LOCAL HYBRID CHILI CULTIVATION AND DRY CHILI PRODUCTION

towards spicing up the process

Shantha Hewage
Sidath Bandara
Dinusha Rathnayake

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Hector Kobbekaduwa Agrarian Research and Training Institute
114, Wijerama Mawatha
Colombo 07
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Tel. Phone : +94 11 2696981
+94 11 2696437

Fax : +94 11 2692423

Email : librarian@harti.gov.lk
Web page : www.harti.gov.lk

FOREWORD

Chili, particularly the dry chili is an import-dependent commodity. How it happened is an interesting story with valuable lessons - simply, import restrictions were lifted in the 1990s. Naturally, extent cultivated as well as the local production declined. It is not necessarily a trend that cannot be reversed though, as this study reveals.

The authors have considered all the important factors which have produced the current situation and also those which paint a picture of hope, moving forward, especially in a context of a foreign exchange crunch and other restrictions generated by Covid-19. Thus, is now almost an imperative to develop innovative strategies targeting the bridging of the demand-supply gap through expanding extent of cultivation and increased seed production.

Importantly, the recommendations flow from a careful assessment of open pollinated varieties and local hybrid varieties and following the study of several aspects including input supply, agronomic practices followed, training received, technology adoption, type of irrigation, constraints associated with chili cultivation and chili seed production.

It is therefore a nuanced essay which examines and evaluates different policy options and maps out pathways informed by a multiplicity of realities. The 'right' policy-mix obviously needs to take into account need-differentiation across varieties, the judicious deployment of incentives and pricing systems. These are detailed in this study and as such provide rich insights to the policy-maker.

Malinda Seneviratne
Director/Chief Executive Officer

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Shantha Hewage
Sidath Bandara
Dinusha Rathnayake

EXECUTIVE SUMMARY

Chili, especially dry chili, has been an essential condiment in the Sri Lankan diet for centuries. In the latter part of the past century, Sri Lanka met the country's demand for green and dry chili with local production. However, owing to the relaxation of dry chili import restrictions in the 1990s, the cultivation extent and the production of chili saw a decreasing trend. The present local annual production varying from 65,000 to 80,000 tons, is insufficient to cater to the country's chili requirement, particularly the dry chili demand so that it has become an import-dependent commodity over the last few decades.

Sri Lanka is home to an extensive collection of chili including Open Pollinated Varieties (OPVs) and recently released local hybrid chili varieties (LHCVs). With the expansion of seed production of LHCVs, making such seeds available at reasonable prices can increase the extent cultivated under LHCVs and thereby minimize chili seed imports. Given the circumstances, increasing chili seed production and intensifying dry chili production is now needed more than ever, due to the current shortage in foreign exchange. Of the hybrid chili varieties available, the local hybrid is recommended for the production of dry chili. Therefore, one of the most positive steps to promote the production of dry chili in the country is to promote the cultivation of local hybrid varieties. It is also important to look for possibilities to improve dry chili production. This study focused on the tendency to cultivate hybrid chili varieties in the country while paying special attention to dry chili production using the same varieties. Furthermore, special attention was paid here to ascertain the cultivation practices of LHCVs, the availability and use of inputs, the constraints associated with the cultivation of LHCVs, with special reference to constraints and potentials of local chili seed production and the constraints associated with dry chili production from LHCVs.

The study covered key districts where chili cultivation is undertaken and in areas where seed production of LHCVs is concentrated. Both primary and secondary data and information were collected from various sources. Primary data were collected from the leading farmers undertaking hybrid chili cultivation at different scales and under different systems (irrigation method, land use and crop protection) in the Anuradhapura, Kurunegala, Puttalam, Hambantota, Monaragala districts and Mahaweli System H via face-to-face interviews and telephone conversations. Several aspects were covered during data collection including input supply, agronomic practices

followed, training received, technology adoption, type of irrigation, constraints associated with chili cultivation, and chili seed production.

Even though it has only been about 5 - 6 years since the LHCVs were introduced, they have gained high popularity among the farmers due to higher yields. However, of the two LHCVs, only MICH HY1, introduced in 2015, is extensively cultivated in different parts of the country, whereas the MICH HY2 (released in 2017) has not been as popular since the seeds are not readily available. In addition to higher yields reported by farmer fields, the longer duration of the crop, less susceptibility to leaf curl complex (LCC) and relatively taller plants making it easy for farmers to carry out certain agronomic practices, have made MICH HY1 a more attractive variety for chili growers.

The variety MICH HY1 is cultivated under different irrigation methods such as conventional surface irrigation, drip irrigation and sprinkler irrigation. Highly efficient micro irrigation systems have always delivered higher yields compared to conventional surface irrigation methods. The hybrid chili crop is maintained for up to 7-10 months in most of the growing areas, except in the Kalpitiya area where the crop lasts for 4-5 months.

At present, as per rough estimates, Sri Lanka requires around 15,000 kg of chili seeds for local chili cultivation, which is dominated by the OPVs. However, this quantity of seed can be further reduced if hybrid seed usage is increased as the required seed rate of hybrid varieties is lower than that of the OPVs. It must be noted that the higher market price of LHCVs (MICH HY1) seeds has been an impediment for small scale farmers to initiate commercial-level cultivation. Furthermore, as the rain-fed conventional cultivation method is not profitable, the ability to invest in supplementary irrigation and/or high efficient irrigation systems has also become a challenge for farmers to venture into local hybrid-chili cultivation. Though the profitability and profit margins of cultivation of MICH HY1 are high, the requirement of the initial capital and the variable costs are also higher. Therefore, the necessary technical support and market linkages should be made available for prospective producers/farmers.

Chili farmers are reluctant to produce dry chili for a number of reasons including unfavourable climatic conditions prevailing in the cropping seasons, high labour demand and less profitability due to low market price. In the case of MICH HY1, owing to the fleshy nature of the pod, the green-chili requirement and the labour demand for making dry chili is higher than that of the OPVs. Therefore, low-cost dryers should be introduced to

and popularized among farmer groups and agri-entrepreneurs in selected chili-producing areas.

The low farm-gate price for dry chili has also become an impediment for farmers, keeping them away from producing dry chili. The higher farm-gate price, mostly prevailing for green chili, was also a reason for farmers not to go for dry-chili production. The import tax on dry chili should be increased to provide a better farm gate price for local dry chili; such moves will certainly encourage local dry chili-production.

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ABBREVIATIONS AND ACRONYMS

ASC	-	Agrarian Service Center
ASMP	-	Agriculture Sector Modernization Project
CIF	-	Cost, Insurance and Freight
CNLD	-	Chili Narrow Leaf Disorder
CoP	-	Cost of Production
DAD	-	Department of Agrarian Development
DCS	-	Department of Census and Statistics
DoA	-	Department of Agriculture
DZ	-	Dry Zone
FAO	-	Food and Agriculture Organization of the United Nations
FCRDI	-	Field Crops Research and Development Institute
FOB	-	Free on Board / Freight on Board
GDP	-	Gross Domestic Product
HARTI	-	Hector Kobbekaduwa Agrarian Research and Training Institute
IZ	-	Intermediate Zone
KII	-	Key Informant Interview
LCC	-	Leaf Curl Complex
LHCV	-	Local Hybrid Chili Varieties
LKR	-	Sri Lankan Rupees
MASL	-	Mahaweli Authority of Sri Lanka
MI	-	Mahaillluppallama
MoA	-	Ministry of Agriculture

OFC	-	Other Field Crop
OPV	-	Open Pollinated Variety
PDoA	-	Provincial Department of Agriculture
SCS	-	Seed Certification Service
SLC	-	Sri Lanka Customs
SMoA	-	State Ministry of Agriculture
SPMDC	-	Seed and Planting Material Development Center
UNDP	-	United Nations Development Programme
USA	-	United States of America
USD	-	United States Dollar

CHAPTER ONE

Introduction

1.1 The Setting

Chili, especially dry chili, is an essential condiment in the Sri Lankan diet, though local production is insufficient to cater to this demand. The annual national requirement for dry chili is around 55,000-60,000 tons, however, annual local production is restricted to about 5,000-7,500 tons. Therefore, about 50,000-55,000 tons of dry chili amounting to over Rs. 14 billion, is annually, imported (Sri Lanka Customs, 2019; DoA, 2020). In addition to the colossal amount of foreign exchange spent on importing dry chili, chili seed imports also involve a drain on foreign exchange.

