



2020 K-Innovation ODA Program with Sri Lanka

2020 STEPI-NASTEC STI Policy Consultation Project on “Supporting the Improvement of Science, Technology and Innovation (STI) Policy and Institutional Framework for Sri Lanka”

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Title	2020 STEPI-NASTEC STI Policy Consultation Project on “Supporting the Improvement of Science, Technology and Innovation (STI) Policy and Institutional Framework for Sri Lanka”
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Executive Summary

Sri Lanka is a lower middle-income country with population of 21.2 million and per capita GDP of \$3,946 as of 2019. Since the civil war ended in 2009, the GDP growth rate in Sri Lanka has averaged 5.88% from 2003 until 2017, reflecting a peace dividend and a commitment to reconstruction and growth. The economy is transitioning from what was previously a predominantly rural-based economy toward a more urbanized one oriented toward manufacturing and services.

The main focus of the policies and economic reforms as stated by the previous government of Sri Lanka was a knowledge-based social market economy. Likewise, the vision proposed by the current new government of President Gotabaya Rajapaksa is “a productive citizen, a happy family, a disciplined society, and a prosperous nation.” In this context, the Sri Lankan government has announced its intention to promote Science, Technology, and Innovation for the achievement of SDGs and pursue a technology-based society.

Sri Lanka has formulated various policies including the National Science and Technology Policy (2008), Science, Technology, and Innovation Strategy for Sri Lanka (2011) and the National Research and Development Framework (2016) for the development and utilization of science and technology. Nonetheless, the country still lacks implementable action plans that fit or change the political, social, and economic contexts of the country, according to the project concept paper submitted by the government of Sri Lanka.

After the successful training provided by STEPI to STI policy experts in Sri Lanka in 2018, the two-year policy consultation project started with generous funding from the government of the Republic of Korea in 2019. The training was aimed at improving the STI

policy capacity of Sri Lankan STI policy makers and experts in order for them to gain deeper understanding and insights of STI policy and strategy development. It also helped government officials from various ministries and STI stakeholders obtain appropriate knowledge of policy analysis techniques and mechanisms for R&D commercialization. In the new project on policy consultation, the STEPI-NASTEC collaborative works have been designed to examine the STI development experiences of both countries and share know-how and knowledge of STI for economic and societal developments together.

As an advisory body to the Government of Sri Lanka on Science and Technology, the National Science and Technology Commission (NASTEC) requested that STEPI identify impediments to the effective implementation of major STI policies and develop incentive-based strategies such as action plan to eliminate or minimize such impediments during the 2019-2020 project. Thus, the STEPI-NASTEC project focused on the assessment of the overall national STI system in Sri Lanka to diagnose the current status of the STI system, governance including the current STI resources, and capabilities and challenges during the first year of the project. In 2020 as the second year of the project, experts from both countries examined the STI action plans in agriculture of both countries and shared methodological policy tools and skills to develop implementable action plans.

This report, which is the second-year STEPI-NASTEC collaborative project's output, contains the first draft on three sub-areas written by the NASTEC and its designated experts and the revised draft on the same three sub-areas written by Korean experts in STI-agriculture. While the global pandemic hindered the active off-line discussions and meetings among experts in two countries, insightful advice was provided, and interactive online workshops and meetings were successfully held throughout the project. As the two-year project has ended, this is expected to bring about more fruitful outcomes, contributing to the sustainable bilateral ties between Korea and Sri Lanka and national STI development, and Sri Lanka growth.

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CHAPTER 1

Project Overview

2020 STEPI-NASTEC STI Policy Consultation Project on
“Supporting the Improvement of Science, Technology
and Innovation (STI) Policy and Institutional
Framework for Sri Lanka”

Chapter 1. Project Overview

1. Introduction

The two-year policy consultation project between STEPI and NASTEC started in 2019, aiming to support the effective implementation of major STI policies in Sri Lanka. It focused on the assessment of the overall national STI system in Sri Lanka to identify the current status of the STI system, including STI governance, policy, resource, and data mechanism during its first year. Based on policy recommendations derived from the assessment, it was agreed during the final workshop in November 2019 that the second-year project would focus on supporting the development of STI action plans of selected technology domains by offering opportunities to investigate the action plans of both countries and share policy tools to develop implementable action plans.

As the global COVID-19 pandemic has wielded enormous impacts on most sectors and regions of the global economy and seriously limited the mobility of humans and products, however, it has also influenced the circumstances of the STEPI-NASTEC project. The Sri Lankan government imposed a nationwide curfew from March 20 to May 11, including visa suspension and border closures, to minimize the spread of the virus within the country. The Korean government also introduced special restrictions to control inbound travelers; in particular, foreign nationals on short-term visas are placed under quarantine at facilities (14 days, Self-Diagnosis App to be installed) and tested at a public health clinic within 14 days (as of June 17, 2020). Furthermore, there are serious concerns over the higher impacts of the second wave of the virus this fall than those of the first one, despite rigorous worldwide efforts to control the virus. All these circumstances require both STEPI and NASTEC to collaborate for the project with a very high level of flexibility.

[Figure 1-1] Confirmed Cases and Deaths of COVID-19 in Sri Lanka



Source: WHO COVID-19 Dashboard (Accessed on November 14, 2020)

Under the high uncertainty of the post-COVID-19 situation, the top priority of the current administration in Sri Lanka has been agriculture, which is expected to bring an upturn of the national economy, meet basic needs, and provide income to its citizens in Sri Lanka. As a policy formulating and advisory body on science and technology matters to the government of Sri Lanka, NASTEC has also committed to supporting the agriculture sector by providing insights on the STI aspects of agriculture in order to contribute to the promotion of the country's socio-economic stability.

Given these domestic and global contexts, NASTEC asked STEPI that both parties focus on the agriculture sector to develop STI action plans in 2020. Themes in the agriculture sector suggested by NASTEC are: a) agriculture with novel technologies for quality mass productions; b) value addition to agri-produce technology; c) small-medium agribusiness by rural sector-entrepreneurship; and d) apps for agriculture production and marketing.

STEPI suggested reorganizing four themes into three: a) productivity: a technology action plan to improve productivity in farms or fields; b) process: a technology action plan for value-added agri-food products; and c) entrepreneurship: action plan to facilitate tech entrepreneurship in agriculture, particularly small and medium agribusiness. STEPI and NASTEC both agree to work on three themes for action planning on May 14, 2020.

2. Objectives

The objective of the policy consultation in 2020 is to develop the STI action plan that aims at fostering the agriculture sector in Sri Lanka. As the STI policy think-tank, both STEPI and NASTEC expect to provide STI perspectives on the sectoral development of agriculture in particular.

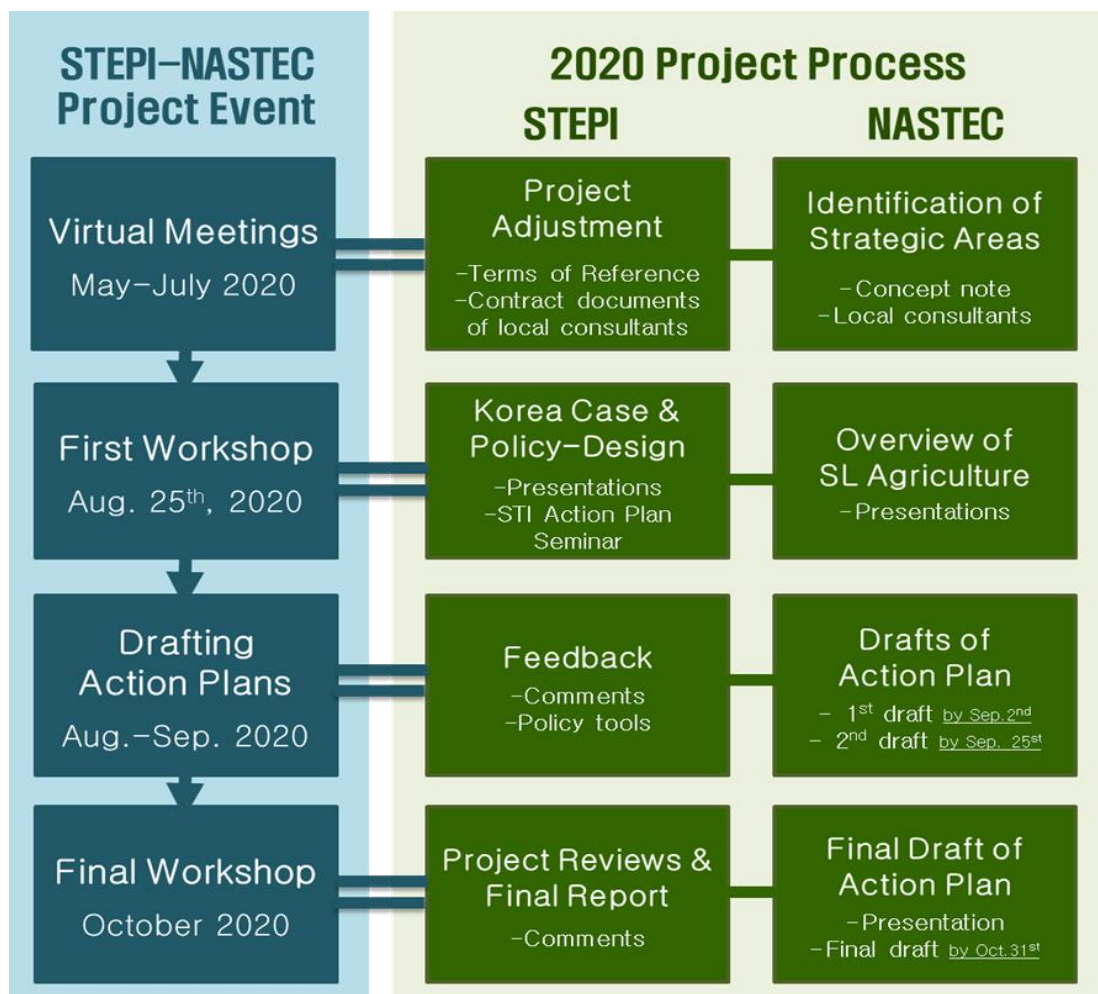
More precisely, this project aims to:

- 1) Share policy cases of Korea and Sri Lanka to foster agricultural technology and its application to the sustainable growth of the national economy and quality of life of general public**
- 2) Provide policy tools and exercises to STI policy stakeholders**
- 3) Draft STI action plans to improve productivity, facilitate the value-added process, and promote entrepreneurship in agriculture throughout interactions among experts in both countries**

3. Project Framework

The 2020 project aims to provide policy consultation on the development of STI action plans in the three sub-fields of agriculture of the Sri Lankan government. STEPI provides NASTEC and other key stakeholders with expertise in the areas of STI policy and agricultural policy, who would be working jointly with a team of local experts from government ministries and agencies, and universities in order to formulate STI action plans in the agricultural sector.

