	-	-	-	-	-	-	-	697	409	40	60
G3 to C1	-	-	-	-	500	800	100		-	-	-	-	800	2400	-	100
C1 to C2	500	600	100	-	534	1011	81	14	514	543	100	-	213	333	100	-
C2 to next	514	2371	67	33	660	2035	53	47	700	1457	83	17	1149	372	100	-
Class A to next	530	1479	76	16	264	1264	82	15	473	1206	75	17	866	1550	75	25
Other systems	771	1029	100	-	547	1126	46	54	-	-	-	-	850	1850	100	-
Total	3315	8979	-	-	2505	6236	-	-	1687	3206	-	-	6276	15759	-	-

Note: Seeds have been utilized for more than one purpose. Hence, multiple responses are observed.
Source: HARTI survey, 2018

Another critical issue is informal seeds potato selling channels practiced by the farmers. From the harvested lot, additional quantities of seeds have been sold to adjacent or other farmers in the areas. Only 19 percent of from the total sample have sold certified seed and the rest were not certified by any means and basis of only physical appearance and trustworthiness of the seller leads to sealing of the deal. Nevertheless, only in Nuwara Eliya DS division G_1, G_2 and G_3 seed multiplication and selling process is observed. Average standard seed potato (seeds including G_2 to C_1) requirement per acre is 734 kg in Badulla and 740 kg in Nuwara Eliya (Department of Agriculture, 2018). This standard is not valid for G_0 and G_1 since seeds of these two generations are relatively smaller in size. The results revealed that in average per acre

only 515 kg of seeds in Uva Paranagama, 486 kg of seeds in Welimada and 562 kg of seeds in Bandarawela were cultivated for a successful season. Imported seed were the lowest among others in terms of quantities compared with the standard seed amount per acre.

Even with less seed amounts farmers try to obtain expected outputs. Hence, slicing of tubers has been practiced by the farmers to fill the seed requirement. Therefore, a minimum number of two to four cuts from a single tuber have been obtained and planted as seeds. This has become a major practice in all studied areas. Chemicals were applied on the cut surface before planting sliced seeds to protect exposed areas from diseases. On the contrary, in Nuwara Eliya actual average seed usage was relatively higher than the standards. Selling of pre-basic seeds were observed in Nuwara Eliya and interestingly, almost all farmers who cultivated G_3 in the first season sold 100 percent C_1 seed output. Hence, in Nuwara Eliya proper seed cycle is in practice to a certain extent. Other seed system mainly comprised of seeds purchased from other farmers or any other improper channel. Generation of these seeds is unknown.

Among all DS divisions the lowest seed production was practiced in Bandarawela. It is noted that, seed production prospects are fairly lower in the areas (Bandarawela and Diyathalawa ASCs) due to water scarcity and irregular crop cultivation pattern. Poly tunnels constructed to cultivate potato through 50 percent subsidy programme was also used for other crop production. Even though government seed supply is in place, lack contribution in the private sector resulted in an improper seed cycle in these areas. Hence, most of the farmers have chosen C_2 and below generation seeds to fulfil seed requirement in both seasons. Also, only a very few (17% each from C_2 and imported seeds separately) used seeds as selling materials.

4.4 Consumption Potato Production

Potato is considered as one of the major cash crops throughout the world. Hence, it plays a pivotal role among the rural and developing agricultural communities. At the outset of the cultivation in Sri Lanka in the late 70s to early 80s, potato generated high returns and this resulted in a wide popularity on potato cultivation among the farmers. This is why Sri Lankan farmers still relied heavily on potato cultivation. Table 4.11 demonstrates the average yield level of consumption potato in the studied areas.

Table 4.10: Average Yield of Potato Grown for Consumption

Badulla (n=160)				Nuwara Eliya (n=70)			
Yield of the First Season (kg/acre)		Yield of the Second Season (kg/acre)		Yield of the First Season (kg/acre)		Yield of the Second Season (kg/acre)	
Mean	SD	Mean	SD	Mean	SD	Mean	SD
4106	5515	10346	12341	7826	4221	7394	9297

Note: Farmers who used seeds from the first cultivation were considered.
Source: HARTI survey, 2018

Average potato yield per acre of the first season in studied areas in Badulla is comparatively low compared to the standard average yield (5803 kg/acre) of Badulla (Department of Agriculture, 2018). On the contrary, harvest of the second season is significantly higher than the first. As mentioned earlier this is due to the practice of paddy cultivation as a fallowing period for potato. Interestingly, in Nuwara Eliya both harvests are similar. However, when considering the standard deviation of both seasons in both areas, there is a considerable variation in the yield. This is due to variation in varieties, generations, agricultural practices and in intensity for cultivation.

Table 4.12 illustrates the productivity ratio of potato production using different seed sources. Productivity ratio for potato implies the number of 50 kg potato containers obtained from a 50 kg potato seed container. In the first season of both areas productivity was largely in equal proportions and also relatively low compared to average yield between 1:12 and 1:15 in Sri Lanka. This is mainly due to seed generation focus by the farmers. In the first season farmers preferred to generate seeds rather than potato for consumption. Hence, productivity aspect is not much emphasized.

Table 4.11: Potato Productivity in Different Systems

Seed Category	Badulla (n=207) Productivity Ratio		Nuwara Eliya (n=69) Productivity Ratio	
	First Season (kg/acre)	Second Season (kg/acre)	First Season (kg/acre)	Second Season (kg/acre)
Pre-basic	1:6	1:16	1:5	1:17
Basic	1:5	1:10	1:6	1:12
Imported	1:6	1:12	1:7	1:13

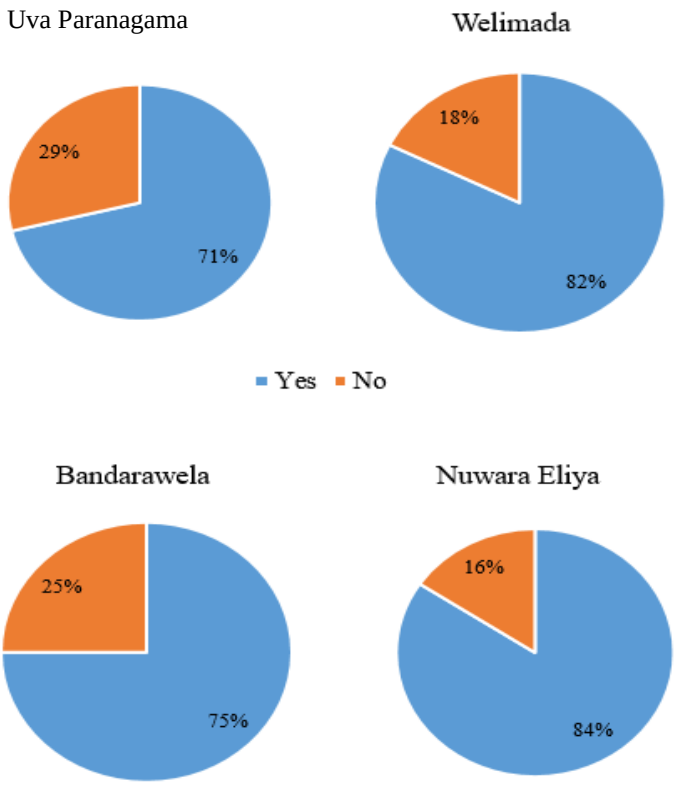
Source: HARTI survey, 2018

However, when considering the second season productivity was comparatively higher than the first. Notably, productivity of the pre-basic category was considerably higher than the other two categories. At the same time, it is also higher than the standard average productivity ratio. (Wickramasinghe & Jayasooriya, 2012), also explored similar results regarding the productivity of potato in their study. Thus In some cases farmers were given basic seeds by the government farms and compared to other seeds category productivity ratio of those seeds are comparatively low. Therefore, there is a common misunderstanding among farmers regarding the government seeds. However, farmers who obtained and were aware of basic seeds strict to their choice due to higher productivity.

4.5 Barriers to Access Quality Seed Potato

According to Figure 5.3 more than 70 percent of farmers in each DS division faced difficulties in acquiring seed potatoes in the planting season. Notably, the highest percentages were observed in Nuwara Eliya and the second highest in Welimada. Even though these two areas are found to be high productive areas, farmers faced

difficulties in accessing good quality seeds. Hence, farmers tend to purchase alternatives available in the market. This also opened up informal selling channels. In general, price increase of imported seeds during the season had been the major barrier (Table 4.13). As mentioned earlier, prices of imported seeds are normally high, hence there is always an increasing trend in prices in each season. Among the four DS divisions, this issue was prominent in Bandarawela. Lower seed potato production capacity in Bandarawela has further worsened this situation. The second major issue was highlighted as insufficient supply of seed potato by the government sector. The third reason was inadequacy of quality seeds within the region.



Source: HARTI survey, 2018

Figure 4.3: Difficulty in Acquiring Seed Potato as Planting Materials

Table 4.12: Reasons for Difficulties in Accessing Seed Potato

Reason	Uva Paranagama %	Welimada %	Bandarawela %	Nuwara Eliya %	Total %
1	51	45	57	39	46
2	49	55	70	46	54
3	43	45	60	35	44
4	14	5	10	30	15
5	27	34	10	39	30
6	8	2	7	4	5
7	3	-	3	-	1
8	5	2	-	-	2

Note: 1- insufficient supply of seed potato by the government sector; 2-price increment of imported potato seeds during the cultivation season; 3-inadequecy of quality seeds; 4-lack of storage facilities for self-seeds; 5-lack of seeds availability at the required time; 6-difficult to find required varieties with the private sellers at the required time; 7-Lack of coordination between farmers and ASCs; 8-insufficient quantities of seeds are sold by the private sellers.

Source: HARTI survey, 2018

Another prominent issue was lack of seed availability at the required time. If seeds are not provided or available at the beginning of the season farmers have to delay the season. However, farmers usually do not delay cultivation and instead tend to move into another crop or else purchase whatever available. With that decision, their options may be limited and quality concern has to be disregarded.

4.6 Cost Component Comparison for Different Seed Potato Systems

Cost-benefit comparison is an important parameter to assess and understand the economics of the any transaction to make strategic decisions. This is vital to evaluate alternatives for a particular transaction. This study also adopted cost-benefit comparison for different seed potato systems in Sri Lanka to suggest the best possible alternative for the cultivation. However, cost-benefit comparison was carried out only for a single season (2017/18 *Maha*) based on the primary data extracted from the structured questionnaire. Furthermore, only the potato cultivation related costs and returns are considered for this analysis. The main cost incurred are as follows:

i. Seed potato cost.
ii. Fertilizer cost.
iii. Chemical cost.
iv. Labour cost.
v. Any other cost.

4.6.1 Seed Potato Cost

The results revealed that the highest cost component in potato is seed. According to the literature seed cost is the main cost among all cost types within the COP of potato cultivation and it accounts for more than half. As mentioned in previous chapters seed types are mainly categorized into three: pre basic, basic and imported. However, farmers also used seeds of which the origin was unknown. These seed potato was

purchased from other farmers and thus, determination of its origin is difficult. This was also considered for the calculation under the category of other seed type. Nevertheless, according to the results, other seed type could comprise both basic and imported seeds.

Table 4.13: ANOVA for Seed Cost of Different Systems

Source	Sum of Squares	df	Mean Square	F	Sig.
Seed Type	3.335E11	3	1.112E11	547.685	0.000
Error	4.445E10	219	2.030E8		
Total	3.779E11	222			

R Squared = .882 (Adjusted R Squared = .881)
Source: Authors' calculation

Based on the results of the ANOVA, seed cost is significant according the seed type used by the farmers. Cost of pre basic seed is significantly different from other three types. Interestingly, Rs.103,467.00 difference for seed cost per acre is observed between the imported and pre basic seeds. Further, farmers could save Rs.79,237.00 per acre from seeds if they opted basic seeds over imported seeds. Cost of basic seed and other seed types are not statistically significant.