In 1990, local chili production exceeded one hundred thousand metric tons. This underscores the potential for increasing domestic production. However, owing to the relaxation of dry chili import restrictions in 1990s, the cultivation extent of chili saw a decreasing trend (HARTI, 2021). Presently, the average extent under chili is limited to around 13,000 ha (varying from 10,000-15,000 ha over the period from 2014-2019), of which 2/3 of the crop is cultivated in the *Maha* season as rain-fed cultivation in the uplands. The average annual chili production of the country is about 70,000 tons (DoA, 2020; DCS, 2021).

Sri Lanka is a country with an extensive collection of chili including open pollinated varieties (OPVs), and recently released local hybrid chili varieties (LHCVs). With the expansion of the seed production of LHCVs, making such seeds available at reasonable prices, can increase the extent cultivated under LHCVs, and thereby minimize chili seed imports. Given the circumstances, increasing chili seed production, and intensifying dry chili production, is now needed more than ever, due to the current shortage in foreign exchange. Of the hybrid chili varieties available, the local hybrid is recommended for the production of dry chili. Therefore, one of the most positive steps to promote the production of dry chili in the country is to promote the cultivation of local hybrid varieties, and look for possibilities to improve dry chili production. This study focuses on the tendency to cultivate hybrid chili varieties in the country while paying special attention to dry chili production using the same varieties.

1.2 Chili Varieties Developed and Cultivated in Sri Lanka

The Field Crops Research and Development Institute (FCRDI) of the Department of Agriculture (DoA) has, since 1962, introduced and released 10 OPVs namely MI-1, MI-2, KA-2, Arunalu, MI-Hot, MI-Green, Galkiriyagama Selection, MI-waraniya 1, MICH-3, MIPC-1 with a potential yield of 10-15 t ha^{-1} as green chili, though the national average of yield is around 5 - 7 t ha^{-1} at farmer-field level. Such low yield levels are mainly attributed to a high incidence of pests and disease, moisture stress, use of inferior quality seeds, poor crop management and high input costs (Gunawardena, 2002; DoA, 2020; Rodrigo, 2020). Similar to most of the other field crops grown in the drier parts of the country, the adverse impact on chili cultivation due to climate change has become a severe threat. The long dry spells and drought conditions at critical stages of the crop, and flash floods and extreme rainfall and storm events at the initial stages of growth, have effectively lowered cultivation extent and crop yields in Sri Lanka (Gunawardena and De Silva, 2014; Marambe *et al*., 2014; UNDP, 2015). Climate adaptation is considered key for such resource poor farmer communities like ours, to increase resilience to extreme climate events (Malawiarachchi *et al.,* 2017; Bhutia *et al*., 2018). Further, gaps between climate adaptations and the innovations recommended, and the level of practice by farmers with special reference to cash crops like chili, need to be studied for planning production systems with increased climate resilience.

1.2.1 Open Pollinated Chili Varieties

- **MI 1 -1962**

The plant is 65-75 cm tall, broadly branched, and does not spread. Thin elongated spikes are 9-13 cm. No seed production is taking place at present.

- **MI 2 -1973**

The well-branched plant spreads horizontally. The internodes are very short and take the form of bushes. Harvesting is easy. Spikes are short and spicier. Raw: Dry ratio is 3.5 : 1. This variety is a selection of the previously introduced MI 1 variety.

- **KA 2 -1991**

The early growth pattern of this variety is similar to that of the MI 2 variety. It grows up to heights of 50-60 cm. The length of spikes is 8-11 cm and it is suitable for *Yala* cultivation, and somewhat

resistant to Leaf Curl Complex (LCC). The average yield is around 12 t/ha, and it is suitable for green chili.

- **Arunalu -1996**

The plant grows up to about 50-60 cm height. Spikes of this variety bend down slightly when ripe. Thin spikes of this variety are about 8-11 cm long. The coating is thin so it can dry easily. However, currently, seeds are not produced.

- **MI-HOT -2002**

This variety is suitable for raw chili as well as dry chili. Length of spikes is 8-9 cm, and they have relatively low pungency levels. The plant is moderately branched and about 60 cm tall. This variety is resistant to fungal disease as compared to other varieties, and moderately resistant to anthracnose. Cultivation of this variety can be well maintained even in low humidity conditions. The average yield of this variety is relatively low (around 3 t ha^{-1}), and currently does not produce seeds.

- **MI-Green -2009**

Plants of this variety grow up to 75-100 cm vertically. It is an ideal variety for the Northern Province. The length of spikes is 12-14 cm, and is suitable for the production of dry chili, as it is spicier, and can retain its colour for a longer period of time.

- **Galkiriyagama Selection -2009**

This variety is more suitable for the North Central Province, and it shows a 60 -65 cm height, and vertical growth pattern with quite small leaves. Spikes have a slender oblong shape, 8-10 cm length. The green chili yield is around 12-15 t ha^{-1}, and dry chili yield is around 3 t/ha. The variety shows resistance to Leaf Curl Complex (LCC) and fungal diseases

- **MI Varaniya 1 -2011**

It is a variety selected and produced from a traditionally cultivated cultivar in small gardens in the lowland wet zone. It grows vertically to a height of about 100 cm, with 15-20 cm long spikes. The average yield is around 20-25 t ha^{-1} and thus, very suitable for home gardening.

- **MICH 3 -2011**

This is a collection of varieties called MI 1 and Wonder Hot. Plants of this variety grow as a branched shrub up to a 60-65 cm height, with dark green and 8-10 cm long spikes. The pods are suitable for export. Moderately resistant to LCC, the average yield is around 15-18 t ha^{-1}. It is a more attractive variety with a higher market demand.

- **MIPC 1 -2014**

It grows to a height of about 100 cm, and can be kept in the field for about 8 months. This variety produce spikes about 5 cm in length and 1.5-2 cm wide. Pods of this variety can be used in green and dry forms. The variety is moderately resistant to disease and pests, and especially recommended for the Eastern Province.

1.2.2 Local Hybrid Chili Varieties (LHCVs)

- **MICH HY 1 -2015**

The height of the plant of this variety is about 75cm, and excessively branched with light green pods. Length of spikes is 13 cm and the average yield is about 35 t ha^{-1}. It shows high resistance to LCC and other viral diseases, and is suitable for green chili. This was the first recommended (LHCV) released by the DoA in 2015.