[Figure 1-2] 2020 STEPI-NASTEC Project Framework



The 2020 The project has four components.

- 1) Virtual meetings: Despite the impacts of the global pandemic on the course of the project collaboration, both STEPI and NASTEC will carry the project out by conducting virtual meetings and email communications to discuss all issues about the project, from re-scoping the project to presenting final drafts of action plans, throughout the year of 2020.
- 2) First workshop: The goals of the first workshop are to build a common ground of understandings of (a) the agriculture sector and related policies and technological

developments in both countries, and (b) a major framework and critical components of action planning. Experts from both parties will make presentations on selected themes during the workshop. The content of the former (a) presentations will be further elaborated in drafts of action plans and the project report by NASTEC; that of the latter (b) in the project report by STEPI.

- 3) Drafts of STI action plans: Throughout intensive online communications between two parties, activities of drafting STI action plans will be conducted. They are composed of two parts: research and drafts.
 - Research is literature reviews with basic statistical information about the developments of policy, technology, and industry of the selected three themes—production technology, process technology, and entrepreneurship in agriculture—and will be discussed during the first virtual workshop. Outputs of research will be included in drafts of action plans and the project report.
 - NASTEC and consultants in Sri Lanka will make drafts of STI action plans throughout interactions with STEPI and experts in Korea. Each version of drafts of the STI action plans in three themes will be shared among experts in both countries by designated dates.
- 4) Final workshop: NASTEC and local consultants will present their final drafts of action plans in the three areas of agriculture. STEPI will provide feedback on the drafts, and discuss the implementation process of action plans with local experts.

4. Project Team

4.1 Korea's Research Team

The research team from Korea is composed of four STEPI experts and five external experts. From the STEPI, Dr. Inkyoung Sun leads the 2020 STEPI-NASTEC project as a principal investigator, Mr. Younghin Kim manages the overall project as well as conducts researches on major policies in Sri Lanka, Dr. Byeongwon Park provides his expertise in STI action planning, and Mr. Yeolrae Cho presents the lessons learned from the Korean cases of STI policy making. As the project this year looks into the intersection of STI and Agriculture, the external experts from the agricultural sector in Korea play critical roles in providing policy consultation for STI action planning to foster the improvement of the Sri Lankan agricultural sector as well. Dr. Saejung Suh, who was in charge of international technical cooperation and crop scientific research at the Rural Development Administration, supervises a team of local consultants and government officials to develop the STI action plan in crop productivity. Dr. Taeyoung Kim, who was a specialist in food processing in the Rural Development Administration, supervises a team of experts in Sri Lanka to develop the STI action plan in crop processing, and Prof. Daeseob Lee provides advices in designing the STI action plan in the agricultural entrepreneurship in agriculture. Dr. Jeehyung Kim is responsible for the statistical analysis on the agriculture in Sri Lanka while Dr. Byoungchoon Jang delivers his field expertise from the Korea Program for International Cooperation in Agricultural Technology (KOPIA) in Candy, Sri Lanka for several years.

[Table 1-1] Korea's Research Team

Name	Institution	Position
Dr. Inkyoung Sun	Science & Technology Policy Institute (STEPI)	Head, Office of Development Cooperation Research
Mr. Youngjin Kim	Science & Technology Policy Institute (STEPI)	Researcher

Name	Institution	Position
Dr. Byeongwon Park	Science & Technology Policy Institute (STEPI)	Research Fellow, Office of Multilateral Cooperation Research
Mr. Yulrae Cho	Science & Technology Policy Institute (STEPI)	Adjunct Research Fellow (former) Vice Minister, Ministry of Education, Science and Technology
Dr. Saejung Suh	Chungcheongnam-do Agricultural Research and Extension Services	Professional Officer (former) Director, Rural Development Administration
Dr. Taeyoung Kim	Hansan F&G Co. Ltd.	Head of Food Resesarch Institute (former) Head, Rural Development Administration
Prof. Daeseob Lee	Kangwon National University	Associate Professor
Dr. Jeehyun Kim	B. T. Insight	CEO
Dr. Byoungchoon Jang	Rural Development Administration	(former) Head, Korea Program for International Cooperation in Agricultural Technology (KOPIA)

4.2 Sri Lanka's Research Team

As the counterpart of STEPI and the main entity in Sri Lanka, NASTEC is responsible for organizing the local research team and experts and managing the progress of their tasks for the project. As for this year, NASTEC is the contact point of this multi-ministerial project on STI action planning in Agriculture by coordinating rigorous interactions among key stakeholders in the Ministry of Science, Technology, and Research (MoSTR), Ministry of Agriculture, Department of National Planning (NPD), and Department of External Resources (ERD).

[Table 1-2] Sri Lanka's Research Team

Name	Institution	Position
Prof. Kshanika Hirimburegama	National Science & Technology Commission (NASTEC)	Chairperson
Ms. Ahamed Naseema	National Science & Technology Commission (NASTEC)	Director
Dr. Kalpa W. Samarakoon	National Science & Technology Commission (NASTEC)	Senior Scientist
Mr. Seyed Shahmy	National Science & Technology Commission (NASTEC)	Senior Scientist
Ms. Rasitha Perera	National Science & Technology Commission (NASTEC)	Scientist
Ms. Munagamage Dona Thilini	National Science & Technology Commission (NASTEC)	Scientist
Mr. Ilmi Ganga Namali Hewajulige	Industrial Technology Institute	Senior Deputy Director
Mr. Keerthi B Kotagama	Maturata Plantations Ltd.	Executive Chairman
Prof. Buddhi Marambe	University of Peradeniya	Professor

4.3 Roles of STEPI and NASTEC in Managing Experts and Tasks

Local consultants will be recruited by NASTEC, and they will a) give presentations on the overviews of the three selected areas of agriculture in Sri Lanka during the first workshop and b) develop and submit the first, second, and final drafts of STI action plans in the three areas to STEPI by the designated dates.

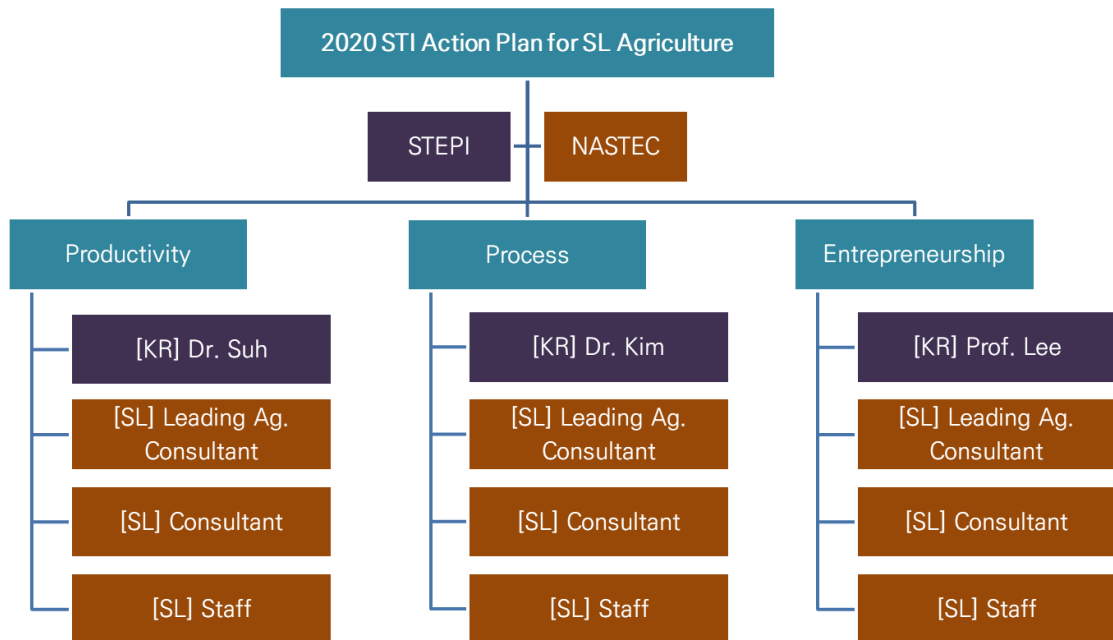
Korean consultants will be recruited by STEPI, and they will a) give presentations on the development of agriculture, technology, and policy in Korea as well as the STI policy framework and tools in Korea during the first workshop and b) review drafts of action

plans submitted by experts in Sri Lanka and provide feedback on them by the designated dates.

Both STEPI and NASTEC are expected to have regular virtual meetings to check the progress of action planning. One may call for a meeting to discuss emerging or urgent issues about the project, and the other shall respond to the call by participating in virtual discussions throughout the project.

Drafts of STI action plans will be developed and submitted under the responsibility of NASTEC, with the project report to be written by STEPI.

[Figure 1-3] Organizational Chart of STEPI-NASTEC Project Research Team in 2020



5. Project Schedule

Each stage of the project will proceed as below.

Tasks	2020											
	1	2	3	4	5	6	7	8	9	10	11	12
Prior consultation												
Virtual Meetings												
- Terms of reference												
- Contracts of local consultants												
Frist workshop												
- Presentation on sub-sectoral overview												
- STI action planning												
Drafting action plans												
- 1 st drafts of action plans												
- Feedback to the 1 st drafts												
- 2 nd drafts of action plans												
- Feedback to the 2 nd drafts												
Final Workshop												
- Presentation and comments												
- Final drafts of action plans												
Project report												

13. Important dates

- August 25, 2020: First workshop (by videoconference)
- September 2, 2020: Submissions of 1st drafts of action plans
- September 25, 2020: Submissions of 2nd drafts of action plans
- October 2020 (TBD): Final workshop
- October 31, 2020: Submissions of final drafts of action plans

6. Project Outputs

STEPI provides the following deliverables:

- **Deliverable 1:** Presentations on overviews of selected three themes—productivity, process, entrepreneurship—in agriculture in Sri Lanka
- **Deliverable 2:** Presentations on the development of agriculture, technology, and policy in Korea
- **Deliverable 3:** Framework and tools of STI policy in Korea
- **Deliverable 4:** Drafts of STI action plans (first, second, and final drafts of three themes of agriculture)
- **Deliverable 5:** Project reports both in Korean and English



CHAPTER 2

Current Status and Major Policies of Agriculture in Sri Lanka

2020 STEPI-NASTEC STI Policy Consultation Project on
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Framework for Sri Lanka”