Table 4.14: Multiple Comparison of Seed Cost of Different Systems

(I) Seed Type	(J) Seed Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Basic	Imported	-79237.46*	2840.15	0.000	-86590.24	-71884.68
	Other	-4067.80	3998.87	0.740	-14420.36	6284.75
	Pre Basic	24229.16*	4505.14	0.000	12565.95	35892.37
Imported	Basic	79237.46*	2840.15	0.000	71884.68	86590.24
	Other	75169.66*	3244.47	0.000	66770.14	83569.18
	Pre Basic	103466.63*	3851.22	0.000	93496.33	113436.93
Other	Basic	4067.80	3998.87	0.740	-6284.75	14420.36
	Imported	-75169.66*	3244.47	0.000	-83569.18	-66770.14
	Pre Basic	28296.96*	4770.37	0.000	15947.11	40646.82
Pre Basic	Basic	-24229.16*	4505.14	0.000	-35892.37	-12565.95
	Imported	-103466.63*	3851.22	0.000	-113436.93	-93496.33
	Other	-28296.96*	4770.37	0.000	-40646.82	-15947.11

Source: Authors' calculation

4.6.2 Fertilizer Cost Comparison for Different Systems

Farmers used both organic and inorganic fertilizers for potato cultivation. Poultry manure was the most regularly used organic fertilizer. Generally, farmers apply one bag (30kg) of poultry manure for 50kg of potato and the price of a bag ranges from

Rs.135.00 - Rs.165.00. Sourcing was done from Kurunegala District. In addition, farmers may apply cow dung as well. Application of organic fertilizer is practiced before planting only once per season. However, application of inorganic fertilizer is carried out twice or thrice per season according to their expectation and experience levels. In most cases farmers used potato mixture rather than straight fertilizer.

Table 4.15: ANOVA for Seed Cost of Different Systems

Source	Sum of Squares	df	Mean Square	F	Sig.
Seed Type	4.927E9	3	1.642E9	12.173	0.000
Error	2.955E10	219	1.349E8		
Total	3.447E10	222			

R Squared = .143 (Adjusted R Squared = .131)
Source: Authors' calculation

According to the ANOVA results, fertilizer cost is different based on the seed type and according to the post hoc test, only fertilizer cost for other seed type is statistically significant from all other seed types. This is because, farmers believe that to get maximum yield from other seed types it requires more fertilizer application compared to higher generations since its origin is unknown. Fertilizer cost for all other seed categories: pre basic, basic and imported are not statistically significant. Further, farmers could save more than Rs.10,000 if they use pre basic, basic or imported varieties compared to other seed types.

Table 4.16: Multiple Comparison of Fertilizer Cost of Different Systems

(I) Seed Type	(J) Seed Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Basic	Imported	-2835.89	2315.62	0.612	-8830.73	3158.94
	Other	-20440.00*	3673.11	0.000	-29949.19	-10930.80
	Pre Basic	-6874.84	3260.34	0.154	-15315.45	1565.75
Imported	Basic	2835.89	2315.62	0.612	-3158.94	8830.73
	Other	-17604.10*	3139.96	0.000	-25733.04	-9475.16
	Pre Basic	-4038.95	2645.27	0.423	-10887.21	2809.30
Other	Basic	20440.00*	3673.11	0.000	10930.80	29949.19
	Imported	17604.10*	3139.96	0.000	9475.16	25733.04
	Pre Basic	13565.15*	3889.36	0.003	3496.11	23634.18
Pre Basic	Basic	6874.84	3260.34	0.154	-1565.75	15315.45
	Imported	4038.95	2645.27	0.423	-2809.30	10887.21
	Other	-13565.15*	3889.36	0.003	-23634.18	-3496.11

Source: Authors' calculation

4.6.3 Chemical Cost Comparison for Different Systems

Application of inorganic chemicals such as pesticides, weedicides and fungicides is prominent in potato cultivation. In general potato farmers are risk averse cultivators and rather than controlling pest and diseases, chemical application is carried out beforehand. Heavy chemical application was observed in the Badulla district compared to Nuwara Eliya district. Blight (early and late) and bacteria wilt are the major crop related issues. Application of chemicals are relatively heavier during rainy weather seasons compared to drier seasons due to washouts. Farmers also apply chemicals to the potato before planting if they slice tubers. Slicing is not recommended and all other costs related to slicing are additional costs.

Table 4.17: ANOVA for Chemical Cost of Different Systems

Source	Sum of Squares	df	Mean Square	F	Sig.
Seed Type	2.357E10	3	7.856E9	179.539	0.000
Error	9.582E9	219	43753641.932		
Total	3.315E10	222			

R Squared = .711 (Adjusted R Squared = .707)
Source: Authors' calculation

ANOVA results revealed that, chemical cost is significant for seed categories and Post Hock Test revealed chemical cost for all four categories are statistically significantly different from one another. The highest chemical application cost was observed for imported seeds since it has a less vigour compared to locally adopted seeds. Interestingly, second highest chemical application cost was observed for pre basic seeds. In certain cases farmers believe pre basic seeds are immature and it needs comparatively higher chemical applications compared to basic seeds. Frequency of applying chemicals are also high for potato when compared to other crops planted in the area.

Table 4.18: Multiple Comparison of Chemical Cost of Different Systems

(I) Seed Type	(J) Seed Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Basic	Imported	-29099.03*	1318.68	0.000	-32512.93	-25685.14
	Other	-13718.18*	1856.67	0.000	-18524.87	-8911.49
	Pre Basic	-24275.00*	2091.73	0.000	-29690.22	-18859.77
Imported	Basic	29099.03*	1318.68	0.000	25685.14	32512.93
	Other	15380.85*	1506.41	0.000	11480.96	19280.75
	Pre Basic	4824.03*	1788.12	0.037	194.83	9453.24
Other	Basic	13718.18*	1856.67	0.000	8911.49	18524.87
	Imported	-15380.85*	1506.41	0.000	-19280.75	-11480.96
	Pre Basic	-10556.81*	2214.88	0.000	-16290.85	-4822.78
Pre Basic	Basic	24275.00*	2091.73	0.000	18859.77	29690.22
	Imported	-4824.03*	1788.12	0.037	-9453.24	-194.83
	Other	10556.81*	2214.88	0.000	4822.78	16290.85

Source: Authors' calculation

4.6.4 Labour Cost Comparison for Different Systems

Potato is highly labour intensive cultivation and according to the (Department of Agriculture, 2018), the second highest cost was recorded for labour. Farmers used both family labour as well as hired labour. However, most of the farmers utilized family labour and in many cases farmers worked mutually in one another's fields. In these cases, farmers owned the field had to afford only the food cost for the labour. The average labour usage per acre of potato cultivation in Badulla and Nuwara Eliya were largely similar and it was nearly 110 days. However, average wage rates per day differed. In Badulla it was Rs.1,200 per male and Rs.700 per female per day. In Nuwara Eliya it was Rs.1,500 per male and Rs.800 per female per day. These costs excluded food cost and farmers are required to provide meals for the labour. In this study labour cost includes machinery cost as well.

Table 4.19: ANOVA for Labour Cost of Different Systems

Source	Sum of Squares	df	Mean Square	F	Sig.
Seed Type	8.821E9	3	2.940E9	218.930	0.000
Error	2.941E9	219	13430068.180		
Total	1.176E10	222			

R Squared = .750 (Adjusted R Squared = .747)
Source: Authors' calculation

According to the results of the ANOVA, labour cost is different based on the seed type. Further, according to the Post Hoc Test, labour cost for pre basic seed is significantly different from imported and other seed types. There is no difference in labour cost

between pre basic and basic seed types. In most cases, imported seeds are affected by diseases and farmers use manual labour to remove those crops without disturbing other healthy plots. Frequency of applying chemicals is also high for imported seeds and this would be another reason for high labour cost.

Table 4.20: Multiple Comparison of Labour Cost of Different Systems

(I) Seed Type	(J) Seed Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Basic	Imported	-15367.62*	730.58	0.000	-17259.02	-13476.23
	Other	-7663.63*	1028.65	0.000	-10326.68	-5000.59
	Pre Basic	600.00	1158.88	0.955	-2400.18	3600.18
Imported	Basic	15367.62*	730.58	0.000	13476.23	17259.02
	Other	7703.99*	834.59	0.000	5543.33	9864.64
	Pre Basic	15967.62*	990.67	0.000	13402.91	18532.34
Other	Basic	7663.63*	1028.65	0.000	5000.59	10326.68
	Imported	-7703.99*	834.59	0.000	-9864.64	-5543.33
	Pre Basic	8263.63*	1227.10	0.000	5086.81	11440.45
Pre Basic	Basic	-600.00	1158.88	0.955	-3600.18	2400.18
	Imported	-15967.62*	990.67	0.000	-18532.34	-13402.91
	Other	-8263.63*	1227.10	0.000	-11440.45	-5086.81

Source: Authors' calculation

4.6.5 Any Other Cost Comparison for Different Systems

In here any other costs for potato is considered as costs which incurred in addition to standard practices. Those costs include time to time weeding, applying growth stimulators, pumping of water and other water management practices, applying lime and after harvesting practices such as applying chemicals when storing, grading and cleaning.

Table 4.21: ANOVA for Any Other Cost of Different Systems

Source	Sum of Squares	df	Mean Square	F	Sig.
Seed Type	1.861E9	3	6.204E8	4.963	0.002
Error	2.738E10	219	1.250E8		
Total	2.924E10	222			

R Squared = .064 (Adjusted R Squared = .051)
Source: Authors' calculation

ANOVA results revealed that there is a significant difference in any other cost for different seed types and according to Post Hoc Test, any other cost for pre basic seed type is significantly different from all other seed types. However, any other cost for all other seed types are not statistically different.

Table 4.22: Multiple Comparison of Any Other Cost of Different Systems

(I) Seed Type	(J) Seed Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Basic	Imported	2044.25	2229.00	0.796	-3726.33	7814.85
	Other	2710.89	3138.39	0.823	-5413.97	10835.77
	Pre Basic	12960.89*	3535.71	0.002	3807.39	22114.39
Imported	Basic	-2044.25	2229.00	0.796	-7814.85	3726.33
	Other	666.64	2546.32	0.994	-5925.45	7258.73
	Pre Basic	10916.64*	3022.51	0.002	3091.76	18741.51
Other	Basic	-2710.89	3138.39	0.823	-10835.77	5413.97
	Imported	-666.64	2546.32	0.994	-7258.73	5925.45
	Pre Basic	10249.99*	3743.87	0.034	557.60	19942.39
Pre Basic	Basic	-12960.89*	3535.71	0.002	-22114.39	-3807.39
	Imported	-10916.64*	3022.51	0.002	-18741.51	-3091.76
	Other	-10249.99*	3743.87	0.034	-19942.39	-557.60

Source: Authors' calculation

4.6.6 Total Cost of Production (per acre)

Total cost of production for potato comprises of all cost component which described above. According to the ANOVA results there is a significant difference in total cost of production per acre between seed types.

Table 4.23: ANOVA for Cost of Production for Different Systems (per acer)

Source	Sum of Squares	df	Mean Square	F	Sig.
Seed Type	6.123E11	3	2.041E11	392.987	0.000
Error	1.137E11	219	5.194E8		
Total	7.261E11	222			

R Squared = .843 (Adjusted R Squared = .841)
Source: Authors' Calculation

Interestingly, Post Hoc Test revealed that total cost to production per acre of pre basic seed is statistically significantly different from imported and other seed types. However, total cost of production to produce an acre of pre basic seed is not statistically significant from the basic seeds. Hence, shifting between pre basic and basic seed types does not imply any differ in total cost of production. Therefore, farmers could use both pre basic or basic seed for cultivation purposes. By adopting pre basic seeds farmers could save Rs.131,136 per acre from the total cost of production compared to imported seeds. Furthermore, by adopting basic seeds compared to imported seeds farmers could save Rs.124,497 per acre from the total cost of production.

Table 4.24: Multiple Comparison of Total Cost for Different Systems (per acre)

(I) Seed Type	(J) Seed Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Basic	Imported	-124496.76*	4543.34	0.000	-136257.88	-112733.65
	Other	-43178.56*	6396.93	0.000	-46174.38	-13052.76
	Pre Basic	6640.47	7206.79	0.772	-25582.37	11732.49
Imported	Basic	124496.35*	4543.34	0.000	112733.65	136257.88
	Other	81318.23*	5190.13	0.000	81445.63	108318.76
	Pre Basic	131136.48*	6160.73	0.000	101621.52	133520.15
Other	Basic	43178.63*	6396.93	0.000	13052.76	46174.38
	Imported	-81318.76*	5190.13	0.000	-108318.76	-81445.63
	Pre Basic	49818.66*	7631.08	0.017	2932.78	42444.49
Pre Basic	Basic	-6640.51	7206.79	0.772	-11732.49	25582.37
	Imported	-131136.48*	6160.73	0.000	-133520.15	-101621.52
	Other	-49818.66*	7631.08	0.017	-42444.49	-2932.78

Source: Authors' calculation

4.6.7 COP Comparison for Different Systems

According to the descriptive results and field observations pre basic seeds may result in 1:15 productivity in average. Hence, the highest average yield was recorded from the farmers who used pre basic as their seed preference. At the same time both pre basic and basic seed types demonstrated comparatively high vigour compared to imported seeds. This is another reason why final yields are high in those two types. Average farm gate price was derived through primary data. According to the results, the lowest unit cost is noted for pre basic seeds and both imported and other seed types demarcated equal unit cost. With all these factors the highest net return is derived for pre basic seed types followed by basic seeds.