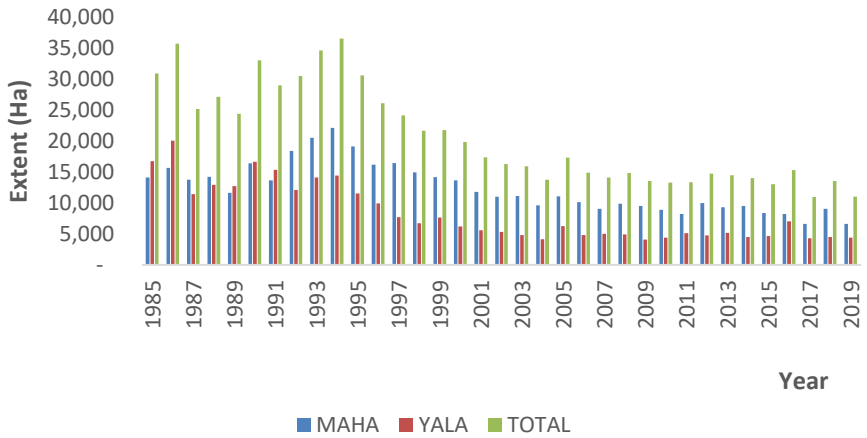
- **MICH HY 2-2017**

The height of this branching plant is about 75 cm. The length of spikes is about 13 cm. The yield is 35 t ha^{-1}. Suitable for dry and green chili production. Resistant to Leaf Curl Complex.

Of the two local chili hybrid varieties, the first one, MICH HY 1 with a yield potential of 32 t ha^{-1} of green chili, developed by the DoA, was released in year 2015. The second LHCV MICH HY 2, with a potential yield of 35 t/ha of green chili, was also released for farmer production in 2017. Even though local OPVs such as MI-2 and KA-2 are highly recommended for dry chili production, the average yields of these varieties remain at about 1-1.5 t ha^{-1} (dry chili) at farmer-field level. Owing to local dry chili production stagnating at a very poor level, a colossal amount of foreign exchange is spent for importing dry chili in the form of whole dry chili, chili powder, flakes and chili paste.

1.3 Chili Production and Imports in Sri Lanka

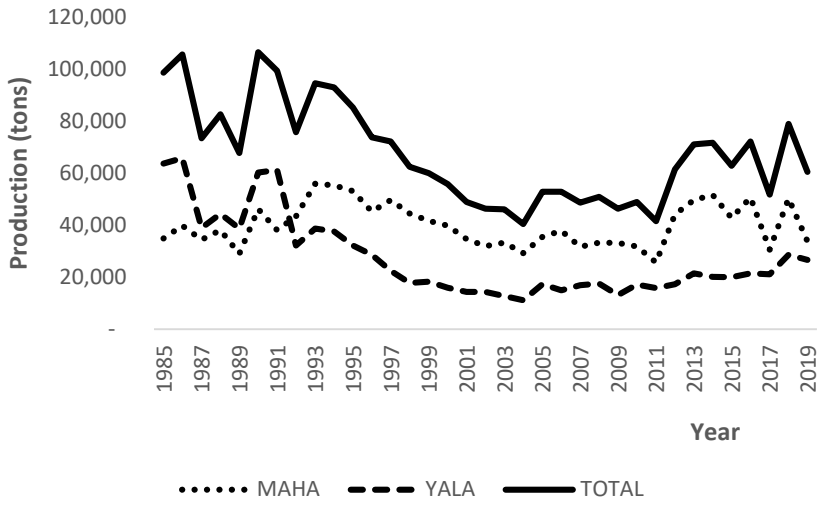
Apart from being an essential spice or condiment, chili has also been one of the most important cash crops grown in Sri Lanka. It has also become an essential ingredient in Sri Lankan meals. With the closed economic policies implemented in early 1970s the extent and production of this important cash crop reached higher levels. Accordingly, by 1976, the highest-ever chili extent of the country was reported as 54,581 ha, and total production was 43,535 tons (Annex 01). The highest-ever chili production was recorded in 1990 with over 106,000 tons (HARTI, 2021). However, owing to the relaxation of dry chili import restrictions in the mid-1990s the cultivation extent of chili saw a decreasing trend (Figure 1.1).



Source: Data Management Division, HARTI (2021).

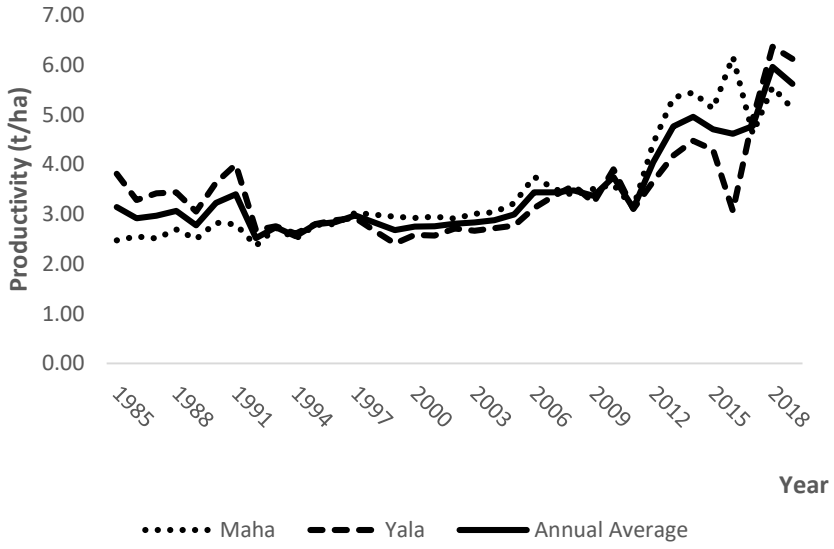
Figure 1.1: Cultivation Extent under Chili (1985-2019)

The annual chili production of the country was badly affected due to the low cultivation extent (Figure 1.2), however, over the last decade, production has seen an increasing trend largely owing to the higher productivities gained (Figure 1.3). Annual green chili production varies from 60,000-79,000 tons (DCS, 2021).



Source: Data Management Division, HARTI (2021).

Figure 1.2: The Chili Production of Sri Lanka (1985-2019)

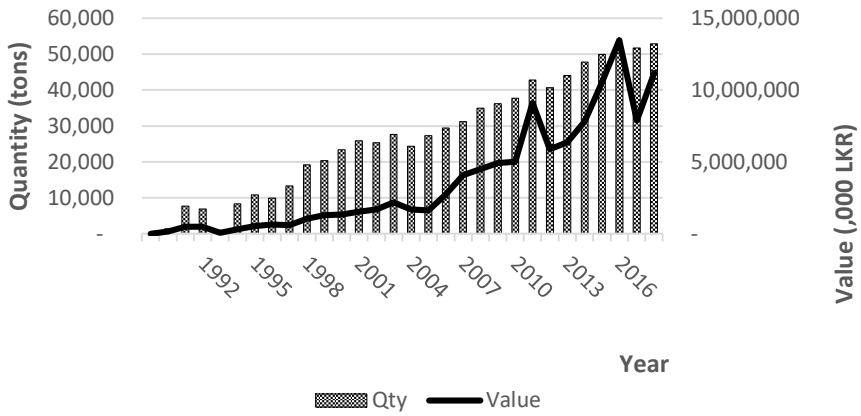


Source: Data Management Division, HARTI (2021).

Figure 1.3: Chili Productivity (1985-2019)

Chili is extensively grown in Sri Lanka for its green pods, but a part of the crop is grown for dry-chili production. Chili contributes an average, Rs. 5,000 million to GDP, and creates employment for 5.3 million work days annually. Per capita consumption of chili in the form of dry chili is estimated to be 2.1-2.3 kg per annum. Average green chili consumption is also in the same range

(https://www.doa.gov.lk/FCRDI). Thus, the national annual requirement of dry chili is around 55,000-60,000 tons, though annual local production is restricted to about 5,000-7,500 tons. Therefore, as indicated in Figure 1.4, an amount of about 53,000 tons of dry chili amounting to over Rs. 11 billion, was imported in 2019, mostly from India (Sri Lanka Customs, 2019).