Chapter 2. Current Status of Agriculture in Sri Lanka

1. Agricultural status in Sri Lanka

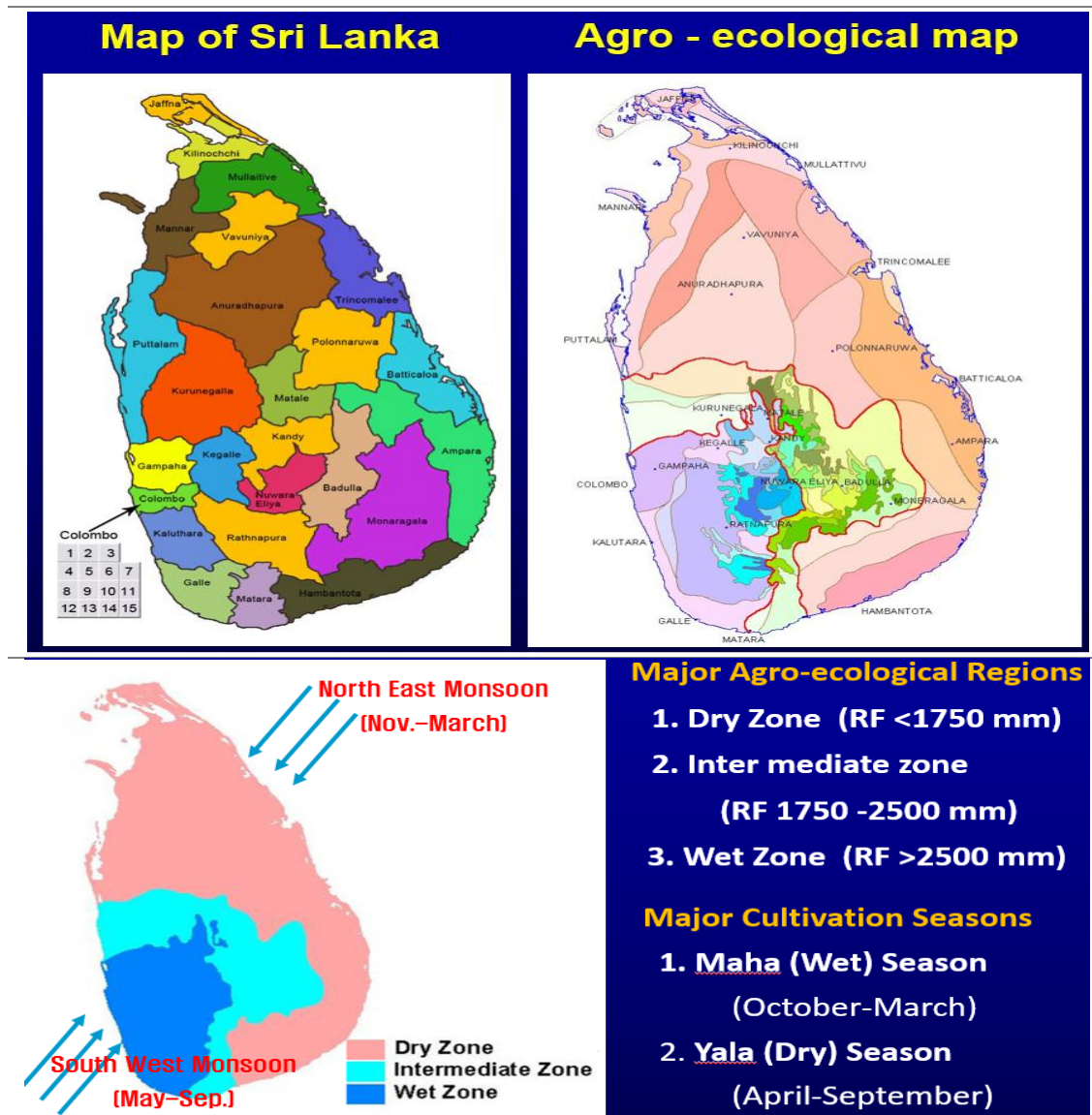
1.1 Overview of agriculture in Sri Lanka

Sri Lanka Overview	
Location	Western Asia (Indian Ocean island country in southern India) 5-10 north latitude
Area	65,610 km ² (1/3 of the Korean Peninsula)
Capital	Colombo
Population	21.67 million ('18)
Ethnicity	Sinhalese 75%, Tamil 15%, Moorish 9%
Language	English (official), Sinhala 74%, Tamil 18%
Religion	Buddhism 69%, Hinduism 11, Islam 7.6, Christianity 7.5
Government	President-centered system (with a parliamentary cabinet system)
GDP per capita	US\$ 4,102 ('18), 3,852 ('19)
Industrial structure	agriculture and fisheries 7.9%, services 56.6%, manufacturing 26.2 ('15)
Exports	Clothing, tea, spices, rubber, jewelry, fruits, nuts
Agricultural structure	Pre-modern structure (18% of the supply rate of excellent rice seeds) <ul style="list-style-type: none">• Disadvantages: Insufficient farmland arrangement and technology distribution system• Advantages: diversity of resources, high education level, willingness to develop agriculture
Self-sufficiency	99% rice, 97 corn, 89 beans, 60 peppers, 40 onions
Rice production	4.3 million tons (2010) 8.2 million tons (2020)

Sri Lanka Overview	
Agricultural exports	tea, spices, rubber, fruits, nuts
Cultivated land:	9% of the nationwide land, 32% forest land, 7% grassland
Agricultural policy	food security → sustainable agriculture → eco-friendly agriculture → farm household income

Source: Byoungchun Jang (2020)

[Figure 2-1] Agro-Ecology in Sri Lanka



Source: Jang Byoungchun (2020)

[Figure 2-2] SWOT analysis of Agricultural sector in Sri Lanka

Strengths	Weaknesses
<ul style="list-style-type: none"> • Low illiteracy rate in rural areas due to high education fever • High adaptability to new agricultural technologies • Food and crop consumption increase due to Tourism • Excellent agricultural talent (7 agricultural colleges, 10 agricultural high schools) • A number of excellent researchers in government research institutes • High-ranking government workers' aspiration for Korean agricultural technology 	<ul style="list-style-type: none"> • Reduction of crop cultivation area due to urban industrialization • Delay of new technology introduction due to poverty of farmers • Reduction of agricultural competitiveness due to uncertain government policy • Lack of water and land used in agriculture • Lack of storage management facilities after harvest • Lack of awareness of resource recycling technology
Opportunities	Threats
<ul style="list-style-type: none"> • Increase in food consumption diversity due to changes in eating habits • Consumer's interest in food safety and quality • High possibility of product value improvement in food processing • Recognition of importance in the fields of agriculture and food business • High growth potential of horticultural crops • Agricultural GDP ratio 7.9% Agricultural population 33% 	<ul style="list-style-type: none"> • -Reduction in overseas agricultural exports • -Reduction in research investment in agricultural products • -Weakened competitiveness due to cheap imported agricultural products • -Import of chemical fertilizers and pesticides • -Environmental pollution due to misuse of livestock meal and pesticides • -77% of agricultural product exporters experienced procedural problems

Source: Jang Byoungchun (2020)

1.1.1 Overview of agricultural history in Sri Lanka

Agriculture in Sri Lanka has thrived since the days of the ancient kingdom, and crops such as coffee, rubber, coconuts, and tea have been cultivated for commercial trade since the colonial era. After gaining its independence at the end of the 1940s, the country began expanding its domestic supply of paddy rice. Today, it is exerting efforts to expand the domestic supply of crops and to increase the production volume of crops for export.

Tea is a major exported product of Sri Lanka, which is among the world's top four tea producers along with China, India, and Kenya. It is also the largest producer and exporter of Ceylon tea. It became self-sufficient in rice production in 2011 and began exporting rice to other countries. However, rice productivity and prices have been fluctuating due to climate change and various circumstances.

1.1.2 Definition of agriculture and scope of research

The Sri Lankan government's definition of agriculture includes not only crop/agriculture production but also livestock and poultry, fisheries and aquatic resources, and forestry. However, detailed sectors such as agriculture and fisheries and agriculture, forestry, and livestock are specified depending on the data. This applies to the statistical data of various countries including Korea and international organizations like the Food and Agriculture Organization of the United Nations (FAO). The classification of agriculture may include livestock and poultry in some materials, or even fisheries or forestry in others. Sri Lanka's Ministry of Agriculture has also classified horticulture as a separate sector, following the rapid growth of the industry.

[Table 2-1] Scope of agriculture in Sri Lanka

Categories	Sub-categories
Crop (Agriculture)	Plantation
	Non-plantation
Livestock and Poultry	
Fisheries and Aquatic Resources	Marine
	Fresh Water
Forestry	
Floriculture	

Source: Ministry of Agriculture(2018)

The present survey focuses on agriculture as crop production and excludes broader categories of livestock and poultry, fisheries and aquatic resources, and forestry.

1.2 Agriculture production status

1.2.1 Agriculture GDP

[Table 2-2] GDP by industrial sector in Sri Lanka (based on present prices)

						Rs. Million	
Economic Activity	2014 Annual	2015 Annual	2016 Annual	2017 Annual (b)	2018 Annual (b) (c)	2019 Annual (c)	CAGR
Agriculture, Forestry and Fishing	829,577	896,229	890,925	1,043,994	1,138,472	1,113,834	6.1%
	8.0%	8.2%	7.4%	7.8%	7.9%	7.4%	
Industries	2,931,998	2,975,232	3,337,428	3,568,560	3,819,811	4,114,102	7.0%
	28.3%	27.2%	27.8%	26.8%	26.6%	27.4%	
Services	5,895,618	6,283,379	6,771,236	7,477,148	8,207,045	8,744,656	8.2%
	56.9%	57.4%	56.4%	56.1%	57.1%	58.2%	
Equals Gross Value Added (GVA) at Basic Price	9,657,194	10,154,839	10,999,589	12,089,702	13,165,327	13,972,591	7.7%
	93.2%	92.7%	91.7%	90.7%	91.6%	93.1%	
Taxes less subsidies on products	703,957	795,782	996,495	1,238,401	1,200,776	1,043,551	8.2%
	6.8%	7.3%	8.3%	9.3%	8.4%	6.9%	
Equals Gross Domestic Product (GDP) at Market Price	10,361,151	10,950,621	11,996,083	13,328,103	14,366,103	15,016,142	7.7%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	

(a) The estimates are based on the base year 2010 GDP estimates

(b) Revised

(c) Provisional

Source: Central Bank of Sri Lanka (2020e)

Based on current prices, the GDP of Sri Lanka's agriculture, forestry, and fisheries and aquatic resources industry saw a 6.1% increase in Compound Annual Growth Rate (CAGR) from 829.6 billion rupees in 2014 to 1.1138 trillion rupees in 2019. The share of total GDP decreased slightly from 8.0% in 2014 to 7.4% in 2019.