Table 4.25: Costs and Returns of per acre Potato Cultivation Using Different Seed Systems

Description	Pre Basic	Basic	Imported	Other
Standard average yield rate	1:15	1:13	1:12	1:10
Standard average yield (kg/acre)	12,000	10,400	9,600	8,000
Average price of produce (Rs./kg)	75.00	75.00	75.00	75.00
Gross income (Rs./acre)	900,000	780,000	720,000	600,000
Seed cost (Rs./acre)	159,066.00	183,295.00	262,533.00	187,363.00
Fertilizer cost (Rs./acre)	63,218.00	56,343.00	59,179.00	76,783.00
Chemical cost (Rs./acre)	59,200.00	34,925.00	64,024.00	48,643.00
Labor/Machinery cost(Rs.acre)	45,600.00	46,200.00	61,567.00	53,863.00
Any other cost(Rs./acre)	48,416.00	61,377.00	59,333.00	58,666.00
Total cost (Rs./acre)	375,500.00	382,140.00	506,636.00	425,318.00
Net income (Rs./acre)	524,500.00	397,860.00	213,364.00	174,682.00
Per unit cost (Rs./kg)	31.00	37.00	53.00	53.00
Seed cost as % of COP	42%	48%	52%	44%

Note: Average standard seed requirement for acre is 16 honders (cwt) and one honder (cwt) includes 50kg of seed potato.

Source: Authors' calculation

When considering seed cost as a percentage of total cost of production, as in the literature if a farmer uses imported seeds it may increase the total cost of production and seed cost solely accounts for more than half of the total cost of production. This study has also proven it and if a farmer uses pre basic seeds, it is only 42 percent from the total cost of production and more importantly that farmer could cultivate consecutive seasons using the same produce as seeds. Hence, seed cost may reduce considerably in the second and consecutive seasons. Also, at the same time farmer could be satisfied with the quality aspect as well. This is also true with basic seeds as well. However, it is always recommended to use pre basic seed as the first seed preference.

4.7 Possible Pitfalls in Seed Production Mechanism

Having an improper seed production cycle within the potato farming system is the main motive of private entities to enter the seed potato sector in Sri Lanka. Hence, a shortage of good quality seeds persists in the market. This directly results in increased price in seed potato. As mentioned earlier chapters, imports are generally consisted of "Class A" type seed potato. However, with the rising seed cost and the shortage of seeds farmers used to cultivate these seeds for both seeds and for consumption. On the other hand, no proper seed inspection is carried out in this system. Hence, the quality of these seeds are questionable. Further, certain private entities import "Class

A" and multiply and sell to the local farmers. However, seed certification process is also carried out in those farms since it is a commercial venture.

As mentioned earlier, majority of farmers have chosen imported seeds as a primary seed source. However, an issue arises in the second cultivation season if farmer retains certain amount as seeds from the first cultivation since those are not recommended as seeds. Nevertheless, this is a common practice and this may have an adverse impact on the yield due to the quality of seeds is affected. With these practices farmers are able to reduce seeds cost thereby reducing the total cost. Interventions should focus on both seasons. However, emphasis should be on the cultivation in the second season as a short term strategy. In the long run, there should be a mechanism to supply quality seeds in the first cultivation itself to retain the quality of the seeds for the next season. Specially, for Badulla quality seed should be provided in *Maha* season beginning starts in October and in Nuwara Eliya it should be again in *Maha* season from September to December.

Another critical issue is slicing of tubers to fill the seed gap as a result of high cost of imported seeds. Almost all imported seeds are being sliced to increase the number of tubers. Even though, some companies provide insurance and guarantee on the imported seeds, if those seeds are sliced and planted any insurance or guarantee may not apply. There are many instances of this nature. This is another important aspect which PPPs are currently struggling to make amends.

Soon after seeds are imported and transported for quarantine and other necessary inspections seed may be exposed to temperature shock. This directly breaks the dormancy status of seeds. Therefore, these seeds are recommended to be cultivated within two to three weeks. This is a common issue related to imported seeds. It is not feasible to conduct inspection and transportation to distribution centers within such a short duration. Yet again, the quality of the seeds is questionable. Another main issue is no entity in Sri Lanka verifies the specific class of imported stocks. All entities solely depend on the label generated by the exporter.

According to large scale farmers, inadequate cool storage facility is a major issue. Seeds should be stored for about three to six months duration in certain instances. However, this is not a major issue for small and medium scale farmers since they practice alternative storage facilities in their homestead. Most of the time large scale farmers tend to store seeds to obtain a competitive price.

In certain seasons farmers are unable to meet the competitive price and decide to retain seed stocks for the next season. The studied areas in Bandarawela showed less seed production capacities with the inherent issues. Therefore, rather than trying to produce seeds setting up a mechanism to provide quality seeds for those areas would be an economically sound strategy.

CHAPTER FIVE

Overall Review of Seed Potato Production Mechanism in Public and Private Sectors

5.1 Introduction

Chapter five describes the seed potato production mechanism of the both public and commercial level private entities. Companies and main countries which import seed potato annually with their relative shares described in the chapter. Further, the chapter elaborates seed certification process for both production and importation purposes aligning with the current seed regulation policies in the country. The Chapter also addresses selling and distribution aspects of seed potato produced in government owned farms. Special attention is also paid to the capacities and future prospects of seed potato production in these farms. Past and present PPPs related to seed potato production is demonstrated and their impact is also described. The chapter concludes by illustrating a sustainable partnership model practiced by one of the co-operative societies in the area as a case study.

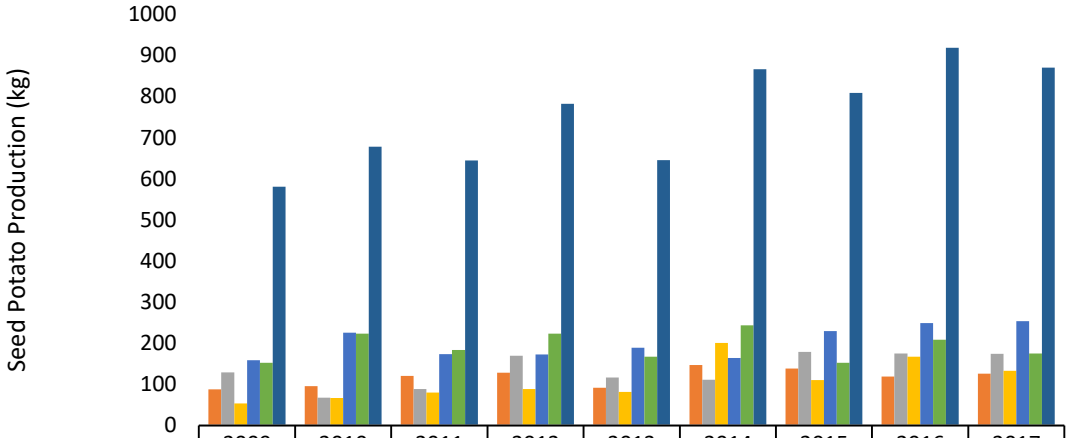
5.2 Structure-Conduct-Performance of Seed Potato Production in the Government Sector

Many government actors are engaging in the production of seed potato in Sri Lanka. Seed potato production starts with the tissue culture process at special laboratories at Seetha Eliya and Bandarawela Research Stations. Both stations are operated under the HORDI, Gannoruwa. Mother plants for tissue culture are imported from the Netherlands and maintained at the facility itself. Official tissue culture process for potato in Sri Lanka is carried out in these stations and no private entity is engaged in the process. In vitro plants are used as the initial plant. Tissue culture plants are produced by the research station itself. In vitro plants are released to the Seed Production and Distribution Division on monthly basis as per the requirement. These in vitro plants are called as breeder seeds. Afterwards, multiplication process may take place using cuttings in the Seed Production and Distribution Division.

Using cuttings mini tubers are produced in the protected house. G_0 production is carried out using mini tubers acquired through the process in poly tunnels using both hydrophonic and aerophonic systems. Subsequently, Generation 1 (G_1) is produced from G_0. However, all G_0 output may not be utilized to produce G_1. A certain amount is sold to the farmers directly as well. The rest is divided among five government farms (Meepilimana, Kandapola, Udaredella, Piduruthalagala and Seetha Eliya) according to their capacity and requirement to produce G_1. Therefore, two entities received G_0 from the Seetha Eliya Research Station. Most of the time G_1 is also produced in the poly tunnels and thereafter, generations up to G_3 are cultivated in open fields. All outputs (mini tubers and G_0) produced and distributed by the Seed Production and Distribution Division are certified and verified under the SCPPC at Gannoruwa.

However, G_0 production in the Bandarawela Research Station is slightly different from that of Seetha Eliya. G_0 produced in Bandarawela is not transferred to Nuwara Eliya and only distributed to the farmers cultivating in the Badulla district. Nevertheless, seeds produced in Nuwara Eliya are transferred and purchased by the farmers in Badulla. Rooted Stem Cuttings are produced from the tissue culture plants and those produced then disseminated to the farmers. This practice is successful in Bandarawela due to prevalence of moderate temperature conditions compared to Nuwara Eliya. Therefore, less prominent and at the same time less demand could be observed for G_0 production in the Badulla district. Also, seeds are not utilized again like in Nuwara Eliya. With moderate temperatures there is a high probability of propagation of bacteria wilt disease. Therefore, in the Badulla district the seed cycle is not practiced throughout the seasons. As a result of improper seed cycle, most of the times G_1 and thereafter pre basic seed generations are directly transferred to the market as potato grown for consumption. Hence, this always creates a gap between the targeted quality seed and actual produced quality seed in the area.

In few cases, G_1 is further multiplied in Government farms up to C_1. However, according to the situation (if there is a shortage of obtaining the previous seeds) C_1 could be further multiplied to obtain C_2. Therefore, in Sri Lanka seed potato generations such as G_0, G_1, G_2, G_3, C_1 and C_2 are considered as seeds and out of that G_0, G_1, G_2 and G_3 are considered as pre-basic seeds. In general, potential average yield ratio is high in subsequent generations starting from G_1 to G_3. Importantly, in Sri Lanka generations after C_2 is not recommended to cultivate as seeds due to low vigour.



	2009	2010	2011	2012	2013	2014	2015	2016	2017
Kandapola	87	95	120	128	91	147	139	119	125
UdaRadella	129	67	88	170	116	111	179	175	174
Meepilimana	53	67	80	88	82	201	110	167	133
Seetha Eliya	159	225	173	173	189	164	229	249	254
Piduruthalagala	153	223	184	223	167	243	152	209	175
Total	580	678	645	782	645	867	809	919	871

Source: HARTI survey, 2018

Figure 5.1: Seed Potato Production in Government Farms (2009 – 2017)

The average annual seed potato production carried out by all the government farms is approximately 755 kg and the leading production is performed by the Seetha Eliya farm. These seeds represent all seed generations up to C_1. However, this was comparatively a trivial contribution after 2013 these farms were able to increase its production and per annum average was approximately 866 kg. Harvested seeds are initially sorted in the field manually, and second sorting is carried in the storage using a sorting machine. Machine is programmed to sort seeds which have a diameter of 28 mm to 55 mm. Damages and out of shape seeds are graded according to the following standard.

Table 5.1: Grades and Prices of Damaged Seeds

Grade	Nature of Damage	Price of 50 kg stock
I	Mild damages with one or two cuts	Rs.7,000
II	Average damages	Rs.5,000
II	Fully damaged and out of shape	Rs.3,000

Sources: HARTI survey, 2018

Seeds with less than 28 mm diameter are also categorized under this grading system. These grades are excluded from the certification process. Hence, no grade is awarded to these stocks. The output produced within the farms except rejects and damages is transferred to the Seetha Eliya storage facility.

A certain amount (depending on the production capacities of farms and farmer requirement) of G_0 and G_3 produced in government farms are distributed by the Uva Province and the Central Province Agriculture Departments at a subsidized price to the farmer. The total price of a G_0 seed is Rs.6.00 and half of it is borne by the government (Cost is measured per seed not per kg). This programme is termed as “50 percent contribution”. Apart from the main five farms, the farm located in Galpalama also contributes as a G_0 producer for this programme. Not only for seeds, but also under this programme poly tunnels are established in farmer fields for 50 percent contribution. A total of 448 farmers have obtained subsidies for seeds in 2017. However, only two farmers have obtained subsidy for the construction of poly tunnels in 2017.