Source: Data Management Division, HARTI (2021).

Figure 1.4: Dry Chili Imports (1990-2018)

Chili is cultivated on a large scale in the dry zone (DZ) especially in North-Central Province, and in the Intermediate Zone (IZ). The major chili growing areas are Anuradhapura, Moneragala, Ampara, Puttalam, Vavuniya, Kurunegala, Hambantota districts and Mahaweli System H. In the dry zone, biotic stress conditions – the Leaf Curl Complex (LCC), Chili Narrow Leaf Disorder (CNLD) – have been the main reasons behind the lower extent of cultivation, and the poorer yield levels reported particularly in the *Yala* season. Water shortage and related issues in the *Yala* season, and severe incidences of pest outbreaks is also causing consequent crop losses (Kannangara and Karunathilake, 2013; Krishnapillai and De Silva, 2017).

1.4 Chili Exports and Value Addition

The high yielding local hybrid varieties are promoted for dry chili production as well. However, the scale and the economics of dry chili production using LHCVs at the farmer-field level have not been studied adequately. Further, higher market prices of local hybrid seeds have become an impediment to popularizing LHCVs among farmers. The procedures followed, and the issues associated with production of local hybrid chili seeds, have also not been studied and documented for better seed production. Thus, it is worth

scrutinizing existing chili hybrid seed production process governed by the state sector, to identify the possibilities and mechanisms of expanding the current level of seed production.

Capitalizing on changes in the food pattern of different social strata in urban and semi-urban areas, and the expanding foreign market for local products among the Sri Lankan diaspora, the processing industry related to green and dry chili products such as chili powder and flakes, pickles, chili paste, chili sauce, *lunu-miris, umbalakada-sambola* and etc. had also seen significant development over the last few decades. Furthermore, the dry-chili processing sector aimed at the local food market has also gained much diversity. while expanding the volumes handled, and the number of stakeholders playing different roles in different capacities. Table 1.1 presents information on chili exports.

Table 1.1: Quantity, Value and FOB Value of Exported Chili

Year	Quantity (t)	Value (Rs.'000)	FOB value (Rs/kg)
2005	75.53	19,066.00	252.43
2006	91.67	27,282.00	297.61
2007	113.00	54,926.00	486.07
2008	112.00	39,697.00	353.33
2009	272.00	83,207.00	305.91
2010	100.00	34,089.00	339.87
2011	356.00	96,442.00	271.00
2012	305.00	100,879.00	330.75
2013	296.00	87,885.00	296.72
2014	240.00	82,504.00	344.45
2015	174.11	79,624.00	457.32
2016	207.81	97,248.00	467.96
2017	279.00	179,747.00	536.87
2018	219.00	127,568.00	582.71
2019	199.00	113,593.00	570.77

Source: Agstat (various issues)

It is encouraging that the present government's policy directions are focusing on increased local dry chili production. Having recognized the importance of increasing local dry chili production, chili has been listed as one of the prioritized crops among 16 crop varieties, where in local

production is expected to be increased, and to thereby curtail imports (Presidential Secretariat, 2020). The Agriculture Sector Modernization Project (ASMP) has also made some interventions by providing technical and material support with financial assistance for chili cultivation, postharvest handling and processing, in different parts of the country. The ASMP has also been promoting hybrid-chili seed production through linking farmers/farmer groups with relevant stakeholders, including research stations, and providing material and financial assistance to increase local hybrid chili seed production.

It is recommended that in attempting to increase production of LHCVs, strategies should be cantered on increased productivity through promoting suitable local high yielding varieties (hybrids), as the expansion of cultivation extent has become unrealistic due to the high land pressure across different agro-ecological zones where suitable climatic and soil characteristics prevail (Herath, et al. 2017). As an important production input, technology and innovation dissemination through existing state-extension-service delivery systems for promoting LHCV also has a significant role to play in achieving higher productivity levels and increased production.

1.5 Chili Seed Imports

Hybrid chili seed imports were first reported in the 1990s. However, until 2009, these seeds were imported without conducting any laboratory testing and following proper procedures. Up to now, around 400 imported varieties have gone through such procedures, though around 10-15 hybrid chili varieties are officially approved for import (Kannangara, 2021). The main chili seed importers are;

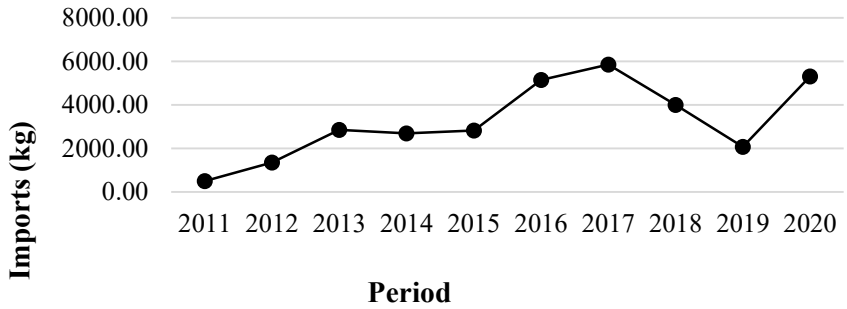
- Hayleys Agro Focus (Pvt) Ltd
- CIC Seeds (Pvt) Ltd
- Agro Focus International (Pvt) Ltd
- Tro Seed (Pvt) Ltd
- Plant Seeds (Pvt) Ltd
- Robin Seeds
- Supreme Marketing

Over the past decade, chili seed imports have seen an increasing trend (Table 1.2, and Figure 4.2). The productivity increase of chili over the same time period can be attributed to adoption of hybrid chili cultivation.

Table 1.2: Chili Seed Imports

Year	Chili Seeds Imported Amount (kg)
2011	510.00
2012	1363.00
2013	2854.32
2014	2697.84
2015	2831.58
2016	5142.00
2017	5850.10
2018	3997.19
2019	2074.10
2020	5308.00

Source: AgStat (Various issues)



Source : AgStat (Various issues)

Figure 1.5: Imports of Chili Seeds in Sri Lanka

Expanding seed production of LHCVs, and making such seeds available at reasonable price, can increase the extent under LHCVs, and thereby minimize chili seed imports.

1.6 Research Problem and Justification

Recent socio-economic studies relating to chili have not focused on micro-level production aspects. Such studies by Samaratunga, Sommers and Varley (2009); Chandrasiri and Bamunuarachchi (2013) and Rathnayake, Ramzy and Alibhutto, (2016) have discussed the macro-level contribution of chili to the local economy, the availability of and accessibility to agricultural credit for crops including chili, and the wholesale price behavior of chili, respectively. Though, several years have passed since the release of local

hybrid chili varieties, comprehensive studies on the economics of cultivation and seed production of those varieties are lacking in the scientific literature. The costs of chili cultivation calculated and published by the DoA, mostly focus on the green chili of OPVs cultivated in rain-fed conditions and/or under irrigation (DoA, 2019), whereas information on the cultivation costs (green chili) of local hybrids and dry chili (either of OPVs and local hybrids) are hardly found. Lack of knowledge and information on local hybrid chili cultivation and their use in dry chili production has led to a great deal of concern about the potential for dry chili production from hybrid varieties. This study aims to fill such an information gap.