[Table 2-3] GDP by industrial sector in Sri Lanka (based on constant prices in 2010)

						Rs. Million	
Economic Activity	2014 Annual	2015 Annual	2016 Annual	2017 Annual (b)	2018 Annual (b) (c)	2019 Annual (c)	CAGR
Agriculture, Forestry and Fishing	639,696	669,725	644,655	642,159	683,816	687,857	1.5%
	7.8%	7.7%	7.1%	6.9%	7.1%	7.0%	
Industries	2,218,711	2,267,725	2,396,833	2,509,421	2,540,315	2,608,211	3.3%
	28.3%	27.2%	26.9%	26.2%	26.5%	26.8%	
Services	4,618,501	4,894,717	5,127,616	5,313,435	5,555,303	5,680,757	4.2%
	56.1%	56.6%	56.7%	56.8%	57.5%	57.4%	
Equals Gross Value Added (GVA) at Basic Price	7,476,908	7,832,167	8,169,103	8,465,015	8,779,434	8,976,825	3.7%
	90.8%	90.6%	90.4%	90.4%	90.8%	90.8%	
Taxes less subsidies on products	758,521	815,667	866,727	894,132	889,166	912,553	3.8%
	9.2%	9.4%	9.6%	9.6%	9.2%	9.2%	
Equals Gross Domestic Product (GDP) at Market Price	8,235,429	8,647,833	9,035,830	9,359,147	9,668,600	9,889,379	3.7%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	

(a) The estimates are based on the base year 2010 GDP estimates

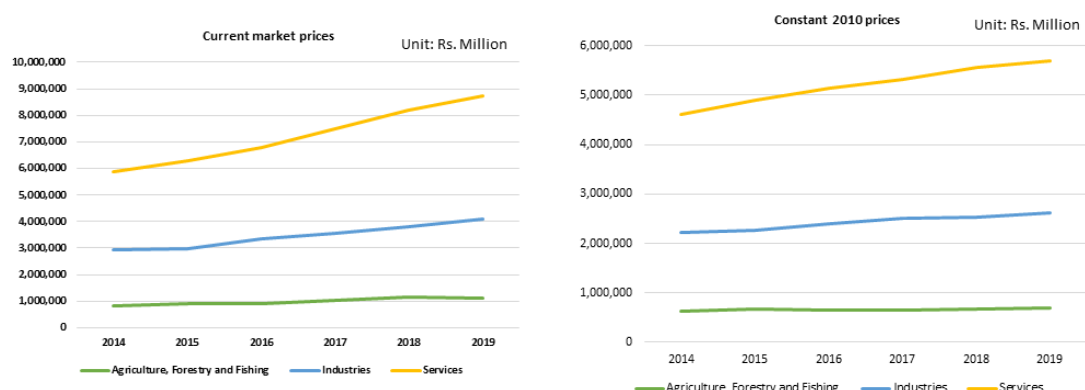
(b) Revised

(c) Provisional

Source: Central Bank of Sri Lanka(2020e)

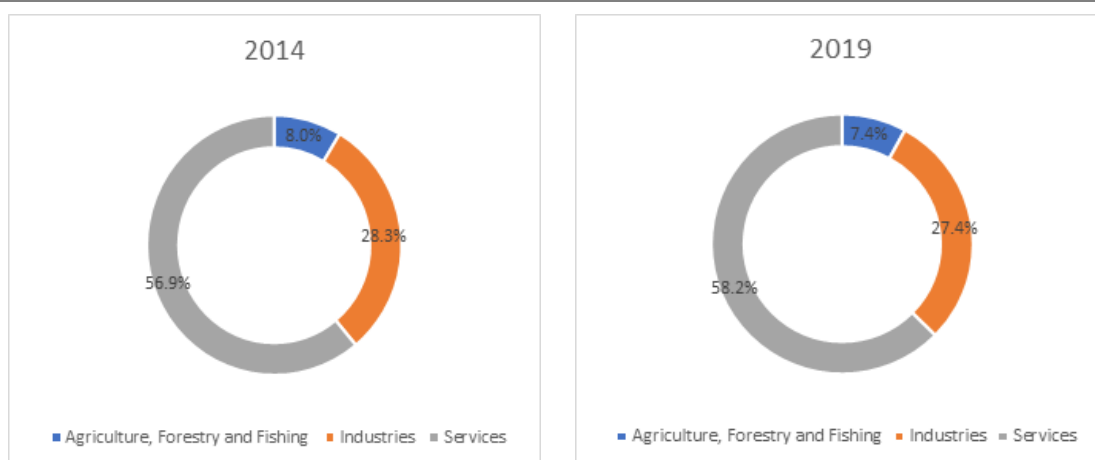
Based on constant prices in 2010, the GDP of Sri Lanka's agriculture, forestry, and fisheries and aquatic resources industry saw an annual average growth of 1.5%, increasing from 63.9 billion rupees in 2014 to 68.7 billion rupees in 2019. The share of total GDP decreased slightly from 7.8% in 2014 to 7.0% in 2019.

[Figure 2-3] Trends in GDP by industrial sector in Sri Lanka
Based on present prices Based on constant prices (2010)



Source: Central Bank of Sri Lanka (2020c)

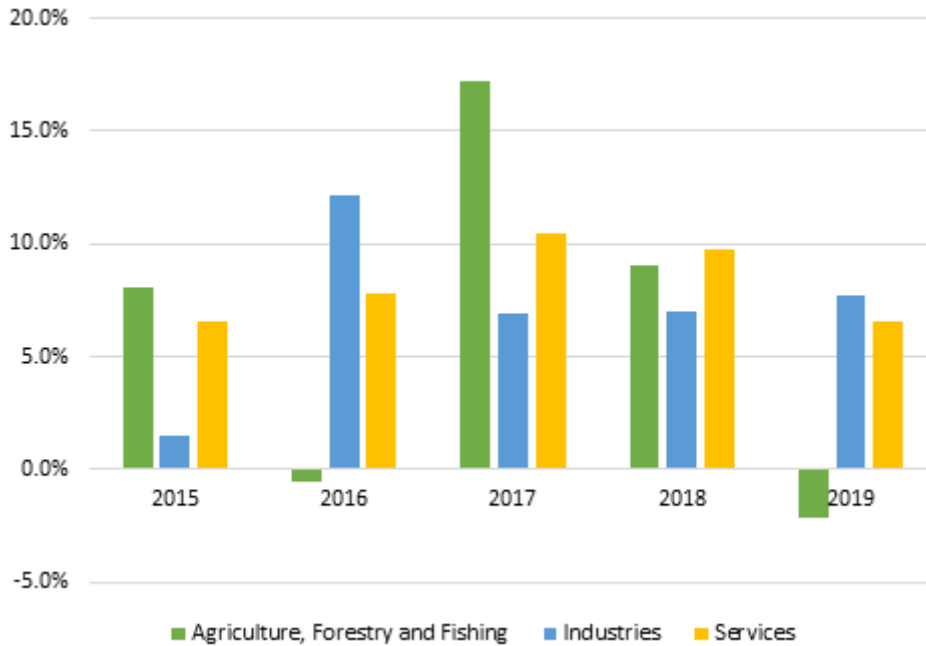
[Figure 2-4] Change in share of GDP (based on present price) by industrial sector in Sri Lanka



Source: Central Bank of Sri Lanka (2020d)

Based on current prices, Sri Lanka's agriculture, forestry, and fisheries and aquatic resources industry saw a dramatic change in the annual growth rate of GDP, recording 8.0% in 2015, 17.2% in 2017, and -2.2% in 2019. This can be traced to the significant change in production volume due to climate change and fluctuating prices caused by changes in the market environment.

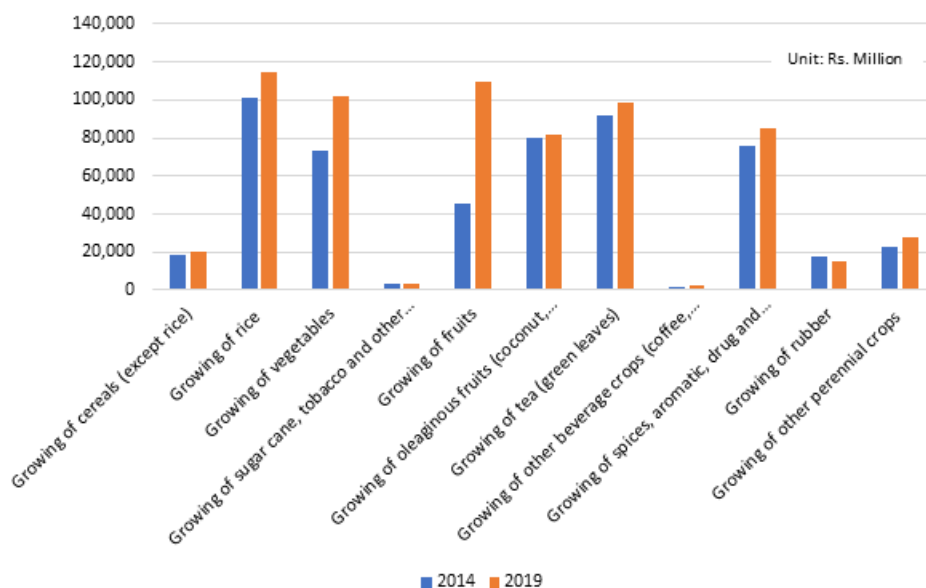
[Figure 2-5] Trends in annual growth rate of GDP (based on present prices) by industrial sector in Sri Lanka



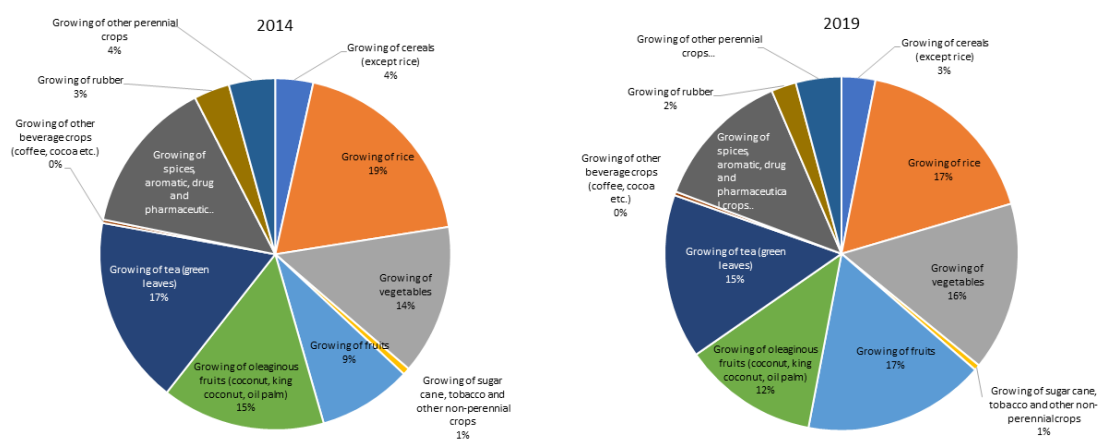
Source: Central Bank of Sri Lanka (2020d)

Looking at the GDP by sector of crop production (excluding livestock and poultry, forestry, fisheries, and aquatic resources) in Sri Lanka based on the current prices, vegetable cultivation increased from 73 billion rupees (13.8% of total crop production) in 2014 to 101.5 billion rupees (15.4% of total crop production) in 2019, and fruit cultivation, from 45.7 billion rupees (8.6% of total crop production) to 109.5 rupees (16.6% of total crop production). Paddy rice cultivation increased from 100.9 billion rupees in 2014 to 114.4 billion rupees in 2019, and oily fruits (coconuts, etc.), from 79.8 billion rupees to 81.5 billion rupees. However, the share of paddy rice and oily fruits out of the total crop production dropped from 19.0% to 17.4%, and from 15.0% to 12.4%, respectively, in the same period.