Table 5.2: Allocations for Potato Seeds Under 50 percent Subsidy Programme in Nuwara Eliya District for the Fourth Quarter, 2017

Activity	Required Amount (cwt)	Allocation (Rs.) Under 50% Farmer Subsidy	Implemented Area/s	Cost for kg (Rs.)
Supply of imported seed potato – C_1 (Granola)	1,500 cwt (76, 203.45 kg)	10,650,000.00	Hanguranketha Nuwara Eliya, Walapane and Kothmale DS Divisions	139.75
Supply of local seed potato - C_1 (From government farms)	500 cwt (25,401.15 kg)	2,250,000.00	Nuwara Eliya and Kothmale DS Divisions	88.57
Supply of imported seeds potato (Atlantic and Hermus varieties) for chip production	350 cwt (17,780.80 kg)	2,485,000.00	Nuwara Eliya and Kothmale DS Divisions	139.75
Total	2350 cwt (119,385.4 kg)	15,385,000.00		

Note: cwt refers to hundredweight and 1cwt = 50.8023 kg
Source: Agriculture Branch, District Secretariat, Nuwara Eliya, 2017

The government total expenditure share in one quarter for imports of potato seeds accounted for more than Rs.12 million (Table 5.2). This was only for the Nuwara Eliya district though it contributes 22 percent to the national production. However, varieties used for chip production have to be imported to maintain the specific standards of the production. Hence, total of Rs.2.5 million has to be allocated for importation of those varieties. When the unit cost is compared the difference between imported and locally produced seeds is Rs.52.18/kg. With uncontrollable forces such as international trade and foreign exchange rates this gap would widen more.

Table 5.3: Estimated Cost of Construction of Polly House Type 01 (6.1 meter x 15.3 meter) Under the G_0 Production Project

Item	Description	Unit	Qty.	Rate (Rs.)	Amount (Rs)
1	Cleaning and levelling the site	Item	Allow	Sum	10,000.00
2	Excavation in foundation in normal earth up to a depth of 1.5m inclusive of backfilling, compacting and disposal of surplus earth.	m^3	2.0	1,006.00	2,012.00
3	Mixing and placing in position concrete grade 20. Nominal mix 1:2:4 (20mm) using a concrete mixer including fuel/ operator/ handling/ vibrator.	m^3	2.6	15,302.00	39,785.20
4	Floor concrete 1:2 ½:5(25mm) 62MM thick with expansion joints filled with 1:2 bitumen and sand rate including curing. Compacting and laying polythene sheet under the concrete.	m^2	30.0	614.00	18,420.00
5	Swan timber formwork in class III timber for ground concrete works at ground level.	m^2	10.0	994.00	9,940.00
6	Supplying & fixing 32mm diameter heavy duty GI pipe for roof & door area including two coats of anticorrosive paint.	m	135.0	950.00	128,250.00
7	Supplying & fixing 25mm diameter heavy duty GI pipe for roof & door area including two coats of anticorrosive paint.	m	290.0	780.00	226,200.00
8	Supplying and stretch Guage 10 PVC coated wire at 300 mm c/c both ways under the polythene	m	450.0	18.00	8,100.00
9	Supplying and stretch UV treated 25 mm width wind belt (over the polythene)	m	275.0	120.00	33,000.00
10	Supplying and covering existing frame of outer line with nylon insect proof net (40 mesh size) including clips as per the drawing.	m^2	155.0	250.00	38,750.00
11	Supplying and covering of roof frame with heavy guage (1000 guage) polythene (UV polythene) sheets with binding clips and wind belt as per the drawing.	m^2	120.0	310.00	37,200.00
12	Supplying and covering existing frame with UV resistant shade net (50%) including clips.	m^2	120.0	250.00	30,000.00
13	Supplying and fixing swing door (900X 2100mm size) 25mm GI pipe frame covering with nylon insect proof net including hinges. Locks and clips etc. as per the drawing.	nr	02	3,525.00	7,050.00
14	Grow beds preparation using engineering bricks as per the drawing.	sum	sum	25,000.00	25,000.00
Total					**613,707.20**
Provisional Sum 10%					61,370.72
Direct Supervision 105%					9,250.61
Administrative cost 1%					6,137.07
Grand Total					**690,420.60**

Source: HARTI survey, 2018

The cost of establishing a standard size (6.1m x 15.3m) of poly tunnel is around Rs.600,000. In 50 percent subsidy programme, government bore half of the cost and in the fourth quarter of 2017 the Central Province Agriculture Departments issued approval for two projects. However, it is reported that, even with the 50 percent support few farmers did not undertake the G_0 production. Instead, those farmers were engaged in vegetable cultivation.

5.3 Seed Certification Process in Farms

Two important physical conditions are considered when producing seed potato. These are,

i. Altitude of the land should be 1350m above the sea level (This condition is not valid for the seed produced in poly tunnels).
ii. Slope of the land should not exceed more than 40^0.

All the government farms are established considering these pre-requirements. Apart from these two special conditions all other general aspects prior to establishment of seed farms are applicable for these farms as well. Field supervision is conducted by the SCPPC, in four stages as follows.

i. 1^{st} field supervision – 2 to 4 weeks after cultivation
ii. 2^{nd} filed supervision – 5 to 7 weeks after cultivation
iii. 3^{rd} field supervision - 8 to 10 weeks after cultivation
iv. 4^{th} field supervision – 10 to 14 weeks after cultivation

If recommended standards are not maintained, SCPPC has authority to downgrade those seeds. Harvesting, grading and labelling is carried out only after final supervision. Storing has to be carried out according to the seed variety, seed class, stock number and location. Immediately after harvesting stocks have to be stored at least for two weeks for curing. Labelling of grades has to be done within 30 days after harvesting and SCPPC has full authority to do so.

5.4 Current Status of the Seed Regulation Policy in Sri Lanka

Seed is one of the crucial inputs in agriculture and importantly, it determines the final output of the production in terms of both quantity and quality. Hence, getting access to a quality seed stock is essential for sustainable agriculture. Inadequate supply of good quality seeds and planting material is considered as one of the major factors contributing to the slow growth rate in the agricultural sector in the country (Udakumbura, et al., 2002). Due to non-availability of good quality seeds farmers are compelled to use their own seeds. However, in many developing countries issues related to quality seeds persist and often farmers in those countries are not be able to access to quality seed sources. In most cases this scenario is prevailing in Sri Lanka as well. To overcome this situation and to strengthen the seeds sector Sri Lanka has resorted to a number of steps. Until 1980s, the government sector of Sri Lanka had the sole authority over seed production and distribution in the country and in 1984 the seed sector was liberalized. Since then the private sector was engaged in seed

production and dissemination. In 1996 government has introduced National Seed Policy knowing the importance of quality seeds. Moving forward, in 2003 government enacted the Seed Act No 22 of 2003 giving priority to quality seeds related activities.

However, the Seed Act came into effect in 2008. The main responsible body in seed production and distribution is the Ministry of Agriculture and DOA. Presently, two institutes under DOA - SCPPC and SPMDC are responsible for seed production, marketing, and distribution in the country. However, there are several controversies surrounding the present Seed Act of 2003. According to the Act, seed handlers (any person who as producer, importer, distributor, conditioner, repackager agent or retailer is responsible for causing a seed to be placed in the market in Sri Lanka) should be registered under the Act. However, the study revealed that, none of the farmers who acted as commercial seed sellers were registered under the current Seed Act. Interestingly, those farmers have very little knowledge on the Seed Act as well. The most important rule under the Seed Act is violated giving rise to grave quality issues.

As mentioned in early chapters there is no systematic compensation system for farmers who become victims of substandard seeds. As a result of the abuse of the Seed Act there are many informal seed channels especially for crops like potato. Hence, farmers may purchase seeds from those venders without a guarantee. Farmers themselves have to bear the loss and vicious cycle is continuing. When referring to seeds, another important stakeholder is the agriculture input dealers. Agriculture input dealers should have reasonable knowledge on selling, storing and checking the quality of seeds. They should be provided awareness as well. Even though there is a proper seed procedure to a certain extent implementation and practice of that procedure is very much limited. Therefore, priority should be given to aware both public and private entities related to the Seed Act. These awareness programmes should be conducted through ASCs accordingly in a timely manner.

5.5 Seed Production Capacity and Prospects in Government Sector

Currently, the government sector as a whole produces approximately 1.2 million G_0 seeds annually. At the end of 2019 the government plans to increase G_0 production to 3 million per annum. Currently, G_0 is mainly produced using Aerophonic System in 800m^2 poly tunnels. Currently the Seetha Eliya Research Station is equipped with five tunnels and three cycles of production is carried out within it. However, before 2014 G_0 production was carried out using Hydrophonic System. Hydrophonic system was highly labour intensive and also due to its structure only two plants could be loaded into a slot. These barriers are not there in Aerophonic System and instead of two plants, five plants could be loaded to a slot. Hence in a standard ploy tunnel (8m x 50m = 400m^2) which adopts Aerophonic System holds 9,000 plants compared to Hydrophonic System which holds 3,500 plants.

Table 5.4: Cost per Seed (G_0) for Different Poly Tunnel Systems

Adopted System	Unit Price (Rs. per seed)
Aerophonic	1.80
Hydrophonic	2.90
Geophonic	4.00

Source: HARTI survey, 2018

Total cost per seed includes, input, labour and electricity. However, total cost excludes tunnel maintenance and tissue culture process. As mentioned earlier tissue culture plants are provided by the Seetha Eliya Research Station for free of charge. Tunnels are used for a single crop cycle and cleaned prior to start the next cycle. Fumigation is carried out only if there are any possible threats.

Furthermore, target of producing 45mt. of G_1 in poly tunnels at the end of 2019 is mooted. A total of 20 poly tunnels are already constructed in Seetha Eliya farm to ensure continuous G_1 production and currently 12 poly tunnels are at the operational level. The rest is planned to function in the end of 2018. All poly tunnels adopt geophonic system and the medium includes paddy husk and the tea reduce. It has been estimated that, 1,500 kg of G_1 production from one poly tunnel, total of 30mt. from all 20 poly tunnels may be released per annum only from the Seetha Eliya farm. Accordingly, from the total G_1 output exactly 50 percent is allocated for farmers and the balance is retained in the farms to produce G_2. Programmes conducted by the Provincial Agricultural Departments are aimed at producing a total of 600 G_0 seeds within the area of 25 m^2 and multiplied it to obtain G_1. This output of G_1 is adequate to cultivate in 0.25 acres. Likewise, this rotation continues subsequently for 3 – 4 times.

Cold storage facility in all government farms except in Seetha Eliya is lacking. However, the facility is situated in the ISTI at Bindunuwewa and Kahagolla research stations. Therefore, all seeds produced in these farms are transported to the Seetha Eliya storage facility and thereafter dissemination is carried out from there. However, if production is expected to increase subsequently, storage facility is also essential to expand. The primary target group of the programmes conducted by the Provincial Agricultural Departments are individual farmers. However, there is no monitoring mechanism during the process. Farmers could sell their seed output for consumption if they obtain a fair market price. Therefore, objectives of the programme are not fulfilled. Hence, seed multiplication cycle could be broken at any given point of time. Monitoring all farmers at once is also not feasible due to practical issues. Therefore, it is strongly recommended to award this subsidy only for a selected number of farmers in selected areas and continue with a strong supervision and monitoring.

5.5.1 Informal Seed Channel within the Formal Seed Channel

Damaged seeds resulted from the production cycles in government farms are sold to the farmers at a reduced price. These seeds are categorized into three grades as mentioned earlier and none of the grades are certified or labelled by the SCPPC.

However, these are sold to the farmers due to the shortage of locally produced seeds within the system. Even though this has been not recognized as a formal channel this is popular among the farmers in nearby government farms. In that sense, farmers purchase these damaged slots by taking risk. Hence, it is the trade-off done by the local farmers. The main reason why farmers put themselves at risk is to reduce their seed cost as much as possible.