1.7 Significance of the Study

The policy document of the current government – *Vistas* of *Prosperity and Splendor* – speaks, under a People-Centric Economy (Chapter 5), of the *expansion of agriculture production by providing good seed and planting materials,* as one of the key strategies to *promote cultivation and production of other field crops (OFCs)*: *dry chili, maize, soya, green grams, cowpea, onions and potatoe*s (Ministry of Finance, 2020). Indicating higher priorities for increased production of the crops cited, a separate State Ministry (*Paddy and Grains, Organic Foods, Vegetables, Fruits, **Chili**, Onion and Potato Cultivation Promotion, Seed Production and Advanced Technology)* has been formulated under the Ministry of Agriculture (Presidential Secretariat, 2020). Intensifying and achieving higher production through increased productivity levels of chili, the State Ministry of Agriculture has identified and included chili as one of the prioritized commodities in the 7 Special Fields on which the Ministry bases its development mechanism. The Ministry further emphasizes the need to expedite government seed-multiplication Programmes, partnering with the private sector to cater to the demand for quality seeds, and to cut down the enormous amount of foreign exchange draining out annually for seed importation (SMoA, 2020). The Sri Lanka Council for Agricultural Research Policy (2017) has identified 'establishing private-public partnership in quality seed production, and ways and means of promoting it', as one of the priority research areas, and it well matches the scope of this study as well.

1.8 Research Objectives

Against this background, the key objective of this study was to ascertain the current status and potential for local hybrid chili cultivation and dry chili production. Special attention is paid here to identify the cultivation practices of LHCVs, with the availability and use of inputs, the constraints associated with the cultivation of LHCVs, with special reference to constraints and potentials of local chili seed production, and the constraints associated with dry chili production from LHCVs.

1.9 Materials and Methods

1.9.1 Study Area and Data Collection

The study was conducted covering key districts where chili cultivation is undertaken, and in areas where seed production of LHCVs is concentrated, and both primary and secondary data and information were collected from various sources. The primary data were collected from leading farmers undertaking hybrid chili cultivation at different scales and under different systems (irrigation method, land use and, crop protection) in Anuradhapura, Puttalam, Hambantota, Moneragala, and Mahaweli System H via face-to-face interviews and telephone conversations. Several aspects were covered during data collection including input supply, agronomic practices followed, training received, technology adoption, type of irrigation, constraints associated with chili cultivation, and chili seed production. The study covered Yakalla, Negampaha, Ipalogama Agrarian Service Centers (ASCs) in Anuradhapura District, Kalpitiya ASC in Puttalam District, Lunama and Beralihela ASCs in Hambantota District, Thelulla ASC in Moneragala District and, Hurigaswewa Unit Area in Mahaweli Systems H. The data and information on hybrid seed production was collected from selected seed producers in Anuradhapura, Kurunegala, Puttalam, Kandy and Matale districts.

In addition, extension managers and extension workers attached to the DoA, PDoA, Department of Agrarian Development (DAD), Mahaweli Authority of Sri Lanka (MASL) were also interviewed. The key informant interviews (KIIs) were conducted with the Project Director, Additional Project Directors, Subject Officers, and Field Officers of the ASMP, to gain a better understanding of the interventions made by the project towards intensified cultivation of local chili hybrids and chili seed production. The researchers, administrators and field level officers attached to the FCRDI, Seed Certification Service (SCS), Seed and Planting Material Development

Center (SPMDC) of the DoA were also interviewed, to obtain information on hybrid chili seed production.

Secondary data and information were collected from various sources such as annual reports, research reports, articles and other scientific documents on chili cultivation and seed production. Data compilation and digital databases available at the such institutes as Sri Lanka Customs (SLC), Department of Census and Statistics (DCS) were also used as the secondary data sources.

CHAPTER TWO

Chili: World Situation

2.1 Introduction

Native to the Americas, capsicum fruit have been a part of human diet for over thousands of years. Capsicum is one of the oldest self-pollinated crops cultivated in Central America, Mexico, and parts of the Americas, as the origins of cultivating chili pepper are traced to east-central Mexico, some 6,000 years ago (Smith and Byers, 1967; Perry *et al.*, 2007; Perry and Flannery, 2007). As a country, Peru has the very best cultivated Capsicum diversity, due to its high diversification, where sorts of all five domesticates were introduced, grown, and consumed in pre-Columbian times. In the region, Bolivia is the country with the largest diversity of wild Capsicum consumed. Bolivian consumers distinguish between two basic forms: ulupicas, species with small round fruit, including *C. eximium*, *C. cardenasii, C. eshbaughii,* and *C. caballeroi* landraces; and *C. arivivis* with small elongated fruits including *C. baccatum* var. *baccatum* and *C. chacoense* varieties (Bosland, 1996).

The widely cultivated chili is scientifically known as C*apcicum annum*, which belongs to the family Solanaceae, is one of the most important constituent of the cuisine of tropical and subtropical countries, and is primarily considered as one of the key global commercial spice crops (Saxena *et al.,* 2016; Prajapati *et al.,* 2020). Over 400 different varieties of chili, commonly called hot pepper, cayenne pepper, sweet pepper, bell pepper, etc. are grown for vegetables, spices, condiments and pickles in different parts of the world, in varying scales. Fresh green pungent fruit are generally used in salads, stuffing, and as a flavouring agent in cooked meals. The non-pungent varieties are cooked as vegetables or processed with other food items for flavour (Welbaum, 2015). The pungent varieties are consumed in small quantities, generally considered as a condiment or spice for seasoning and for stimulating appetite (Grubben and Mohamed El, 2004).

Apart from its extensive use in the preparation of processed food, chili varieties are also used as colouring agents in salad dressings, meat products, cosmetics, and even clothing. Capsicum possesses various medicinal and nutritional values as well. Chili contain a diverse range of phytochemicals, including vitamins, phenolics, and flavonoids, which act as anti-oxidants, and may help to prevent degenerative diseases (Howard *et al.*, 2000; Salam,

2015). Chili are rich in vitamin C, vitamin A, vitamin E, most B vitamins, and in particular vitamin B5 (Howard *et al.*, 2000; Van Zonneveld *et al.*, 2015). Red chili are nutritionally enriched with vitamin C and small amounts of vitamin A. These are rich source of iron, magnesium and potassium (Van Zonneveld *et al.*, 2015). Fresh green chili fruit contain more Vitamin C than found in citrus fruit, while red chili fruit have more Vitamin A content than as found in carrots (Than et al., 2008). The active ingredient of the spice, *capsaicin,* is a complex of capsaicinoid alkaloids found in variable concentration in different chili varieties (Grubben and Mohamed El, 2004). The amount of *capsaicin* has been the measure of the pungency of the chili variety, and is generally expressed in Scoville Heat Units (Scoville, 1912). *Capsaicin* possesses antioxidant, anti-mutagenic, anticarcinogenic, and immunosuppressive activities, having the ability to inhibit bacterial growth and platelet aggregation. It is also used as an anti-arthritic and anti-inflammatory agent (Welbaum, 2015). *Capsaicin* extracted from chili is used in pepper sprays, and some tear-gas formulations, as a chemical irritant, to use as less-lethal weapons for the control of individuals or crowds considered unruly (Haar *et al.*, 2017). Capsaicin, the chemical in chili peppers that makes them hot, is used as an analgesic, in topical ointments, nasal sprays, and dermal patches, to relieve pain.