[Figure 2-6] GDP change and share of total crop production by crop production sector in Sri Lanka (based on present prices)



Source: Central Bank of Sri Lanka (2020d)

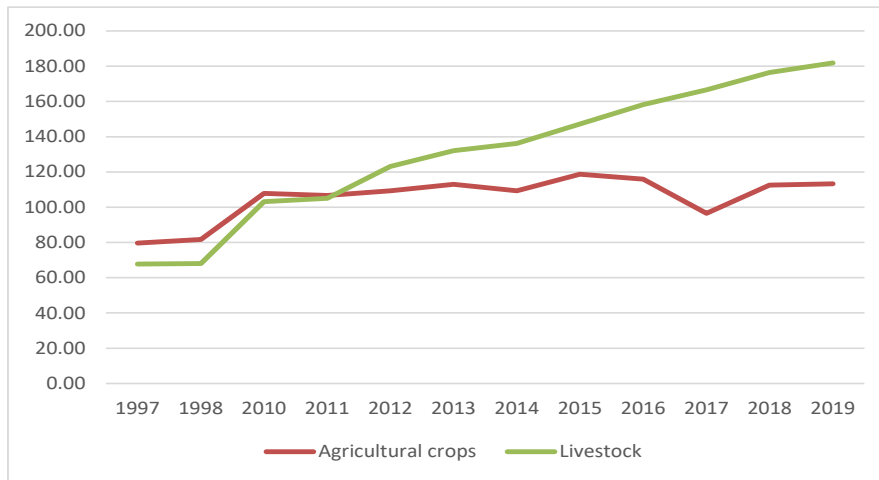


Source: Central Bank of Sri Lanka (2020d)

1.2.2 Agriculture production index

Looking at Sri Lanka's agriculture production index (2007-2010=100), crop production began at 78.36 in 1997, recorded an all-time high of 121.88 in 2015, and fell to 121.0 in 2019. On the other hand, livestock and poultry began at 67.81 in 1997 and showed a consistent increase, recording 181.9 in 2019.

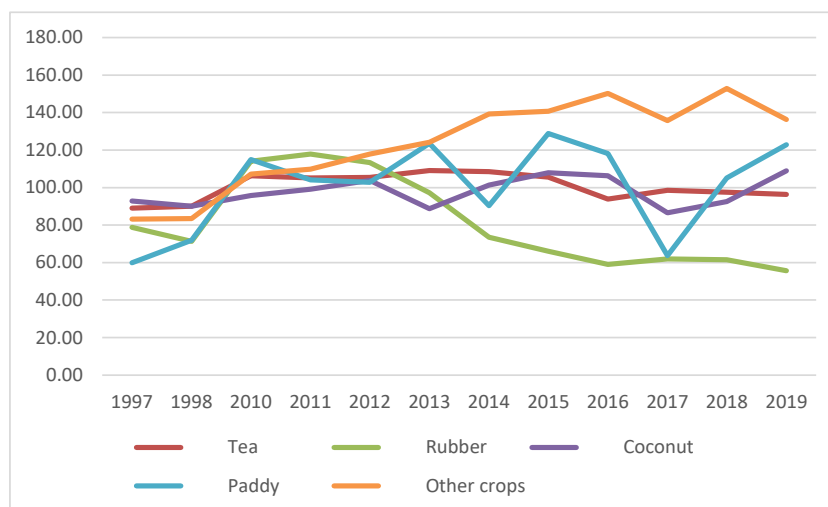
[Figure 2-7] Agriculture production index in Sri Lanka (base period: 2007-2010 = 100)



Source: Central Bank of Sri Lanka (2020a)

As for the agriculture production index (API) of major agricultural products, tea and coconuts maintained an API of around 100 after 2010, with paddy rice staying in the range of 60 ~ 130. Natural rubber peaked at 103.77 in 2012 and fell to 55.7 in 2019. Other crops, including vegetables and fruits, have risen continuously since 1997, reaching 136.3 in 2019.

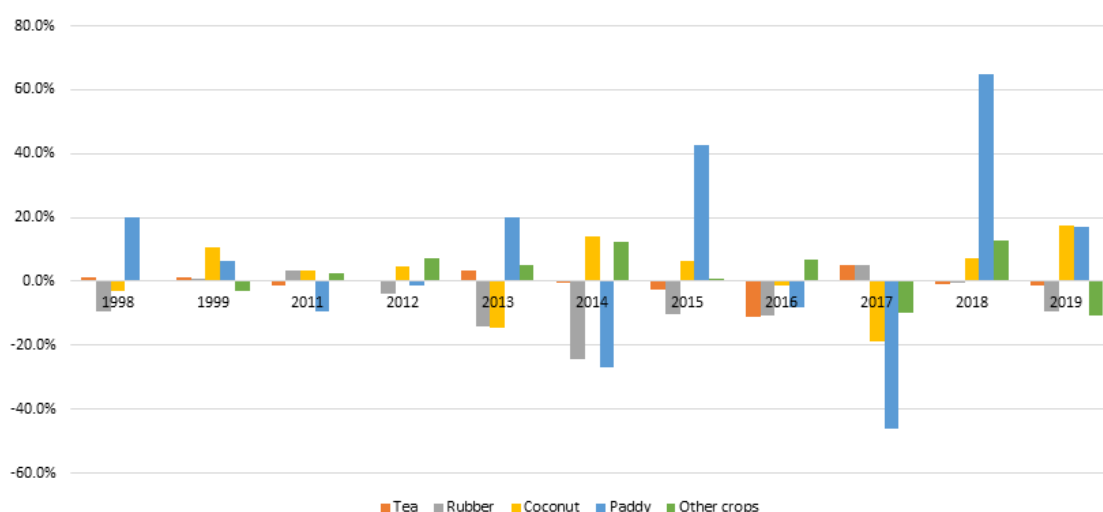
[Figure 2-8] Agriculture production index of major agricultural products (base period: 2007-2010 = 100)



Source: Central Bank of Sri Lanka (2020a)

The API of paddy rice showed a dramatic change in annual growth rate, recording -46.1% in 2017/2018 and 65.0% in 2018/2019, Natural rubber, on the other hand, saw a minus growth rate throughout.

[Figure 2-9] Annual growth rate of agriculture production index of major agricultural products



Source: Central Bank of Sri Lanka (2020a)

1.2.3 Status of production of major agricultural products

1) Major agricultural products

a) Top products by production quantity

The top products based on production volume in 2018 were paddy rice, coconuts, bananas, sugarcane, and mango in that order. Compared to the top products in 2006 and 2011, tea fell from 5th place to 7th in 2016, whereas mango moved up in ranking.

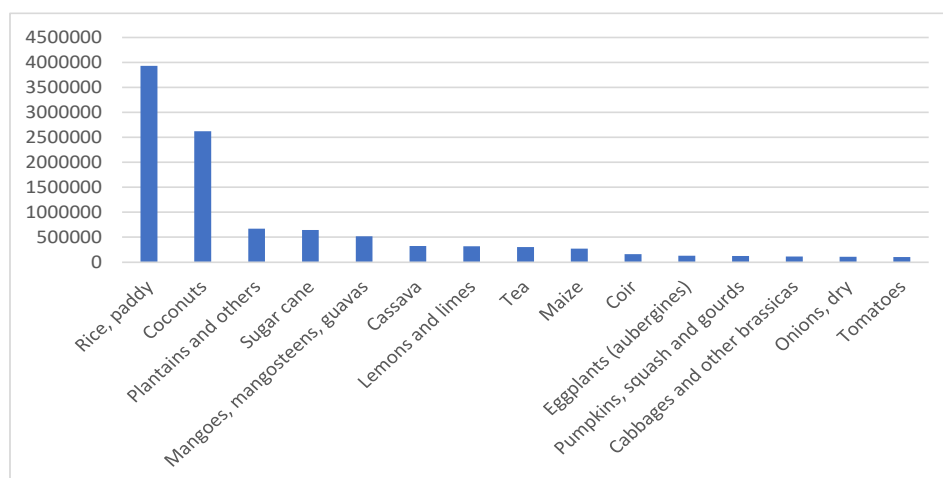
[Table 2-4] Top products based on production quantity in 2006, 2011, 2016

Unit: tonnes

	2006		2011		2016	
	Item	Value	Item	Value	Item	Value
1	Rice, paddy	3,342,000	Rice, paddy	3,894,890	Rice, paddy	4,420,085
2	Coconuts	2,115,840	Coconuts	2,057,320	Coconuts	3,011,000
3	Sugar cane	1,136,600	Sugar cane	729,010	Sugar cane	815,312
4	Plantains and others	504,480	Plantains and others	605,440	Plantains and others	648,160
5	Tea	310,800	Tea	327,500	Mangoes, mangosteens, guavas	444,023
6	Cassava	226,080	Cassava	292,740	Cassava	324,080
7	Coir	148,100	Rubber, natural	158,198	Tea	292,574
8	Onions, dry	134,370	Coir	148,000	Lemons and limes	259,230
9	Rubber, natural	109,140	Maize	137,797	Maize	243,960
10	Eggplants (aubergines)	88,370	Pumpkins, squash and gourds	127,890	Coir	159,525
11	Mangoes, mangosteens, guavas	85,360	Onions, dry	118,030	Onions, dry	128,898
12	Potatoes	78,490	Eggplants (aubergines)	116,670	Eggplants (aubergines)	127,194
13	Pumpkins, squash and gourds	78,170	Mangoes, mangosteens, guavas	87,730	Cabbages and other brassicas	123,365
14	Chillies and peppers, green	66,550	Tomatoes	75,890	Pumpkins, squash and gourds	98,303
15	Fruit, fresh nes	61,672	Cabbages and other brassicas	70,610	Tomatoes	92,748

Source: FAO (2019b)

[Figure 2-10] Top products based on production quantity in 2018



Source: FAO (2019b)

b) Top products by cultivation area

The top products based on cultivation area in 2018 were paddy rice, coconuts, tea, natural rubber, and corn in that order. This list remained largely the same over the years.