5.6 Structure-Conduct-Performance of Seed Potato Production in the Private Sector

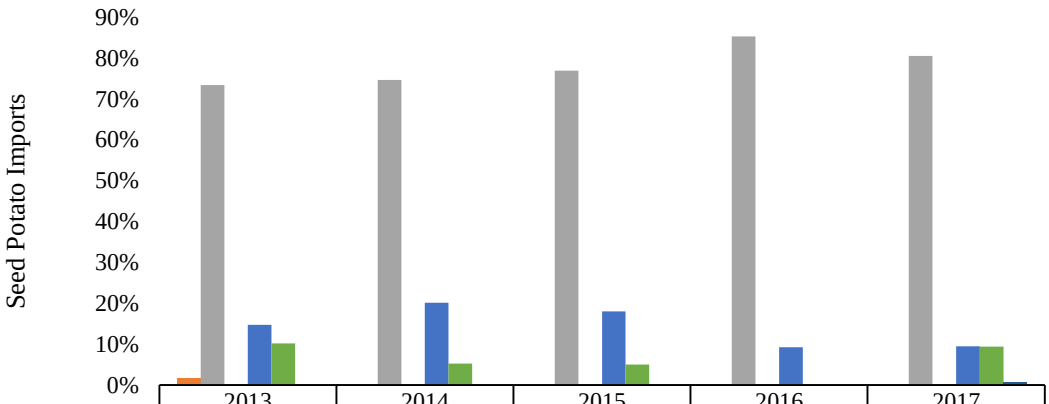
Private sector entities are engaged in both seed production and importation processes in Sri Lanka. However, majority of companies import seed potato. Local seed production is mainly handled by farmers. However, majority production is referred as informal seed channels since seeds are not certified. According to the SCPPC, total of 13 private entities have been importing seed potato to the Sri Lanka since 2009. However, when considering the last five years from 2013 a continuous importation process could only be observed from two companies.

Table 5.5: Seed Potato Importation Companies and Their Relative Contribution

Company Name	2013	2014	2015	2016	2017
CIC Agribusiness	12%	-	-	-	-
Hayleys Agriculture Holdings	54%	50%	48%	66%	76%
Opex Holdings	19%	-	-	-	-
Troseed (Pvt.) Ltd.	15%	18%	18%	8%	9%
Mahaeliya Agro Products	-	31%	23%	22%	12%
Iona Traders	-	-	8%	4%	-
Plant Seeds	-	-	1%	-	-
Ranscrisp Marketing	-	-	1%	-	1%
Rasi Seeds	-	-	1%	-	-
Oasis Marketing Co. (Pvt.) Ltd.	-	-	-	1%	1%
Agrotechnica	-	-	-	-	1%

Source: SCPPC, 2018

From the total imported quantities over the past five years majority share had been imported by the Hayleys Agriculture Holdings (Table 5.5). In 2017, Hayleys had imported more than two third of seed potato from the total imports by establishing the market leadership in imported seed potato sector. The second and third players were Mahaeliya Agro Products (12%) and Troseed (Pvt.) Ltd. (9%) respectively.



	2013	2014	2015	2016	2017
Germany	2%	0%	0%	0%	0%
Netherlands	73%	75%	77%	85%	81%
Thailand	0%	0%	0%	0%	0%
USA	15%	20%	18%	9%	9%
France	10%	5%	5%	0%	9%
Australia	0%	0%	0%	0%	1%

Source: SCPPC, 2018

Figure 5.2: Sri Lanka's Seed Potato Imported Countries (2013 – 2017)

Sri Lanka has imported seed potato from six countries since 2013 and the Netherlands tops the list. Average annual importation of last five years is approximately 1762mt. On average (from 2013 to 2017) more than two third of seed potato stocks had been imported from the Netherlands (Figure 5.2). The second and third contributors were the USA and France respectively.

5.6.1 Importation Process

NAK is the Dutch General Inspection Service for seed and seedling of agricultural crops and, imported seed potatoes are also certified and verified by the NAK. According to their standards, seed potatoes are classified into three broad categories as follows.

Table 5.6: NAK Classification of Seed Potatoes

Category	Output Class	Class Generation
Prebase	Mini tubers (vitro) Starting plant (traditional)	G_1
	PB 1 (1 year strain)	G_2
	PB 2 (2 year strain)	G_3
	PB 3 (3 year strain)	G_4
	PB 4 (4 year strain)	G_5
Basic	S (Super)	G_6
	SE (Super Elite)	G_7
	E (Elite)	G_8
Certified	A	G_9

Source: NAK, 2018

In general, private entities import “Class A” directly from their suppliers. Technically, “Class A” is recommended to cultivate the consumption varieties since it is certified and the last generation of the classification. However, “Class E” could be used to produce seeds, yet the cost is high. Hence, “Class E” is not imported frequently by the companies. All seed potato stocks are imported in reefer containers which are used for intermodal freight transportation in refrigerated conditions. Total duration for one shipment is roughly about three weeks. Temperature is adjusted in each week systematically and the final temperature ranges between 16 ^{0}C and 18 ^{0}C before the stock is unloaded. Mainly five potato varieties are imported to Sri Lanka (Table 5.7).

Table 5.7: Main Seed Potato Varieties Imported to Sri Lanka

Variety	Company	Recommended Area/s
Granola	Hayleys Agriculture Holdings	Nuwara Eliya
Arnova	Troseed (Pvt.) Ltd.	Badulla
Rudolph	Troseed (Pvt.) Ltd.	Nuwara Eliya
Red La Soda	Mahaeliya Agro Products	Jaffna
Sassy	Mahaeliya Agro Products	Jaffna

Source: HARTI survey, 2018

Imported seeds quantities may depend on the tax applied to the imported potato meant for consumption and the seasonal variations. For example if the specific tax for imported consumption potato increases, then the cultivation extent of the local farmers may also increase. Imported stocks are stored in warehouses for about a week until completion of disease tests. Soon after test are completed and if there are no any issues, then the stocks are released from the harbour. If there are issues stocks are re-exported.

5.7 Past Partnership Initiatives and Their Mechanism

There have been a number of programmes and projects implemented in the area of potato cultivation in Sri Lanka. Even though these projects do not imply aspects related to PPPs, still exploring their mechanism is important for future reference. However, it is important to note that, many of the programmes and projects are aimed at enhancing the production of consumption potatoes and only a very few are focused on the areas of seed potatoes. Among those few, two comprehensive and well-structured projects have been identified as major initiatives related to seed potato production and distribution. Following facts were identified as common barriers related to seed potato production and distribution in Sri Lanka before implementing both projects. Hence, these two projects had been implemented to overcome those barriers to a certain extent.

i. The shortage of seed potatoes at the time of cultivation. Often the seeds issued by the government institutes constitute a small proportion of the total seed requirement of the farmers.
ii. The prices of seed potatoes are high during the cultivation season. Specially, the imported seed prices are increasing at an increased rate.

iii. Seed potatoes are not available at the required time due to the delays in their importation and distribution.
iv. Due to the high cost of seeds, cost of cultivation has increased and many farmers find that the scale of finance provided by the banks is inadequate.
v. In consequence, the net income derived by small farmers from the cultivation of potatoes is poor.
vi. Loss of seed quality and quantity due to improper seed storage methods.

Interestingly, many of the issues identified during 90s still remain. However, the level of intensity of those issues might have changed from time to time. During the present study some of these facts were revealed by the farmers. On the other hand, these projects have achieved their objectives to a certain extent. Yet the issue is the sustainability of the system. Success of the model or the system would heavily depend on the monitoring and evaluation. Within the given period both projects were able to achieve their targets. But in the long run the question whether it would it be sustainable is not addressed. PPPs come in to the context here. It is also envisaged that, only offering infrastructure would not be productive but providing credit facility at the beginning and during the harvesting time is essential.

Table 5.8: Project 1 – UNICEF – Nuwara Eliya RRDB Programme for Promoting the Production of Seed Potatoes among Small Farmers

Project Locations	Meepilimana, Kandapola and Nuwara Eliya
Stakeholders	UNICEF, RRDB, DOA, Potato Farmers
Duration	5 years (1989-1993)
Objectives	To assist the small potato producers by financing the cultivation of the small plots of agricultural lands. To assist the small farmers whose agricultural land holdings are 20 -4- purchase to produce their own seed potato requirements by financing the construction of small scale potato stores. To assist the small farmers with short term finance in order to overcome the financial difficulties arising following harvesting. A marketing loan will be provided to supplement their income in the period when the seeds are stored. To increase income and employment for stallholders who cultivate very small plots of land with potatoes.
Components	Credit scheme to finance the cultivation, construction of low-cost seed potato storage facilities, providing short term marketing loans. Training for both officers and farmers.
Funding Body/s	UNICEF, RRDB
Number of Farmer Beneficiaries	Every year 80 farmers and after end of the project a total of 400 farmers have benefited.
Achievement/s	Able to reduce seeds cost by 37%

Source: Regional Rural Development Bank , 1989

This project was implemented mainly to provide credit facilities and training options for stakeholders. Credit facilities were provided at the beginning of the cultivation as a cultivation loan. Also, during the process infrastructure facilities such as storage of seeds and at the end of the harvesting season marketing loans were provided. The objective of the marketing loan was to address short term financial needs of the farmers immediately after harvesting. Potato storing racks installed in a small space inside the dwelling were built during the project. Single set of racks (12 racks) were able to store 150 kg of seed potato at once where seed requirement for 20 perch of land. Structured training programmes were conducted for each farmer group in each area. Technical training was carried out by the experts in the DOA. Training related to financial aspects were carried out by the experts in the banking sector. Further, agricultural officers in those areas were trained for both aspects.

Table 5.9: Project 2 – Quality Seed Potato Production Programme through FFS

Project Locations	Welimada, Uva Paranagama, Bandarawela and Haliela
Stakeholders	IFAD, Provincial DOA, Seetha Eliya Research Station, Potato Farmers
Duration	5 years (2008-2012)
Objectives	i. To increase the production of quality seed by introducing farmer field school model. ii. To transfer technology to the farmers on quality seed potato production.
Components	i. Establishment of FFS. ii. Formation of Cooperative society for seed potato distribution iii. Training for both officers and farmers.
Funding Body/s	DZLiSP Badulla
Number of Farmer Beneficiaries	Total of 2,353 farmers benefited.
Achievement/s	Able to reduce seeds cost by 19%

Source: Wickramasinghe & Jayasooriya, 2012

The main focus of the second project related to seed potato was to establish Farmer Field Schools to transfer technological knowledge. Basically, farmers were introduced a tried and tested technology transfer model to the farming communities having farming community as the mobilizer. In the first stage, selected members were provided training on quality seed potato production by IFAD in collaboration with the provincial DOA. Then, G_0 production in poly tunnels was introduced to the farmers. Partial investment for poly tunnels was taken up by the partnership itself. As the next step, farmers were instructed to produce G_1 in specially treated open fields. In the final stage cooperative societies consisting all stakeholders were constructed to continue the process after the project.

However, currently many of the introduced systems and mechanisms from both projects were not in use due to improper monitoring and evaluation. Even though the IFAD model was a successful initiative at the beginning of the project, a few years later

it disappeared. The farmers encountered many issues related to marketing of G_0 output. This has been identified as the main reason for the collapse of the model. The present study also revealed that, G_0 production should be limited to the government farms and only for selected farmers in the area. However, those limited farmers should be selected systematically using their capacity to do so and at the same time those farmers should be monitored and evaluated on regular basis. This will be further discussed in Chapter Six.

5.8 Current Partnership Initiatives and Their Mechanism

According to the findings, a number of partnerships for potato cultivation in Sri Lanka is observed. Certain partnerships are entirely operated by the private sector and some are operated by the public sector. However, these partnerships are not much prominent and widespread. Interestingly, some of the partnerships contain have unique features and those unique features are considered as the lifeblood of those partnerships. The results revealed that, 43 percent in Uva Paranagama, 70 percent in Welimada, 20 percent in Bandarawela and 46 percent in Nuwara Eliya currently had partnerships with external parties related to seed potato and potato production. In general, nearly half (46%) of the farmers from the total sample have associated with one or several partnerships.

Table 5.10: Stakeholder Contribution for Current Partnerships

Stakeholder	Uva Paranagama % (n=30)	Welimada % (n=48)	Bandarawela % (n=14)	Nuwara Eliya % (n=34)	Total % (n=126)
Public	83	81	88	68	79
Private	7	19	12	32	21

Source: HARTI survey, 2018

From the farmers who formed partnerships, majority (79%) associated with the public sector stakeholders and the rest with the private sector stakeholders. Within a partnership there may be partners from both sectors. However, it is important to note that, based on the prominent partner, type of the partnership is decided. Hence, in most cases prominent contribution was made by the government sector. Notably, in Bandarawela partnership formation is much poor. Comparatively, partnership progression in other three DS divisions are at a moderate level. In Welimada strong capacity to form partnerships was observed. Currently, following public stakeholders were identified as main contributors for the partnerships.