2.2 Global Chili Production Export and Imports

At a global level, chili is annually cultivated to an extent of about 2 million ha yielding, on average, 38 million tons of green chili, also producing 4.2 million tons of dry chili. (FAOSTAT, 2020). Chili was unknown in Europe, Asia and Africa prior to Christopher Columbus landing in the Americas. The spread of chili peppers to Asia occurred through its introduction by Portuguese traders, who conscious of its trade value, and resemblance to the spiciness of black pepper, promoted its commerce on Asian spice trade routes (Bosland, 1996; Bosland and Votava, 2000). Asia accounts for over 72 percent of world chili production followed by Africa and Europe. China plays the leading roles in chili production while Mexico, Turkey, Indonesia, Spain and USA (Table 2.1) are the other key chili producing countries (FAOSTAT, 2020: PJTSAU, 2020).

Table 2.1: Leading Countries of Green Chili Production (2019)

Country	Quantity (t)
China, Mainland	14,502,846
Mexico	2,221,306
Turkey	2,003,586
Indonesia	1,490,190
Spain	1,068,109
United States of America	881,964
Nigeria	732,070
Egypt	597,926
Algeria	383,540
Netherlands	338,800

Source: FAOSTAT (2020).

Mexico plays the leading role in green chili exports, followed by Spain, Netherlands, USA and Canada (Table 2.2), while green chili imports are largely concentrated in the temperate zones of North America and Europe (Table 2.3).

Table 2.2: The Major Green Chili Exporters (2019)

Country	Quantity (t)
Mexico	663,540
Spain	547,287
Netherlands	386,236
United States of America	103,138
Canada	90,868

Source: FAOSTAT (2020).

Table 2.3: The Major Green Chili Importers (2019)

Country	Quantity (t)
United States of America	732,706
Germany	331,166
United Kingdom	156,182
France	137,865
Canada	113,839

Source: FAOSTAT (2020).

The world's dry chili production is vastly contributed by Asian and African countries such as India, China, Thailand, Ethiopia Bangladesh, Pakistan and Vietnam (Table 2.4). The USA, Malaysia, Thailand, Sri Lanka, Vietnam and Spain together contribute a share of 66% of world dry chili imports. The global dry chili market involves approximately USD 942,107 thousand (RAM, 2018; Market Reports, 2020).

Table 2.4: Leading Countries in Dry Chili Production (2019)

Country	Quantity (t)
India	1,364,376.55
China, Mainland	268,751.50
Thailand	219,535.90
Ethiopia	167,946.15
Bangladesh	136,133.00
Pakistan	128,361.40
Myanmar	110,456.75
Côte d'Ivoire	92,091.15
Viet Nam	87,380.30
Ghana	86,348.00

Source: FAOSTAT (2020).

CHAPTER THREE

Costs and Practices in the Cultivation of Local Hybrid Chili Varieties

3.1 Introduction

Even though it has only been about 5 - 6 years since the LHCVs were introduced, they have gained high popularity among the farmers due to their high yielding ability. However, of the two LHCVs, only MICH HY1 introduced in 2015 is extensively cultivated in different parts of the country, whereas the MICH HY2 (released in 2017) has not been as popular since the seeds are not readily available. In addition to higher yields reported in the farmer fields, the longer duration of the crop, less susceptibility to LCC, relatively taller plants making it easy for farmers to carry out certain agronomic practices, have made MICH HY1 a more promising variety for chili growers.

Figure 3.1: MICH HY1 Cultivation under a Sprinkler Irrigation System

However, farmers with inadequate financial resources are still reluctant to invest in the cultivation of LHCVs, due to high seed cost. The market price of the MICH HY1 variety varies from 110,000-190,000 LKR per kg. Therefore, farmers having the initial capital for investing in supplementary and/or high

efficient irrigation, novel crop-protection measures and weed management techniques, have the capacity to commercially cultivate this variety.

3.2 Cultivation Practices of Local Hybrid Chili Varieties

The variety MICH HY1 is cultivated under different irrigation methods such as conventional surface irrigation, drip irrigation and sprinkler irrigation. Highly efficient micro irrigation systems have always delivered higher yields compared to conventional surface irrigation methods.

Figure 3.2: MICH HY1 Cultivation under a Drip Irrigation System

As a crop belonging to the Solanaceae family, chili is highly susceptible to such pests as leaf miners, mites, thrips, and white flies and therefore, chemical pest control for chili has become very costly. Insect-proof nets have been introduced as an effective pest control measure for most annual crops including chili.

Figure 3.3: MICH HY1 Cultivation Protected with an Insect-Proof Net

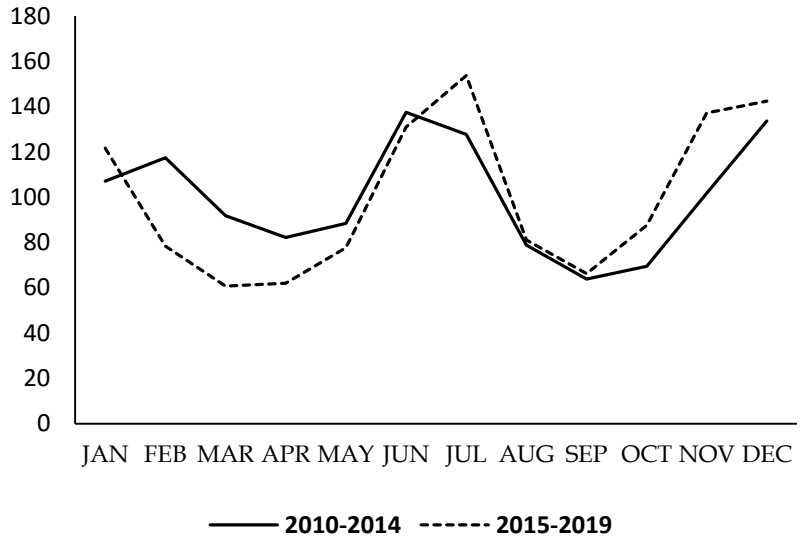
Polythene (poly) mulching (plastic-mulching) is used in crop lands for multiple purposes such as soil erosion control, fast organic matter decomposition, soil temperature retention, and weed control. Poly-mulch is widely used in MICH HY1 cultivation especially for weed control. However, in the Kalpitiya area, poly-mulch is not applied as farmers experience root damage due to higher temperatures by using poly-mulch.

Figure 3.4: MICH HY1 Cultivation with Poly-Mulching

The DoA recommends plant spacing for chili as 60 cm x 45 cm with two plants per hill (for OPVs) and one plant per hill (for hybrids). Farmers receiving technical and material support from the ASMP have adopted 45 cm x 30 cm spacing for higher plant densities, resulting in higher crop yield.

Figure 3.5: Fields with Recommended Plant Density (*left*) and Higher Plant Density (*right*)

The time of crop establishment under conventional chili cultivation for the *Maha* and *Yala* seasons are September-November and March-May, respectively. However, taking the price behavior of green chili in the market, farmers tend to undertake crop establishment in August so that the harvest can be sold at higher prices in the off seasons of the November-January period (Figure 3.6). Further, the hybrid chili crop is maintained for up to 7-10 months in most of the growing areas, except in the Kalpitiya area. In the Kalpitiya area, the crop lasts for 4-5 months.



Source: Data Management Division of HARTI (2021)

Figure 3.6: Price Index of Green Chili (Retail Price)

3.3 Cultivation Cost of Green Chili

As there are some differences in agronomic practices followed in cultivating MICH HY1 in different geographic locations, and under different cultivation methods, the cost of cultivation (CoP) was estimated for each system. Accordingly, chili cultivation under the sprinkler irrigation system, with poly-mulch and insect-proof nets, was calculated on the basis of a farmer field in Tissamaharama in the Beralihela ASC area (Table 3.1).