[Table 2-5] Top products based on cultivation area in 2006, 2011, 2016

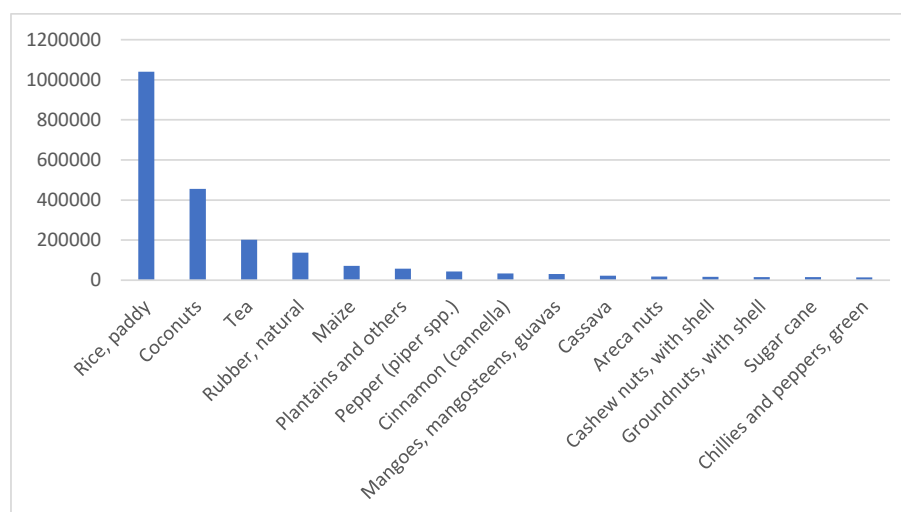
Unit: ha

	2006		2011		2016	
	Item	Value	Item	Value	Item	Value
1	Rice, paddy	910,493	Rice, paddy	1,091,050	Rice, paddy	1,141,323
2	Coconuts	394,840	Coconuts	394,840	Coconuts	440,457
3	Tea	212,720	Tea	221,969	Tea	216,515
4	Rubber, natural	116,480	Rubber, natural	127,000	Rubber, natural	120,867
5	Plantains and others	48,860	Plantains and others	53,630	Maize	67,630
6	Maize	32,000	Maize	50,545	Plantains and others	56,317
7	Pepper (piper spp.)	30,490	Pepper (piper spp.)	36,430	Pepper (piper spp.)	39,515
8	Cinnamon (cannella)	25,620	Cinnamon (cannella)	29,160	Mangoes, mangosteens, guavas	33,169

	2006		2011		2016	
	Item	Value	Item	Value	Item	Value
9	Mangoes, mangosteens, guavas	25,320	Mangoes, mangosteens, guavas	27,680	Cinnamon (cannella)	30,130
10	Cassava	23,560	Cassava	24,200	Sugar cane	23,557
11	Cashew nuts, with shell	19,950	Cashew nuts, with shell	23,090	Cassava	22,754
12	Sugar cane	18,780	Areca nuts	15,640	Groundnuts, with shell	19,975
13	Chillies and peppers, green	17,900	Sesame seed	14,360	Areca nuts	18,794
14	Onions, dry	13,040	Chillies and peppers, green	13,310	Cashew nuts, with shell	18,683
15	Areca nuts	11,970	Sugar cane	12,190	Chillies and peppers, green	15,267

Source: FAO (2019b)

[Figure 2-11] Top products based on cultivation area in 2018



Source: FAO (2019b)

c) Top products by yield

The top products based on yield in 2018 were in the order of sugarcane, lemon, cabbage, Allium vegetables, and carrot. Compared to the top products in 2006 and 2011, potato fell

in ranking, while lemon and carrot moved up.

[Table 2-6] Top products based on yield in 2006, 2011, 2016

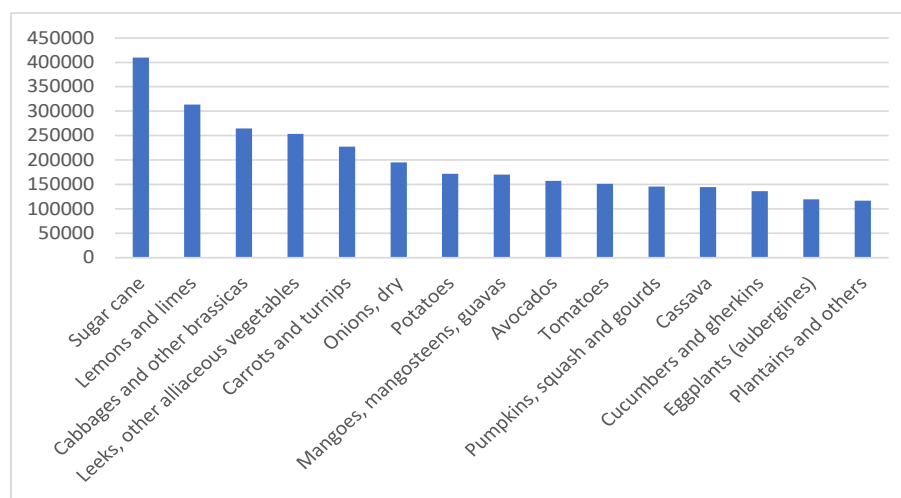
Unit: hg/ha

	2006		2011		2016	
	Item	Value	Item	Value	Item	Value
1	Sugar cane	605,218	Sugar cane	598,039	Sugar cane	346,102
2	Potatoes	148,094	Cabbages and other brassicas	202,321	Leeks, other alliacious vegetables	278,207
3	Cabbages and other brassicas	145,564	Leeks, other alliacious vegetables	161,071	Cabbages and other brassicas	277,724
4	Leeks, other alliacious vegetables	145,029	Potatoes	132,500	Lemons and limes	236,373
5	Avocados	127,028	Avocados	132,197	Carrots and turnips	215,377
6	Carrots and turnips	122,466	Onions, dry	123,076	Potatoes	158,009
7	Pineapples	115,262	Pumpkins, squash and gourds	122,853	Tomatoes	149,089
8	Plantains and others	103,250	Cassava	120,967	Onions, dry	143,571
9	Onions, dry	103,044	Carrots and turnips	120,446	Cassava	142,428
10	Vegetables, fresh nes	101,695	Plantains and others	112,892	Pumpkins, squash and gourds	140,835
11	Cassava	95,959	Eggplants (aubergines)	103,065	Avocados	134,393
12	Pumpkins, squash and gourds	95,797	Vegetables, fresh nes	100,800	Mangoes, mangosteens, guavas	133,867
13	Tomatoes	91,928	Cucumbers and gherkins	99,938	Cucumbers and gherkins	128,232
14	Eggplants (aubergines)	86,893	Tomatoes	99,593	Eggplants (aubergines)	123,537
15	Cucumbers and	86,596	Pineapples	85,024	Plantains and	115,091

	2006		2011		2016	
	Item	Value	Item	Value	Item	Value
	gherkins				others	

Source: FAO (2019b)

[Figure 2-12] Top products based on yield in 2018



Source: FAO (2019b)

d) Top products by production value

The top products based on production value in 2016 were paddy rice, coconuts, bananas, sugarcane, and mango in that order. Compared to the top products in 2006 and 2011, tea fell from 5th place to 7th in 2016, whereas mango moved up in ranking.

[Table 2-7] Top products based on production value in 2006, 2011, 2016

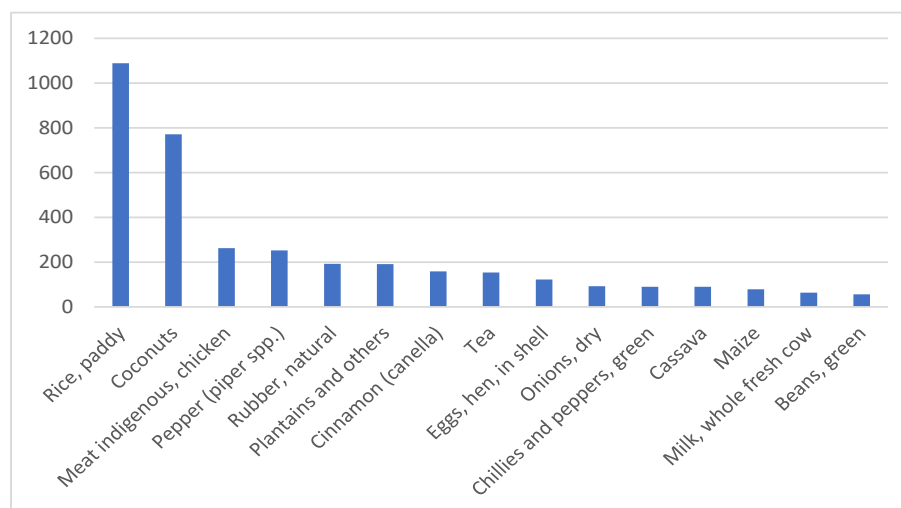
Unit: 1000 Int. \$

	2006		2011		2016	
	Item	Value	Item	Value	Item	Value
1	Rice, paddy	446.7173	Rice, paddy	1030.745	Rice, paddy	1089.141
2	Coconuts	351.2946	Coconuts	573.0397	Coconuts	771.5008
3	Rubber, natural	203.4616	Rubber, natural	324.6335	Meat indigenous, chicken	262.2395
4	Meat indigenous,	121.6509	Meat indigenous,	201.4052	Pepper (piper spp.)	252.4043

	2006		2011		2016	
	Item	Value	Item	Value	Item	Value
	chicken		chicken			
5	Plantains and others	110.6886	Tea	198.598	Rubber, natural	191.7451
6	Tea	87.30501	Plantains and others	185.9056	Plantains and others	191.0272
7	Onions, dry	59.86974	Pepper (piper spp.)	144.8958	Cinnamon (canella)	158.3818
8	Cinnamon (canella)	58.46688	Onions, dry	131.8061	Tea	154.1261
9	Eggs, hen, in shell	53.56542	Eggs, hen, in shell	124.0374	Eggs, hen, in shell	122.2416
10	Potatoes	39.69274	Cinnamon (canella)	121.7602	Onions, dry	92.68413
11	Milk, whole fresh cow	38.88641	Cassava	80.33026	Chillies and peppers, green	90.06732
12	Chillies and peppers, green	37.36273	Milk, whole fresh cow	66.48541	Cassava	90.05198
13	Cassava	33.30899	Chillies and peppers, green	60.72587	Maize	78.71499
14	Pepper (piper spp.)	27.19626	Eggplants (aubergines)	49.02526	Milk, whole fresh cow	63.22032
15	Tobacco, unmanufactured	24.62307	Maize	48.51831	Beans, green	55.88715

Source: FAO (2019b)

[Figure 2-13] Top products based on production value in 2016



Source: FAO (2019b)

2) Production status of major crops

a) Paddy rice

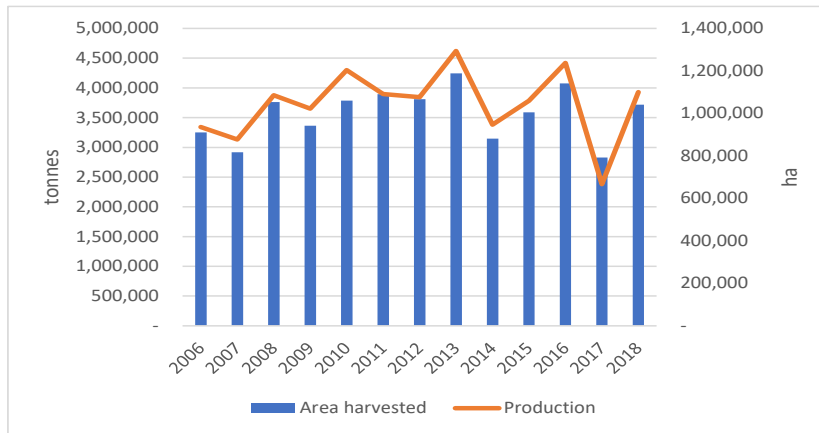
The cultivation area of paddy rice in Sri Lanka increased from 0.91 million hectares in 2006 to 1.04 million hectares in 2018, and production quantity from 3.34 million tons to 3.93 million tons.