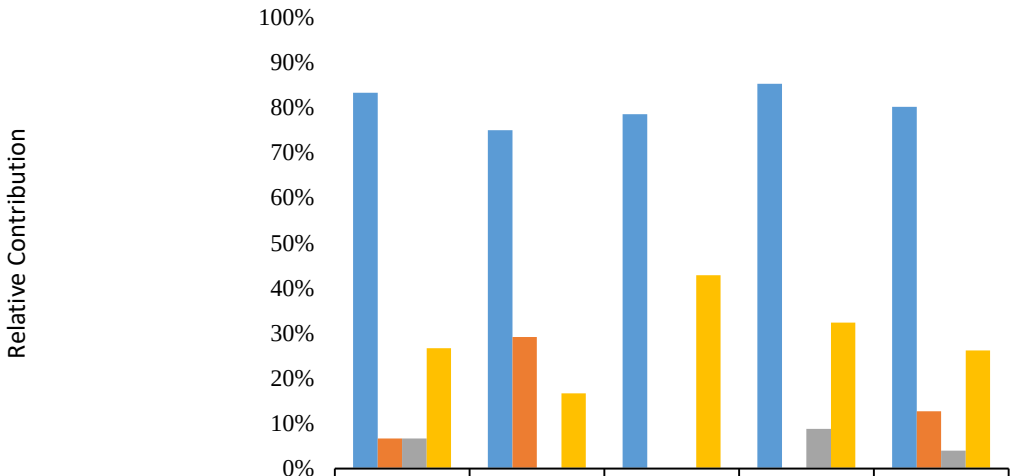
i. ASCs
ii. Ministry of Agriculture / DOA
iii. Seed Farms (Bindunuwewa, Seetha Eliya, Dowa, Kahagolla, Rahangala, Boralanda Galpalama, Piduruthalagala, Kandapola and Uda Radella)
iv. Farmer Banks including Peoples Bank
v. Department of Agrarian Development

In most cases, public sector provided credit facility, training and various subsidies for the farmers to strengthen the seed potato production. On the other hand following private sector stakeholder were identified in partnerships.

i. Private Agribusiness Organizations (e.g. Hayleys Agriculture Holdings, Troseed (Pvt.) Ltd., Ranscrisp Marketing etc.)
ii. Large scale potato farmers
iii. Farmer Organizations
iv. Asian Development Bank
v. Co-operative Societies

Private entities are mainly engaged in transferring technology to the farmers. Apart from that, they also provide training and credit facilities. Few interesting models were introduced by the private entities to the farmers to improve the overall production process. When considering private agribusiness organizations their main strength is up-to-date technical know-how on seed potatoes. However, in general activities implemented through partnerships could be broadly categorized into four areas. Those four areas were provision of input, credit, infrastructure and technical know-how. According to Figure 5.3, provision of input was the main activity facilitated by a majority of partnerships in all four DS divisions. Provision of seeds and fertilizer at a subsidized price was only two inputs provided by the partnerships. From those two inputs many partnerships opted to provide quality seeds for the farmers at a subsidized price. In many cases these were provided by public sector entities and partial cost was also borne by the government sector.

The second highest activity carried out by the partnerships was disseminating and providing technical know-how on production of seed potatoes. Introduction of G_0 production was a prominent technological aspect. This was introduced to the farmers earlier as well. Another aspect was training component on cultivation practices and pest and diseases of potato. The training component was provided by both public and private sector stakeholders. Furthermore, awareness programmes were conducted on the seed certification process. This is also a critical knowledge update on seed potato production in order to enhance the quality parameters of the seeds. However, according to the farmers' view this was not a successful initiative. Hence, knowledge dissemination was relatively poor and provided only by the public sector stakeholders. For example, the study revealed that none of the farmers in the sample have satisfactory knowledge on the Seed Act and its components. Similarly, few farmers have worked as employees in that project and from that opportunity those farmers were able to receive benefits such as technical work experience.



	Uva Paranagama	Welimada	Bandaraw ela	Nuwara Eliya	Total
Provision of Inputs	83%	75%	79%	85%	80%
Provision of Credit	7%	29%			13%
Provision of Infrastructure	7%			9%	4%
Provision of Technical Know-how	27%	17%	43%	32%	26%

Source: HARTI survey, 2018

Figure 5.3: Activities Performed by the Partnerships

The next main activity was provision of credit. This activity was performed in both partnerships. Farmers received credit facilities for land preparation and maintenance of soil conservation techniques, seed procurement, construction of poly tunnels and marketing loans. In here 50 percent subsidy was provided to purchase seeds and construct poly tunnels by government entities. In most cases, market loans were provided by the banking sector. Soil conservation is a critical factor when referring to the upland agriculture. However, this has been prioritized by some partnerships coupled with other cultivation practices. Provision of infrastructure facilities was another move. In this case, some partnerships have built common storage facilities for the farmers. However, these facilities were more or less similar to the storage facilities provided by the UNICEF – Nuwara Eliya RRDB partnership programme. Furthermore, construction materials were provided to the farmers to establish poly tunnels for seed potato cultivation. In addition, through certain projects materials were provided to establish sprinkler irrigation systems in the field.

5.8.1 Partnership in the Private Sector

Private entities have potential capacity to enter in PPPs since they demonstrate strong willingness towards production of quality seed potato. One such local private entity is having a partnership with AGRICO Company located in South Africa. This local private company is willing to produce seed potatoes particularly, G_1 and below grades. AGRICO has also agreed to transfer technical know-how and partial investment for the project. Partial investment includes the capital for tissue culture laboratory and poly tunnel establishment. However, the main issue is acquiring a suitable land in Nuwara

Eliya area to execute the project. Therefore, if public entities could provide a suitable land for this project this would yield a successful partnership. Private entities only consider about the possession of a suitable land from the public sector and not the capital or technical know-how.

5.9 Partnership Model Used by the Co-operative Society

ALDMCS Ltd. was established in 2014 with a mission to uplift the lifestyles of the farming community in the Nuwara Eliya district and to provide a sustainable income for them. Currently co-operative society holds more than 1500 registered members and comprised of 22 committees. Since its inception corporation has initiated number of programmes related to seed potato. One such prominent and popular initiative was "potato seeds on buyback system". The Co-operative society has selected G_0, G_3 and C_1 for this programme. The project was implanted via partnering with the Seetha Eliya Research Center, Ranscrip Marketing Pvt. Company, CIC Agribusiness, Hayleys Agriculture Holdings and potato farmers. In most cases, the co-operation has played the mediator role in between the members and the external parties. In partnerships an important role is mediation. Even though mediation is defined in the law as a peace maker, in general mediation role is very much feasible to Sri Lankan situation and could be identified as a much broader concept when referring to PPPs.

In the case of G_0 seeds, the co-operative has taken a selective procedure and distributed only among those selected farmer members in the society. In 2015, 50,000 G_0 seeds were distributed among 16 farmer members and the price of one tuber was Rs.6.00 as per the government rates. Further, in 2018 from January to June the co-operative society has facilitated to distribute 27,000 G_0 seeds to their members. Their target for 2019, is to aid members to produce a quarter of their potato seed requirement in the subsequent season by providing quality seeds to them. In here the co-operative role is to act as a mediator in between the farmer and the government. This is an important mediatory role since the G_0 production is limited and majority output retained in the public sector for their purposes. According to the calculations by the co-operative, farmers could produce 15,000 kg of seeds from the above mini tubers and save Rs.2.7 million worth of value compared with the importation. Furthermore, the co-operative has distributed G_3 and C_1 to the members with the aid of government fund as follows:

Table 5.11: Quantity of Seed Potato (G3 & C1) Purchased by the Members in 2014 *Yala*

No of Farmer Beneficiaries	Value of 50 kg Bag (Rs.)	Contribution of the Farmer (Rs.)	Contribution of the Government (Rs.)	Total Value
403	8,750	3,526,250	3,526,250	7,052,500
94	8,750	822,500	822,500	1,645,000
50	9,000	450,000	450,000	450,000

Source: ALDMCS Ltd. Reports, 2018

Apart from the government partnership programme, ALDMCS Ltd. has also partnered with Ranscrip Marketing Pvt. Company to implement potato seeds on buyback system project. In this project, imported variety "Sassy" is introduced to the farmers at a subsided price and the output was agreed to purchase back at a guaranteed price of Rs.100 per kg by the company.

Table 5.12: Seed Programme under Buyback System

Location	No of Farmer Beneficiaries	Quantity (50 kg boxes)	Cash Basis (Rs.)	Credit Basis (Rs.)
Meepilimana	03	05	31,250	31,250
Hawa Eliya	04	08	50,000	50,000
Toppass	02	02	12,500	12,500
Kandapola	05	09	56,250	56,250
Shanthipura	11	22	137,500	137,500
Magasthota	06	11	68,750	68,750
Nuwara Eliya	07	12	75,000	75,000
Seetha Eliya	02	04	25,000	25,000
Ruwan Eliya	03	05	31,250	31,250
Total	**43**	**78**	**487,500**	**487,500**

Source: ALDMCS Ltd. Reports, 2018

At the end of the duration company has purchased 20,045 kg of potato harvest at a guaranteed price of Rs.100 per kg from the farmer members. The farmers received an income of additional two percent on market price. Hence, this was a win-win situation for both parties. Further, the co-operative society has conducted promotional programmes to educate on their programmes and benefits to the farmers. Also, by forming partnerships with other external stakeholders such as CIC Agribusiness and Hayleys Agriculture Holdings, it aids farmers to purchase other farming inputs at a subsidized price. This is identified as a direct and a favourable platform to build trust between these companies and farmers. Building trust is an important factor for successful partnerships. Hence, indirectly this is a way to share the risk involved in agribusiness and partnering. The case study of Ranscrip Marketing Pvt. Company is the best example to demonstrate this. This way the companies have conducted several promotional campaigns related to seed potato production. New members have to pay a monthly subscription fee as membership fee. This monthly subscription fee is utilized to expand the operations of the society as well as to derive benefits for the farmers as well.

Another important aspects is that, the co-operative provides training on seed potato production for farmers. It has partnered with Seetha Eliya Research Station and even with foreign delegates to conduct training programmes on G_0 production in poly tunnels. This directly implies the sustainability of the model. Mere provision of G_0 without proper training to its members will not fetch long term benefits. This is how ALDMCS Ltd. has operated since its inception by incorporating all these aspects.

Figure 5.4 illustrates the SWOT analysis for the seed potato production in Sri Lanka. Strengths and weaknesses imply the possibilities and barriers respectively within the potato cultivation. Opportunities and threats imply the prospects and challenges which may arise externally to the potato cultivation.

Strengths	Weaknesses
1. Positive attitudes of seed potato production aspects by majority of stakeholders related to potato cultivation. 2. Well established research facilities for seed potato production and cultivation (Seetha Eliya & Bandarawela). 3. Separately allocated human capital and institutional bodies in both public and private entities related to potato cultivation. 4. Fairly strong private sector involvement in the potato cultivation. 5. Considered as one of the best cash crops for farmers in developing countries. 6. In some areas there are farmer groups that are willing to produce only quality seed potato for commercial purposes (e.g. Nuwara Eliya large scale farmers).	1. Limited awareness of farmers on pre basic seed production and its benefits. 2. Limited land area for private entities to enter into seed potato production. 3. Financial limitations in public sector to establish and expand poly tunnel capacities. 4. Lack of cold storage facilities to store seeds for the large scale farmers and farmer organizations. 5. Granola is the only variety which could multiply for commercial purposes and lack of locally developed seed varieties. 6. Relatively poor seed regulation policy (e.g. Seed Act of 2003)
Opportunities	**Threats**
1. Possible and realistic PPP prospects for seed potato production and cultivation (e.g. BOT approach). 2. Positive government initiatives to expand pre basic seed production in their farms. 3. Positive support from the international institutes for cultivation (e.g. AGRICO).	1. Fairly increasing trend of cultivating green vegetables like lettuce types and aromatic herbs for restaurant chains by upland farmers. 2. High cost of imported seed potato varieties. 3. Sudden changes in weather may cause unfavourable conditions for the cultivation. 4. High environmental concerns due to soil erosion and pollution

Source: Authors' compilation

Figure 5.4: SWOT Analysis for Seed Potato Industry in Sri Lanka

CHAPTER SIX

Conclusion and Recommendations

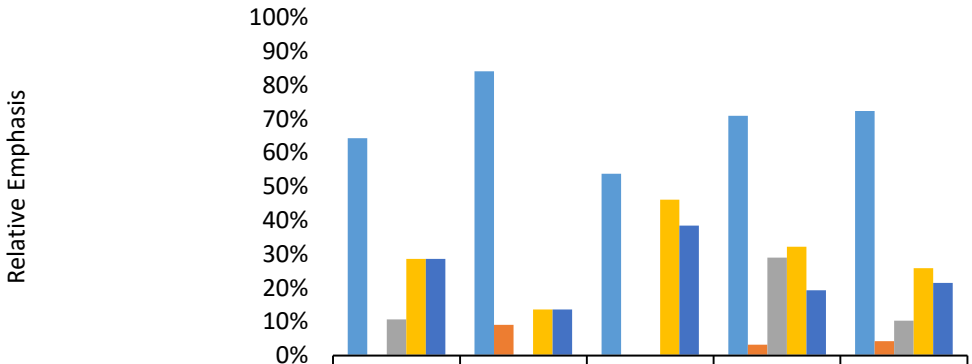
6.1 Introduction

Chapter six includes farmers' views on forming PPPs for potato sector in Sri Lanka. Further, important concerns, findings and recommendations related to potato sector specially focusing on the ways to strengthen quality seed production based on all key stakeholders are summarized. Recommendations are based on possible strengths, weaknesses, opportunities and threats to the seed potato production sector in the country. More importantly, an ideal model to enhance the quality seed potato production is elaborated using examples and case studies.