Table 3.1: Cost of Cultivation of MICH HY1 under the Sprinkler Irrigation Method in Hambantota

Operation	Cost (Rs./0.5 ac)				
	Labour	Machinery	Material	Utility bill	Total
Nursery preparation & Management	5,000.00		7,500.00		12,500.00
Seeds			30,000.00		30,000.00
General land preparation	25,000.00				25,000.00
1st & 2nd land preparation with 4wt		8,000.00			8,000.00
Preparation beds & ridges and laying polythene mulch	30,500.00		139,500.00		170,000.00
Transplanting	7,500.00				7,500.00
Fertilizer application	16,000.00		24,364.00		40,364.00
Pest & disease control	6,500.00		60,000.00		66,500.00
Water management (Sprinklers)				10,500.00	10,500.00
Harvesting and grading and packaging	216,000.00		7,000.00		223,000.00
Transport		25,000.00			25,000.00
Total cost	306,500.00	33,000.00	268,364.00	10,500.00	618,364.00

Source: HARTI Survey (2021)

Fixed cost

- Insect proof net – Rs.164,500.00
- Sprinkler system – Rs.150,000.00
- Water pump – Rs. 75,000.00
- Nursery trays – Rs. 24,000.00

The average yield of the crop is 10 tons (for 0.5 ac), and the average farm-gate price is Rs. 210/kg, so that total income is Rs. 2,100,000/=.

Table 3.2: Cost of Cultivation of MICH HY1 under the Sprinkler Irrigation Method in Kalpitiya

Operation	Cost (Rs./ac)				
	Labour	Machinery	Material	Utility Bill	Total
Nursery preparation & management	7,500.00		12,550.00		20,050.00
Seed			45,000.00		45,000.00
General land preparation	4,000.00				4,000.00
1st & 2nd ploughing with 2wt		10,000.00			10,000.00
Preparation of planting pits/hills	6,000.00		58,320.00		64,320.00
Transplanting	12,000.00				12,000.00
Fertilizer application	19,800.00		95,000.00		114,800.00
Weeding & earthing up	89,500.00				89,500.00
Pest & disease control	6,250.00		125,000.00		131,250.00
Water management	80,000.00			35,000.00	115,000.00
Harvesting	231,550.00				231,550.00
Grading and Packaging	36,500.00		9,000.00		45,500.00
Transport		83,750.00			83,750.00
Total cost	493,100.00	93,750.00	344,870.00	35,000.00	966,720.00

Source: HARTI Survey (2021)

Fixed cost

- Sprinkler system – Rs. 200,000.00
- Water pump – Rs. 75,000.00
- Nursery trays – Rs. 32,200.00

The average yield of the crop is 14 tons/ac, and the average farm-gate price is Rs. 210/kg, so that total income is Rs. 2,940,000/=.

CHAPTER FOUR

Chili Seed Production and Dry Chili Production

4.1 Chili Seed Production

At present, as per rough estimates, Sri Lanka requires around 15,000 kg of chili seeds for local chili cultivation, which is dominated by the OPVs. However, this quantity of seed can be further reduced if hybrid seed usage is increased, as the required seed rate of hybrid varieties is lower than that of the OPVs. Only a portion of the annual chili seed requirement can be met with the local production and the rest is imported. Chili seed imports are mostly limited to hybrid varieties largely from countries like India, Malaysia and Thailand. The FCRDI develops and releases new varieties through their varietal development breeding Programmes, while the subsequent vital step of planting material multiplication is done by the SPMDC of the DoA. In this context, the Mission of the SPMDC is to assure the supply of high quality seeds and planting materials at competitive prices to the farming community of Sri Lanka. The Seed Certification Service (SCS) of the DoA, virtually embraces seed and planting-material related activities, wherever they are bred, multiplied, imported and traded through a country-wide network of 24 regional stations, supported by 5 seed testing laboratories, a seed health testing laboratory, and 6 post control testing farms.

The government enacted the Seed Act, No. 22 of 2003 to regulate the quality of seed and planting materials (MoA, 2014). Accordingly, to be a seed producer, the relevant application form should be completed and submitted to the office of the nearest SCS with the recommendation of the extension officer, the Agriculture Instructor (AI). Farmers are required to make a payment (Rs.1000) as the registration fee. All registrations must be renewed before the expiry date specified in the registration form. Samples of locally produced and imported seeds should also be taken to verify their conformity with prescribed standards.

According to the SPMDC, approximately 5,000 kg of basic chili seeds are produced by the government seed farms and registered seed producers each year. The SPMDC purchases between 15,000 and 20,000 kg of dry chili from the registered seed-producing farmers in order to produce the basic seed quantity required. At the moment, approximately 150 farmers have registered with the FCRDI of DoA to produce hybrid chili seeds. The AIs and other field officers select farmers who are capable of producing chili seeds.

Farmers have to build up poly tunnels to grow parental plants of chili to produce hybrid seeds. Poly tunnels are constructed using farmer's own finances, or the financial assistance provided by different project-implementing agencies representing both the government and non-government sectors. The DoA, particularly the FCRDI provides accompanying training Programmes on the production of hybrid chili seeds. These training Programmes and seeds of pure parental lines are provided free of charge to farmers. In addition to individual farmers, farmer groups and farming communities as well as seed companies are also provided with the training and seeds for seed multiplication.

Figure 4.1: Plants of Parental Lines of MICH HY1 Variety

Chili seed production (of OPVs) is primarily undertaken during the dry *Yala* season, as the high rainfall condition during the *Maha* season is not favorable to the seed production process. When farmers cultivate OPVs to produce chili seeds, there can be no other types of chili plants within a proximity of 200m. The ideal solution, to avoid cross-pollination with other varieties, is to grow the same varieties of chili in the same area. Farmers are provided with 200-250 g of basic chili seeds per half an acre. Field officers attached to the SCS and the SPMDC make field inspections and provide advice, guidance, and training for farmers towards quality seed production. A disease-free condition is very important to maintain the vigour of the variety. Farmers perform harvesting of chili at the bright red-colour stage,

and sun-dry those to bring the moisture level to the accepted range (9%). The samples from stocks of the sorted dry chili (for size, color and etc.) of each farmer, are collected by officers attached to the CSS and the SPMDC, and those samples are subject to laboratory procedures to meet the standards of the products. The germination level, and moisture content of those seed samples, are tested. The dry chili stocks, whose samples pass the tests, are purchased by the SPMDC at the rate of Rs. 1,500.00 per kg.

Basically, under the DoA's seed production scheme, two types of seed producers are involved; contract producers and private producers. Both types of seed producers have to register with the SCS, and are provided with basic seeds and field inspections by the DoA. The contract producers are required to sell their seeds produced to the DoA, whereas the private farmers do not necessarily have to provide seeds to the DoA.

Figure 4.2: Chili Drying for Seeds Production – MI2 Variety

MICH HY1 seed production is governed by the FCRDI and the SCS of the DoA. Farmer training and parental seeds are provided by the FCRDI, while field supervision and seed certification are undertaken by the SCS.

Table 4.1: Local Hybrid Chili Seed Production

Year	No. of farmers	Cultivated Area Under Poly Tunnel (ft^2)
2019	102	129,000
2020	108	235,000
2021	156	400,000*

*Provisional
Source: Kannangara (2021)

FCRDI were with the target of producing about 4000kg of hybrid chili seeds (MICH HY1) in 2021. One hybrid chili plant produces about 200g of seeds, and one healthy and well grown chili pod produces 65-70 of chili seeds.

In order to increase the seed multiplication of the locally developed hybrid chili variety – the MICH HY1 – the DoA adopts an approach similar to those followed in the OPV varieties. However, hybrid chili seed production is required to be undertaken in protected environments such as poly tunnels. On average, a poly tunnel of about 1000 ft^2 can produce about 10 kg-12 kg of chili seeds.