[Table 2-8] Cultivation area, production quantity and yield of paddy rice by years

Category	Area harvested	Production	Yield
Unit	ha	tonnes	hg/ha
2006	910,493	3,342,000	36,705
2007	816,713	3,131,000	38,337
2008	1,052,993	3,875,000	36,800
2009	942,410	3,651,670	38,748
2010	1,060,360	4,300,620	40,558
2011	1,091,050	3,894,890	35,699
2012	1,066,620	3,845,941	36,057
2013	1,188,000	4,621,000	38,897
2014	881,000	3,381,000	38,377
2015	1,005,288	3,782,934	37,630
2016	1,141,323	4,420,085	38,728
2017	791,679	2,383,153	30,103
2018	1,040,954	3,929,831	37,752

Source: FAO (2020b)

[Figure 2-14] Cultivation area and production quantity of paddy rice



Source: FAO (2020b)

b) B) Tea

The cultivation area of tea in Sri Lanka decreased slightly from 200,000 hectares in 2006 to 210,000 hectares in 2018, and production volume, from 310,000 tons to 300,000. The production cost of tea per kilogram surged from 314 rupees in 2010 to 475 rupees in 2018, and the average export price per kilogram, from 496 rupees to 821 rupees in the same period.

[Table 2-9] Cultivation area, production quantity and yield of tea by years

Category	Area harvested	Production	Yield
Unit	ha	tonnes	hg/ha
2006	212,720	310,800	14,611
2007	212,720	305,220	14,348
2008	221,969	318,700	14,358
2009	221,969	290,000	13,065
2010	221,969	331,400	14,930
2011	221,969	327,500	14,754
2012	221,969	330,000	14,867
2013	221,969	340,230	15,328
2014	221,969	338,032	15,229

Category	Area harvested	Production	Yield
Unit	ha	tonnes	hg/ha
2015	217,563	320,686	14,740
2016	216,515	292,574	13,513
2017	202,540	307,720	15,193
2018	202,540	303,840	15,001
CAGR	-0.4%	-0.2%	0.2%

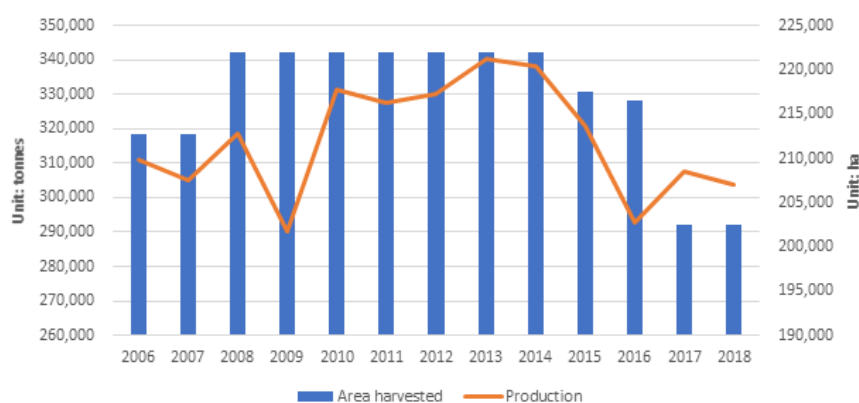
Source: FAO (2020b)

[Table 2-10] Cost of production and average export price of tea by years

Category	Cost of Production	Average Export Price
Unit	Rs./kg	Rs./kg
2010	314.17	496.27
2011	355.02	510.41
2012	390.89	563.94
2013	422.70	623.91
2014	475.11	649.44
2015	458.84	593.08
2016	469.24	639.88
2017	466.98	807.44
2018	475.29	820.75
CAGR	5.3%	6.5%

Source: FAO (2020b)

[Figure 2-15] Cultivation area and production quantity of tea



Source: FAO (2020b)

c) Coconuts

The cultivation area of coconuts in Sri Lanka increased slightly from 390,000 hectares in 2006 to 450,000 hectares in 2018, and production quantity from 2.12 million tons to 2.62 million tons. The production cost of coconuts rose significantly from 11 rupees in 2010 to 19 rupees in 2018, and the average export price from 25 rupees per coconut to 68 rupees in the same period.

[Table 2-11] Cultivation area, production quantity and yield of coconuts by years

Category	Area harvested	Production	Yield
Unit	ha	tonnes	hg/ha
2006	394,840	2,115,840	53,587
2007	394,840	2,180,440	55,223
2008	394,840	2,210,840	55,993
2009	394,840	2,168,280	54,915
2010	394,840	1,990,440	50,411
2011	394,840	2,057,320	52,105
2012	417,000	2,224,500	53,345
2013	394,836	2,513,000	63,647
2014	440,000	2,870,000	65,227
2015	440,662	2,732,921	62,019
2016	440,457	3,011,000	68,361
2017	452,550	2,445,000	54,027
2018	455,330	2,623,000	57,607
CAGR	1.2%	1.8%	0.6%

Source: FAO (2020b)

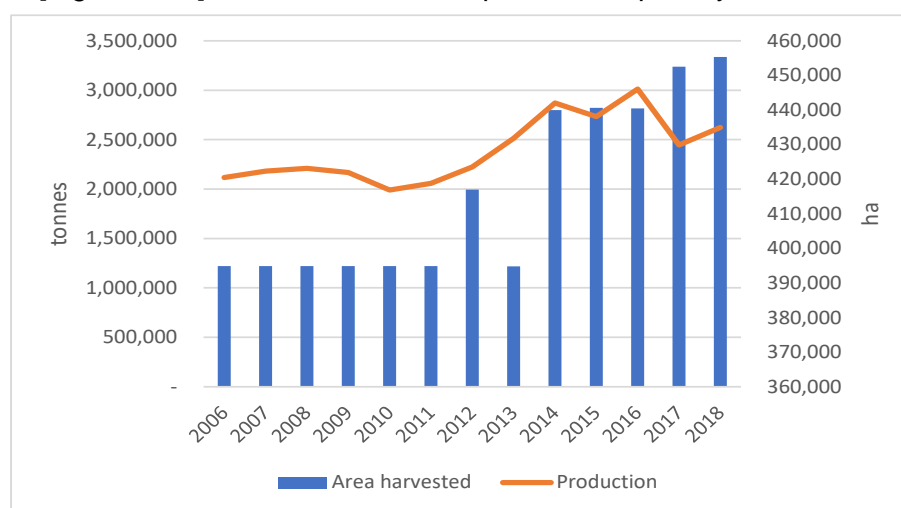
[Table 2-12] Cost of production and average export price of coconuts by years

Category	Cost of Production	Average Export Price
Unit	Rs./nut	Rs./nut
2010	11.27	24.64
2011	10.27	39.15

Category	Cost of Production	Average Export Price
Unit	Rs./nut	Rs./nut
2012	11.63	28.80
2013	13.58	29.36
2014	13.67	39.08
2015	16.39	54.54
2016	16.70	41.16
2017	16.69	62.03
2018	18.84	68.29
CAGR	6.6%	6.5%

Source: FAO (2020b)

[Figure 2-16] Cultivation area and production quantity of coconuts



Source: FAO (2020b)

d) Natural rubber

The cultivation area of natural rubber in Sri Lanka increased from 116,000 hectares in 2006 to 137,000 hectares in 2018, but production quantity decreased from 109,000 tons to 83,000 tons. The production cost of natural rubber rose from 120 rupees in 2010 to 205 rupees in 2018, and the average export price per kilogram dropped slightly from 378 rupees to 364 rupees.

[Table 2-13] Cultivation area, production quantity and yield of natural rubber by years

Category	Area harvested	Production	Yield
Unit	ha	tonnes	hg/ha
2006	116,480	109,140	9,370
2007	116,480	117,550	10,092
2008	116,480	129,240	11,095
2009	124,000	136,000	10,968
2010	124,734	152,990	12,265
2011	127,000	158,198	12,457
2012	128,700	150,600	11,702
2013	136,243	130,421	9,573
2014	173,530	146,406	8,437
2015	122,543	91,823	7,493
2016	120,867	79,100	6,544
2017	136,632	83,070	6,080
2018	136,875	82,560	6,032
CAGR	1.4%	-2.3%	-3.6%

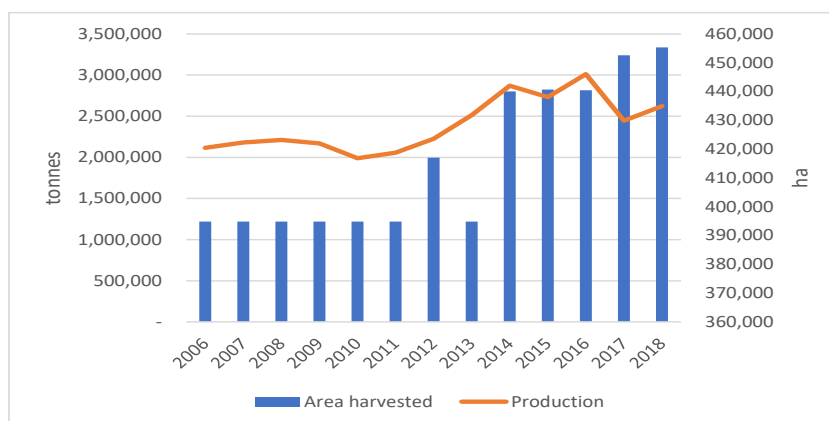
Source: FAO (2020b)

[Table 2-14] Cost of production and average export price of natural rubber by years

Category	Cost of Production	Average Export Price
Unit	Rs./kg	Rs./kg
2010	119.83	377.54
2011	129.56	535.40
2012	136.00	420.74
2013	150.00	389.81
2014	160.00	362.83
2015	170.00	342.03
2016	180.00	294.33
2017	195.00	343.56
2018	205.00	363.93
CAGR	6.9%	-0.5%

Source: FAO (2020b)

[Figure 2-17] Cultivation area and production quantity of natural rubber



Source: FAO (2020b)

1.3 Agricultural trade

1.3.1 Export and import

Sri Lanka's agricultural exports amounted to 1.08 billion dollars in 2006, and grew to 2.96 billion dollars in 2017. In the same period, agricultural imports increased from 1.44 billion dollars to 26.6 billion dollars.