6.2 Farmers' Views on Forming PPPs

The survey revealed few important concerns of farmers on seed potato production. Even though both private and public entities offer various types of partnership prospects to the farmer it is important to consider farmers' point of view related to seed potato production. As mentioned earlier no entity could withstand alone in the industry without the aid and contribution of other entities. Hence, the best way is to consider all ideas of all stakeholders and plot strategies only for the feasible ones. However, strategies should be aligned with the best possible manner to meet the requirement of many stakeholders. Figure 6.1 represents farmers' suggestions to improve partnership on seed potato production in each area.

According to the Figure 6.1, majority (72%) of farmers thrust on input related support from a partnership. Also, in all four DS divisions the input aspect was the highest concern and most essential input is the seed. In most cases adequate quality seeds were not available in the cultivation season and farmers were forced to purchase or supply seeds from informal channels. This is also the main reason why farmers preserved imported seeds for the second round even those are not recommended to be used as seeds in consecutive rounds. Also, farmers are willing to purchase quality local seeds at a lower price than the imported seeds. As a result of limited local production certain amount of quality seeds are produced in a season and those are distributed among a limited farmer base.



	Uva paranagama	Welimada	Bandarawela	Nuwara Eliya	Total
Provision of Input	64%	84%	54%	71%	72%
Provision of Credit		9%		3%	4%
Provision of Infrastructure	11%			29%	10%
Provision of Technical Know-how	29%	14%	46%	32%	26%
Other	29%	14%	38%	19%	22%

Note: Multiple responses are observed
Source: HARTI survey, 2018

Figure 6.1: Farmers' Suggestions to Improve Partnership on Seed Potato Production

Farmers who have strong linkages with the research and farm centers may acquire seeds. The cost of seeds distributed via government farms generally ranged between Rs.7,000 to Rs.10,500 and at the same time, quality wise those seeds are better since it is categorized above C_2. However, during last couple of seasons majority of farmers were not able to access this quality seeds which distributed through local farms. Hence, provision of quality seed is an essential aspect when structuring a partnership.

Since the prices of local seeds are comparatively lower than imported seeds, most farmers are satisfied with the local prices. However, it is noted that, continuation of 50 percent subsidy programme should be strengthened furthermore. Introduction of G_0 production to a selected local farmers should be implemented. However, G_0 production should be limited only to a selected farmer base. Second essential input is fertilizer. The fertilizer subsidy programme has been transformed in to a cash grant system from 2016 *yala* season onwards. Since then farmers receive cash to purchase fertilizer instead of fertilizer. However, there are many controversial issues related to the policy. Nevertheless, provision of fertilizer is also considered as an essential activity. Those were the main points suggested by the farmers related to partnership formation.

The second concern when forming a partnership is dissemination of technical know-how related to seed potato industry. Specially, new techniques of producing seeds. Another important point is introduction of new varieties. Even though there are a few local varieties introduced by the research stations, awareness among farmers on those varieties is limited. Also, participatory approach was proposed to acquire new

knowledge on seed related production. These participatory approaches could be conducted for small farmer groups in selected areas. Technical aspects and training specially related to G_0 production in poly tunnels is the best example for this. Partnerships could be formed between selected farmer groups and other public and private entities to enhance the production of G_0. Likewise, seeds after the G_0 production could be enhanced by partnering with other stakeholders. Another important point was that, farmers' awareness on parties involved in the process of seed potato production and distribution. If farmers are aware of the roles and responsibilities of main actors then farmers could have direct links with those actors. Presently, PPPs have paid attention to those two aspects. However, due to limited number of partnerships final results have not be able to achieve so far.

Forming long lasting partnerships was a grave challenge. The farmers emphasized that building trust between parties is a worthy exercise. This is a key component when forming sustainable partnerships. A strong trust between parties directly implies the level of risk shared between each party. Ultimately this would pave way to a long lasting relationship between partners. For example when disseminating seed potato through some of the ASCs there have been many irregularities and this directly leads to poor linkage and trust between government bodies and the farmers. Sometimes this is experienced in the private sector as well. When referring to risk sharing, a suggestion is to implement an insurance scheme for seed potato. However, the ideology is that, insurance scheme should be awarded only to seed borne diseases and not for any other circumstances. If cultivation is unsuccessful due to the issues related to seeds particular farmer is eligible for the insurance.

However, that farmer should follow the correct cultivation procedures. For example, most of the time farmers slice imported seeds to meet their total seed requirement, which is not an acceptable practice. However, if a farmer practices this procedure then he/she is not eligible for the insurance claim. Insurance claim has to be awarded on cash basis and not by any other means. Also, one fourth of the total seed cost incurred equals to the insurance claim, according to the farmers' perception. By the time they purchase bulk seed stocks latent diseases cannot be determined in the naked eye. Generally, a few weeks after cultivators detect the symptoms. Hence, farmers are in the middle of the cultivation season and if insurance awards seeds as the insurance claim those farmers face difficulties to start the cultivation due to lapse of cultivation season. Lack of storage facilities may intensify this furthermore. Therefore, awarding seeds is worthless and instead awarding cash may be useful to the farmers for at least to pay debt obligations if any.

The next concerns for forming partnership is related to provision of infrastructure facilities to strengthen the seed production and distribution. Establishment of poly tunnels are a major infrastructure facility required by the farmers. As mentioned earlier poly tunnels to produce G_0 should be awarded only to a selected farmer group in each DS division. None of the farmers were observed cultivating G_1 and below grades in poly tunnels throughout the survey. All the farmers cultivated seeds in open fields and interestingly none was willing to produce G_1 and below grade in poly tunnels since establishment and operation of ploy tunnels for those seed types are not

economically feasible to them. Therefore, establishment of poly tunnels should be mainly focused on enhancing the production of G_0 seeds. Furthermore, continuous monitoring and supervision is utmost important after establishment of poly tunnels. Efficient and effective monitoring could be executed since poly tunnels are provided to a selected farmer base.

Another concern is storage facilities to store seeds for the second season. However, for small scale farmers this is not a major concern and seeds are stored in a dark room inside the dwelling. Hence, constructing of individual storage facilities are not required. Nevertheless, large scale farmers face difficulties to store seeds and the particular suggestion is to build cold storage facilities for selected large scale farmers in each DS division. Assistance is required to construct the storage facility and maintenance including payment of utility bills may done by the particular farmer base. However, these facilities have to be delivered only to selected farmer groups with small capacity basis (e.g. 10mt. to 15mt.). Another option is that, research stations could establish large cold storage facilities with a capacity ranging from 50mt. to 100mt. and rent out under their supervision. Currently, single cold storage with a capacity of 170mt. is located at the Seetha Eliya Research Station. Average monthly electricity bill alone accounts for Rs.1,000,000 for that facility.

However, there is a proposal on construction of cold storage facilities in the station and rent it out to the farmers. The project proposed to allocate 100mt. of capacity to the farmers and to charge Rs.2.00 to Rs.3.00 per kg of seed potato. Another newly established cold storage is located in the ISTI at Bindunuwewa, Bandarawela and the capacity is 200mt. However, poly tunnels with aerophonic system are lacking in this facility. Hence, there is possibility to strengthen production in here through establishment of aerophonic stsyems. Kahagolla research station is also equipped with a similar type and capacity of cold storage.

Apart from these two elements partnerships are required to award irrigation schemes like sprinkler systems. Since potato cultivation is scattered around the Central and Uva Provinces soil conservation is a critical and controversial issue. Improper land use practices may harm the soil structure and it often leads to soil erosion. However, one such remedy to minimize soil erosion is establishment of sprinkler irrigation systems in these areas. Natural landscape of the area may aid to retain the water pressure automatically in most case. Establishment of sprinkler irrigation system is much cheaper compared to a drip irrigation system and also has a moderate level of water usage capacity. The last concern of forming partnership is to acquire credit facility. However, this was not a prominent suggestion of farmers.

6.3 Recommendations for Future PPPs

From the overall study it is clearly envisaged that a certain lag existed in quality seed potato production in Sri Lanka over the years. Hence, to evade this situation most sustainable solution is identified as forming viable and realistic PPPs since none of the single entity could sustain alone. Provision of quality inputs and dissemination of technical know-how are the two main aspects expected from the PPPs.

Seed potato production starts with the minitubers generation under in-vitro conditions. Since this is a highly sensitive and technical aspect it should be limited to the public sector entities. Comparatively low market share is there for minitubers and it is only limited to the clients such as government farms plus limited selected large scale farmers in the potato grown areas are another concern. Therefore, minituber production is not commercially feasible for private entities.

Production of G_0 is the next step. It is highly recommended this aspect should be also limited to the government research stations since the process encounters relatively low cost in the public sector compared to any other private entity in Sri Lanka. This has been well proven in the case of Hayleys Agriculture Holdings a few years ago. Even though Hayleys has pioneered in producing G_0, with the support and other aids of the international organizations public entities produced G_0 at a lower cost compared to the Hayleys. The initial pact was to purchase G_0 from Hayleys through a partnership; however partnership ended as a result of high cost and also with the initiation of seed potato production in the public sector. With low or limited demand for G_0 from the farmers Hayleys ultimately moved away from the seed potato production. Since then no other entity entered into the business.

However, G_0 production could be strengthened by introducing it only to selected farmer groups with poly tunnel facility. Currently, a few farmers have been engaged in this process. Then, effective and efficient extension and monitoring could be done if this process is promoted in a limited farmer base. Quality of seed also could be assured. PPP could be formed between the government sector and those selected farmers. Public sector could continue 50 percent subsidy programme for both seeds and poly tunnels for those farmers with the required extension and monitoring services. Buyback system could be applied for partial harvest to evade storage issues and to increase production of G_1 in the government farms since G_0 output produced by the research stations is not adequate. With this initiative G_1 production could be strengthened.

G_1 production should be carried out in poly tunnels under geophonic system. Currently, farm located at Seetha Eliya initiated this process and expected to expand the project. Even though there is an issue related to limited lands and minimum of three years of fallowing period for potato, both of these issues could be resolved with this project. Public and private entities could possibly form a viable partnership to construct poly tunnels and to expand G_1 production.

Currently there are five government seed potato production farms as mentioned in above chapters. All five farms adhere to the requirement of fallowing period and as a result one or two slots are utilized to produce seed potato. However, if these lands are transformed in to poly tunnels fallowing period requirement is not essential and continuous production could also be carried out within those farms. Hence, the land issue could be resolved with this project. However, one should understand that this strategy does not imply 100 percent production or self-sufficient level in seed potato in Sri Lanka. Construction could be done through BOT approach.

BOT approach is an option for the government to outsource public projects to the private sector. In this approach private entity receives concession for a fixed period from the public party for development and operation of a public facility. Development consists of the financing, design and construction of the facility, managing and maintaining the facility adequately and making it sufficiently profitable. The private entity secures return of investment by operating the facility and, during the concession period and also as the owner. At the end of the concession period, private entity transfers the ownership of the facility free of liens to the public entity at no cost. This approach is very much useful to share risk between the parties, considered as a vital aspect of a PPP.