Table 4.2: Cost of Production of MICH MI1 Seeds

Operation	Cost (Rs./ 2000 ft^2)				
	Labour	Machinery	Material	Utility bill	Total
All nursery preparation	5,000.00		700.00		5,700.00
Preparation of grow bags	5,475.00		47,550.00		53,025.00
Transplanting	2,000.00				2,000.00
Fertilizer application	8,000.00		118,000.00		118,000.00
Polination	609,000.00				609,000.00
Pest & disease control	52,500.00		132,000.00		184,500.00
Water management (electricity bill)	6000.00			9,000.00	15,000.00
Harvesting, drying and seed separation	50,000.00				50,000.00
Total excluding imputed cost	723,975.00		298,250.00	9,000.00	1,043,725.00

The quantity of seeds produced is 20 kg, and the average price is Rs. 140,000/kg so that total income is Rs. 2,800,000/=.

4.2 Issues in Chili Seed Production

Price competition from the private sector in purchasing chili seeds from the farming communities has become a threat to the SPMDC's acquisition of the required seed quantities. Certified hybrid chili seeds are purchased by the DoA at the rate of Rs.60, 000 per kg. However, in many instances, the private sector entities involved in seed production/marketing purchase chili seeds by offering higher prices. Framers sell seeds to the private sector even before getting the results of seed tests, as the procedures associated with seed testing are lengthy and time consuming. For hybrid seeds, it takes more time to complete the seed certification procedure as it includes testing for the hybridity of the variety.

The LHCVs are sold at relatively higher market prices. Most of the time, a 10 g seed packet is sold for between Rs.1300 -2000. Some farmers allege that private seed companies tend to mix F_2, F_3 of LHCVs or OPVs with F_1 seeds resulting in inferior quality of seeds. Further, it says that some seed producers use seeds of F_2 and F_3 generations to produce hybrid chili seeds to exploit high demand causing high market price.

4.3 Dry Chili Production in Sri Lanka

In general, Sri Lankan chili farmers are reluctant to produce dry chili due to number of reasons including, unfavourable climatic conditions prevailing in the cropping seasons, high labour demand, and less profitability due to low market price. There is no uniform sunlight throughout the day suitable for drying chili while the levels of humidity are ranging from 60–90% during different seasons (Sirisena *et al.*, 2017). On average, farmers have to spend about 6 days to dry chili even if there is enough sunlight throughout the day. Chili can be contaminated with various substances when drying in the sun. If proper drying conditions are not maintained, the colour of red chili spikes will turn white leading to lower market price. In addition, farmers also have to bear additional labour costs and high opportunity costs. If the government can introduce suitable drying machines for individual farmers or farmer groups, dry chili production can be properly done without such problems.

Most agricultural products require a drying process in an effort to preserve the quality of the final product. The drying process requires high heat to

vaporize the material, but the use of high heat also results in a loss of colour, aroma and vitamins in the product (Nagaya *et al.*, 2006). Solar drying offers a less-expensive method, but have two main weaknesses. The drying is discontinuous and depends on weather conditions and location. At night-time, ambient temperature decreases, and relative humidity increases. In some cases, dry chili absorbs moisture in the air until the moisture of the dry chili balances with the relative humidity in the air. The high humidity in the air affect dry chili products, making fungi proliferate easily, causing these products to have low quality.

Non-sanitary conditions in the drying, transport, and storage stages of chili production could lead to aflatoxin contamination (Jalili and Jinap, 2012). Local production of dry chili would assure consumption of healthy chili, and save money on import costs. At present farmers in Mahaweli System H are producing dry chili on a small scale, with kerosene driers provided by the ASMP (Figure 2.10).

Figure 4.3: Chili Dryer Provided by the Agriculture Sector Modernization Project

Table 4.3: Cost of Dry-Chili Production in Sri Lanka

Chili Variety (MICH HY1)	
Required red chili quantity to produce 1kg of dry chili	- 5 kg
Price of 1kg of red chili	- Rs 120
Total price for red chili to produce 1kg of dry chili	- Rs. 600
Required total kerosene amount to produce 1kg of dry chili	- 0.2 liters
Price of 1litter of kerosene	- Rs. 87
Total price for kerosene to produce 1kg of dry chili	- Rs. 17
Labour cost to produce 1 kg of dry chili	- Rs. 80
Expected farm gate price of dry chili	- Rs. 800

CHAPTER FIVE

Concluding Remarks

The cultivation of hybrid chili varieties has seen an increasing trend over the last decade, and this is reflected in the high productivity (average yield) and increased chili-seed imports.

The LHCVs have gained higher popularity over the imported varieties due to high crop yields, relatively higher resistance to LCC, longer duration of the crop, ease in harvesting due to the height of the chili plant. Therefore, this situation should be capitalized, and appropriate initiatives discussed below should be taken to increase its popularity.

The higher market price of LHCVs (MICH HY1) seeds has been an impediment for small scale farmers to initiate commercial-level cultivation. Further, as the rain-fed conventional cultivation method is not profitable, the ability to make investments in supplementary irrigation sources and/or high efficient irrigation systems has also become a challenge for farmers to enter local hybrid-chili cultivation. Though the profitability and profit margins of cultivation of MICH HY1 are high, the requirement of the initial capital and the variable costs are also higher. Therefore, the necessary technical support and market linkages should be made available for prospective producers/farmers.

Chili farmers are reluctant to produce dry chili for a number of reasons including, unfavourable climatic conditions prevailing in the cropping seasons, high labour demand, and less profitability due to low market price. In case of MICH HY1, owing to the fleshy nature of the pod, and the green-chili requirement, the labour demand for making dry chili is higher than that of the OPVs. Therefore, introduction and popularization of low-cost dryers should be implemented targeting farmer groups and agripreneurs, in selected chili-producing areas.

The low farm-gate price for dry chili has also become an impediment for farmers, keeping them away from producing dry chili. The higher farm-gate price mostly prevailing for green chili, was also a reason for farmers not to go for dry-chili production. The import tax on dry chili should be increased to provide a better price for local dry chili, and such moves will encourage local dry chili-production.

Like production of LHCVs (MICH HY1), the seed production of the same variety is a highly profitable activity due to higher seed price. Existing training and other supportive Programmes targeting prospective seed producers should be intensified to achieve a higher level of seed production. As the price offered by the SPMDC (Rs 60,000 per kg) is much lower than the price given by private seed companies, farmers are not providing their seeds to the DoA, and this has created a manipulated chili seed market, where the seed price is unfairly high. Therefore, the purchasing price offered by the DoA should be increased at least to Rs. 80,000, while regulating the market price of the seeds of the private sector seed companies by declaring a maximum price for seeds.

There is no any mechanism to test the quality of the seeds (hybridity) available in the market. Therefore, protocols and regulations should be developed to maintain seed quality.

Limitations and Upcoming Research Opportunities

It is noteworthy mentioning that due to the risk posed by the prevailing Covid-19 pandemic situation, farmer interviews were limited to a smaller sample in selected Agrarian Service Center areas. However, based on data collected from leading chili growers and relevant officials, this study highlights the current status of the cultivation of LHCVs, and the potential for improvement in the production of dry chili using them. The conclusions and policy implications provided will be of great help in formulating appropriate policies at the national level.

The study also reveals the constraints faced by those agri-entrepreneurs, in general. However, there is still room for in-depth study of the micro-level aspects of the industry, through the collection of data from representative samples of farmers representing different chili-producing areas in the country.

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