Then G_1 output could be disseminated through proper marketing channels with both public and private entity involvement. This also eliminates resource duplication to a certain extent since all certification and other secondary activities are also carried out in one place rather than scattered around the area.

If production flows seamlessly, then secondary aspects like storage facilities are required to hold buffer stocks and surpluses. However, maintaining such facilities are costly and willingness of commercial level private entities to build those types of facilities are not much concern. However, study revealed that cold storage facilities should only be constructed for large scale and active farmer groups. In such cases two options are available for the public sector. Either public entity could extent 50 percent subsidy or else 100 percent financial contribution to construct the facility. However, in both options maintenance including utility cost should be transferred to the specific farmer group to make it a realistic investment. Capacity ranging from 50mt to 100mt is more than adequate for this purpose. The research station at Seetha Eliya is willing to obtain farmer seeds and the minimum quantity should be 25mt of seed potato.

However, in some government farms due to high elevation, strong wind may affect poly tunnels time to time. For instance, in Rahangala due to strong winds construction of poly tunnels seems to be a challenging task. Construction projects were carried out in Rahangala a few years ago and all poly tunnels had been destroyed due to strong wind. This was observed in the Uda Radella farms as well. Establishing suitable trees as a wind barrier could possibly overcome this issue. This has been practiced in other farms and identified as a successful strategy.

Further, strengthening the national seed policy is vital to enhance PPP formation. SCPPC and SPMDC should aware both public and private entities regarding current Seed Act of 2003. The Seed Act of 2003 clearly stipulated that, the Act is only valid for those who engaged in commercial seed multiplication and distribution. Traditional ways such as exchanging and sharing is not governed under the Act. Sri Lanka needs a strong Seed Act since most of the facts of current act is outdated. Current Seed Act does not create the ideal environment for the expansion of seed industry in Sri Lanka. Specially, none of the concerns were given for PPPs for seed industry. Time consumed for certification process should be less and clear demarcation procedures are required since private entity shares more risk when forming PPPs. National seed policy should

illustrate government actions and the roles of relevant stakeholders in coordination, structure, functioning and development of the seed system. This aids to understand the roles and responsibilities of each stakeholder within defined boundaries. Seed policy has to be initiated aligning with the national seed requirement, assessment of relevant technical and institutional aspects of the seed sector and participatory approach of all stakeholders. This depends largely on the proper institutional and administration setting. The National Seed Policy should address seed supply chain process including imports, seed production in both formal and informal, seed quality and standard assurance, extension, seed distribution and marketing, seed production capacities within public and private entities, roles and responsibilities of seed actors. Effectiveness of the seed policy depends on capacity of government to manage the policy making process as well as the full participation of all stakeholders related to seed industry.

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Annexures

Annexure 1 – Type of Data

Indicator	Variable/s	Data Source/s	Tool/s
Relative importance of crops cultivated	• Number of crops cultivated • Cultivated extent for each crop • Most preferred crop to cultivate in next season	Primary	Survey
Purpose of potato cultivation	• Total cultivated extent of seed potato and consumption potato	Primary	Survey
Potato production	• Number of seed production systems used • Quantity of seeds cultivated • Quantity of seeds harvested • Quantity of potato harvested for consumption • Constraints of cultivating potato	Primary	Survey
Availability of seeds	• Source of seeds • Number of seeds suppliers in the area • Quantity of seeds purchased	Primary	Survey
Quality of seeds	• Percentage of certified seeds from the total seeds purchased • Percentage of certified seeds from the total seeds sold • Awareness on seed certification	Primary / Secondary	Survey / Key informant interviews
Income & expenditure source/s	• Number of income sources and types • Quantity of seed potato sold and price • Quantity of potato sold for consumption and price • Quantity of other crops sold and prices • Net income from non-agricultural activities • Cost of seed potato, fertilizer, chemical, labour and other costs • Household expenditure	Primary / Secondary	Survey / Key informant interviews
Land usage patterns	• Type of land • Ownership of the land • Characteristics of the land • Types of soil conservation techniques used	Primary / Secondary	Survey / Key informant interviews / Other sources

Availability of partnerships	• Number of stakeholders engaged in partnerships • Nature of the relationships • Type of contract • Duration of the partnership	Primary / Secondary	Survey / Key informant interviews / Focus group discussions / Other sources
Performance of partnerships	• Types of contribution/s • Number of beneficiaries • Number / percentage of achieved targets • Income and expenditure	Primary / Secondary	Survey / Key informant interviews / Focus group discussions / other sources

Annexure 2 – Data Collection Methodology

Specific Objective	Data Collection Method	Sample Composition
1) To study prevailing seed potato production systems and PPPs in seed potato production in Sri Lanka	Key informant interviews	35 stakeholders representing both public and private entities
	Focus group discussions	4 focus group discussions with 8-10 farmers in each representing farmer organizations within the selected GN divisions
	Structured questionnaire survey	276 individuals representing seed potato producers and potato farmers
2) To propose strategic guidelines for a viable PPP model for quality seed potato production in Sri Lanka	Key informant Interviews	35 stakeholders representing both public and private entities (same stakeholder sample as in Specific Objective 01)
	Focus group discussions	4 focus group discussions with 8-10 farmers in each representing farmer organizations within the selected GN divisions (same focus group discussion sample as in Specific Objective 01)
	Structured questionnaire survey	276 individuals representing seed potato producers and potato farmers (same sample as in Specific Objective 01)
	Review of literature from local and international contexts on PPPs	N/A

N/A=not applicable

Annexure 3 – Average Cultivation Extent of Potato from 2013-2017

District	2013		2014		2015		2016		2017	
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
Badulla	3451	81	3579	73	3000	67	3509	69	2254	68
Nuwara Eliya	765	18	1267	26	1345	30	1463	29	971	29
Others	63	1	83	2	102	2	120	2	75	2
Total	4279	100	4929	100	4447	100	5092	100	3300	100

Source: Department of Census and Statistics, 2017

Annexure 4 – Stakeholders Selected for Key Informant Interviews

No	Name/s	Institute/location	Position	Remarks
1	Mrs. W. Bandara	Division of Agronomy, Agriculture Research & Development Center, SeethaEliya, NuwraEliya	Research officer (Assistant Director of Agriculture)	Seed production and Research
2	Mr. B.M.R.K. Basnayake	Government Seed Farm ,Galpalama	Farm Manager	Seed Production Systems
3	Ms. M. Udawela	Government Seed Farm ,Galpalama	Agriculture Instructor	Poly tunnels and production
4	Mr. W.M. Meththananda	1.Community Based Seed Potato Producing Farmers Organization Meepilimana 2.Dimuthu Farmers Organization	President	G0 seed potato production Community based seed potato production
5	Mr. M.C. Jayasinghe	Seeds & Planting Materials Office, NuwaraEliya	Deputy Director of Agriculture (Seeds)	Seed Production systems, Seed production process
6	Mr. S. Disanayake	Seeds & Planting Materials Office, NuwaraEliya	Assistant Director of Agriculture (Seeds)	Poly tunnel preparing and maintenance Seed potato production methods in poly tunnels
7	Mr. A. Nawarathne	Seeds & Planting Materials Office, NuwaraEliya	Agriculture Instructor	Poly tunnel preparing and maintenance Seed potato production methods in poly tunnels
8	Mr. R.M.D.Y.B. Ranathunga	Deputy Director of Agriculture Office, NuwaraEliya (Central Provincial Department of Agriculture)	Subject Matter Officer	Seed potato subsidy for farmers
9	Mr. R.D.M.M.K. Wimalachandra	In-Service Training Institute, Bindunuwewa, Bandarawela	Deputy Director of Agriculture (Training),Uwa	Seed Systems
10	Mrs. J.M.D. Jayamanna	Regional Agriculture Research and Development Center, Bandarawela	Assistant Director of Agriculture (Research)	G0 Seed production Technology Transfer

11	Mr. C.K. Manage	Troseed (Pvt) Ltd. Colombo 02	General Manager	Public-private partnership aspects of quality seed potato production
12	Mr. S. Gamaethige	Hayleys Agriculture Holdings Limited, Colombo 10	General Manager	Public-private partnership aspects of quality seed potato production
13	Ms. V.D.N. Ayoni	Socio Economics and Planning Centre (SEPC), Peradeniya	Assistant Director of Agriculture (Agriculture Economics)	Economic aspects of seed potato production
14	Mr. K.D. Pushpananda	Seed & Planting Material Development Centre (SPMDC), Peradeniya	Director	Seed & planting material development process of potato and PPP prospects
15	Ms. P. Malathy	Horticultural Crops Research and Development Institute (HORDI), Gannoruwa	Additional Director	Seed & planting material development process of potato and PPP prospects
16	Dr. P. Weerasinghe	Horticultural Crops Research and Development Institute (HORDI), Gannoruwa	Director	PPP prospects of seed potato production
17	Ms. M.G.N. Sandamali	Deputy Director of Agriculture Office, Kandy	Deputy Director	PPP prospects of seed potato production
18	Ms. Indira Ariyaratne	Seed Certification and Plant Protection Centre (SCPPC), Gannoruwa	Assistant Director (Development)	Seed certification process
19	Mr. E.W.K. Koddithuwakku	Seed Certification and Plant Protection Centre (SCPPC), Gannoruwa	Assistant Director (Development)	Potato seed certification process and inspection
20	Mr. D. Karunarathne	Seed Certification and Plant Protection Centre (SCPPC), Gannoruwa Seed Act Unit, Gannoruwa	Agriculture Instructor	Potato seed inspection process and seed registration process
21	Mr. T. Samarasinghe	Seed Certification and Plant Protection Centre (SCPPC), Gannoruwa Field Inspection Unit, Gannoruwa	Agriculture Instructor	Potato seed inspection process

22	Mr. R.N. Premakumara	Seed Certification and Plant Protection Centre (SCPPC), Gannoruwa Seed Act Unit, Gannoruwa	Assistant Director (Agriculture)	Overall seed act and potato seed registration process
23	Mr. H.M.D.R. Bandara	Meeplimana Government Seed Potato Farm	Farm Manager	Seed potato production mechanism and practices adopted
24	Mr.Ruwan Rajapaksha	Meeplimana Government Seed Potato Farm	Assistant Farm Manager	Seed potato production mechanism and practices adopted
25	Mr. Bandara Weerakoon	Ambewela Livestock Company Ltd.	Farm Manager	Seed potato production mechanism and practices adopted
26	Mr. Arjuna Samarasinghe	Hayleys Nanuoya Biotech Facility	Deputy General Manager	Seed potato production mechanism and practices adopted and partnership prospects
27	Mr. Harsha Wanigasekara	Hayleys Nanuoya Biotech Facility	Assistant Manager	Seed potato production mechanism and practices adopted and partnership prospects
28	Mr. P.D. Ambethilakarathna	Seetha Eliya Government Seed Potato Farm	Deputy Director Research	Seed potato production mechanism and practices adopted and partnership prospects
29	Mr. A. Nawarathne	Seetha Eliya Government Seed Potato Farm	Farm Manager	Seed potato production mechanism and practices adopted and partnership prospects
30	Ms. C.K.L. Jayawardena	Kandapola Government Seed Potato Farm	Technical Assistant	Seed potato production mechanism and

				practices adopted
31	Dr. M.M.J.P. Gawarammana	1.Tea Research Institute 2.Agriculture Livelihood Development Multi-Purpose Co-operative Society Ltd	Founder of Rural Livelihood Development Multi-Purpose Corporative Society	Process and mechanism and partnership prospects
32	Mr. L.R.M.S. Dissanayake	Udaredella Government Seed Potato Farm	Farm Manager	Seed potato production mechanism and practices adopted
33	Mr. Thushara Nawarathne	Udaredella Government Seed Potato Farm	Assistant Farm Manager	Seed potato production mechanism and practices adopted
34	Mr. Ranjith De Silva	Agriculture Livelihood Development Multi-Purpose Co-operative Society Ltd.	Hon. Chairman	Specific models related to seed potato production and distribution
35	Mr. Rasika Fernando	CIC Seeds (Pvt.) Ltd.	Manager R & D – Seeds	Public-private partnership aspects of quality seed potato production

Annexure 5 - Areas & Sample Selected for the Study

Districts	Average Cultivation Extent of Potato (2011-2015)	DS Divisions	No. of Farmers*
Badulla (Uva Province)	77%	Uva Paranagama	69
		Welimada	69
		Bandarawela	69
Nuwara Eliya (Central Province)	22%	Nuwara Eliya	69
Total		**04**	**276**

*This indicates the number of farmers (seed potato producers and potato farmers) selected from all GN divisions in each DS division.