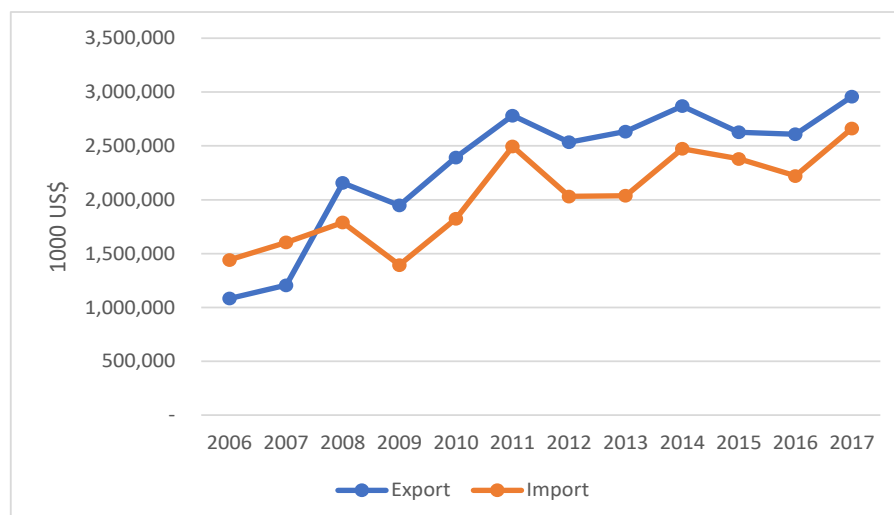
[Table 2-15] Sri Lanka's agricultural export and import by years

Year	Export	Import
2006	1,083,821	1,441,944
2007	1,206,636	1,604,169
2008	2,156,415	1,789,663
2009	1,948,876	1,395,038
2010	2,393,400	1,823,918
2011	2,781,707	2,494,729
2012	2,534,718	2,031,614
2013	2,634,251	2,038,473
2014	2,870,355	2,474,512
2015	2,627,294	2,379,883
2016	2,609,471	2,221,904
2017	2,959,075	2,663,733

CAGR	9.6%	5.7%
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Source: FAO (2018)

[Figure 2-18] Trends in Sri Lanka's agricultural exports and imports



Source: FAO (2018)

The share of agricultural exports out of total exports in Sri Lanka was maintained in the range of 20 to 25%, recording 21.6% in 2007 and 20.6% in 2017.

[Table 2-16] Trends in export amount by industrial sector and agricultural product (unit: 1 million dollars)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Agricultural exports	1,648.2	1,969.3	1,828.5	2,306.4	2,527.8	2,331.5	2,581.1	2,793.9	2,481.5	2,326.1	2,767.2	2,579.3	2,461.9
	21.6%	24.3%	25.8%	26.7%	23.9%	23.9%	24.8%	25.1%	23.5%	22.6%	24.4%	21.7%	20.6%
Industrial exports	5,936.8	6,112.2	5,228.2	6,096.1	7,991.7	7,371.2	7,749.4	8,262.0	8,017.1	7,940.1	8,541.9	9,258.2	9,426.3
Mineral exports	23.8	21.4	19.8	24.2	32.9	61.3	51.6	59.5	28.4	29.0	34.5	34.4	33.9
Unclassified	31.3	7.7	8.0	199.2	6.5	9.6	12.2	14.7	19.5	14.5	16.9	17.8	17.9
Total exports	7,640.0	8,110.6	7,084.5	8,625.8	10,558.8	9,773.5	10,394.3	11,130.1	10,546.5	10,309.7	11,360.4	11,889.6	11,940.0

Source: Central Bank of Sri Lanka (2020d)

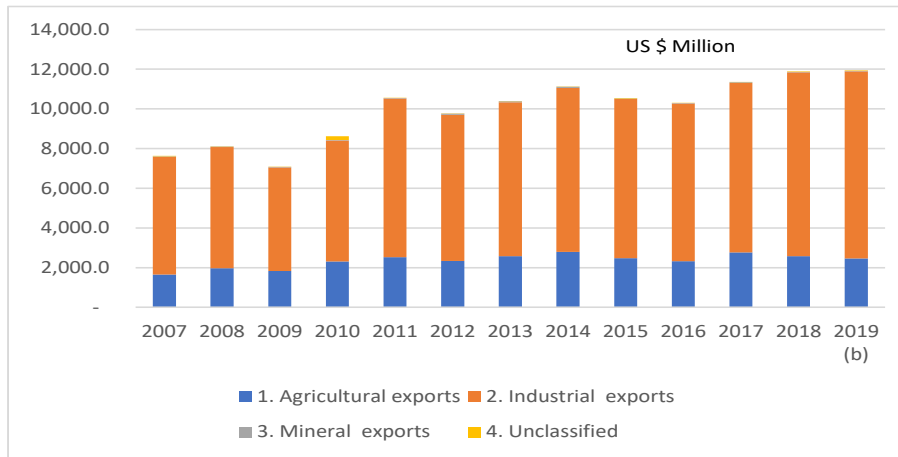
Category	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019 (b)
1. Agricultural exports	1,648.2	1,969.3	1,828.5	2,306.4	2,527.8	2,331.5	2,581.1	2,793.9	2,481.5	2,326.1	2,767.2	2,579.3	2,461.9

2020 K-Innovation ODA Program with Sri Lanka

Category	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019 (b)
	21.6%	24.3%	25.8%	26.7%	23.9%	23.9%	24.8%	25.1%	23.5%	22.6%	24.4%	21.7%	20.6%
Tea	1,025.2	1,271.5	1,185.3	1,440.6	1,490.9	1,411.9	1,542.2	1,628.3	1,340.5	1,269.0	1,529.8	1,428.5	1,346.4
	13.4%	15.7%	16.7%	16.7%	14.1%	14.4%	14.8%	14.6%	12.7%	12.3%	13.5%	12.0%	11.3%
Rubber	109.2	125.0	98.6	173.2	206.4	125.1	71.3	45.3	26.1	32.7	38.9	31.6	24.2
	1.4%	1.5%	1.4%	2.0%	2.0%	1.3%	0.7%	0.4%	0.2%	0.3%	0.3%	0.3%	0.2%
Coconut	128.5	145.1	162.2	165.8	266.0	208.9	204.6	356.4	351.7	366.0	347.9	311.0	329.5
	1.7%	1.8%	2.3%	1.9%	2.5%	2.1%	2.0%	3.2%	3.3%	3.5%	3.1%	2.6%	2.8%
Spices	134.6	161.4	122.6	207.3	235.2	256.1	355.4	264.6	377.4	317.1	406.2	360.2	312.5
	1.8%	2.0%	1.7%	2.4%	2.2%	2.6%	3.4%	2.4%	3.6%	3.1%	3.6%	3.0%	2.6%
Vegetables	11.3	12.8	12.1	23.4	16.9	13.3	24.9	40.1	30.5	26.5	28.5	28.2	32.0
	0.1%	0.2%	0.2%	0.3%	0.2%	0.1%	0.2%	0.4%	0.3%	0.3%	0.3%	0.2%	0.3%
Unmanufactured tobacco	40.2	39.6	33.5	32.2	38.4	42.2	47.6	41.3	31.8	31.2	36.5	35.6	34.7
	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.5%	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%
Minor agricultural products	36.8	49.2	43.5	71.6	88.7	76.0	101.3	165.2	160.4	114.1	138.7	118.4	120.0
	0.5%	0.6%	0.6%	0.8%	0.8%	0.8%	1.0%	1.5%	1.5%	1.1%	1.2%	1.0%	1.0%
Sea Food	162.5	164.7	170.6	192.2	185.3	198.0	233.7	252.7	163.1	169.6	240.6	265.8	262.5
	2.1%	2.0%	2.4%	2.2%	1.8%	2.0%	2.2%	2.3%	1.5%	1.6%	2.1%	2.2%	2.2%
2. Industrial exports	5,936.8	6,112.2	5,228.2	6,096.1	7,991.7	7,371.2	7,749.4	8,262.0	8,017.1	7,940.1	8,541.9	9,258.2	9,426.3
	77.7%	75.4%	73.8%	70.7%	75.7%	75.4%	74.6%	74.2%	76.0%	77.0%	75.2%	77.9%	78.9%
3. Mineral exports	23.8	21.4	19.8	24.2	32.9	61.3	51.6	59.5	28.4	29.0	34.5	34.4	33.9
	0.3%	0.3%	0.3%	0.3%	0.3%	0.6%	0.5%	0.5%	0.3%	0.3%	0.3%	0.3%	0.3%
4. Unclassified	31.3	7.7	8.0	199.2	6.5	9.6	12.2	14.7	19.5	14.5	16.9	17.8	17.9
	0.4%	0.1%	0.1%	2.3%	0.1%	0.1%	0.1%	0.1%	0.2%	0.1%	0.1%	0.1%	0.2%
Total exports	7,640.0	8,110.6	7,084.5	8,625.8	10,558.8	9,773.5	10,394.3	11,130.1	10,546.5	10,309.7	11,360.4	11,889.6	11,940.0
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Central Bank of Sri Lanka (2020d)

[Figure 2-19] Trends in exports by industrial sector



Source: Central Bank of Sri Lanka (2020c)

1.3.2 Major traded products

1) Top products by export value

The top products by export value in 2017 were tea, cinnamon, fiber crops, and coconut oil in that order. Natural rubber fell from 2nd place in 2007 to 15th.

[Table 2-17] Top products by export value

Unit: 1000 US\$

	2007		2012		2017	
	Item	Value	Item	Value	Item	Value
1	Tea	544,868	Tea	1,403,154	Tea	1,513,207
2	Rubber natural dry	84,099	Cinnamon (cannella)	130,519	Cinnamon (cannella)	202,515
3	Cinnamon (cannella)	63,861	Rubber natural dry	115,511	Fibre crops nes	143,951
4	Crude materials	47,286	Flour, wheat	88,219	Nuts, prepared (exc. groundnuts)	103,324
5	Flour, wheat	40,171	Pepper (piper spp.)	69,778	Oil, coconut (copra)	94,498
6	Tobacco,	29,223	Coconuts,	67,634	Coconuts,	88,802

	2007		2012		2017	
	Item	Value	Item	Value	Item	Value
	unmanufactured		desiccated		desiccated	
7	Coconuts, desiccated	26,499	Food wastes	46,585	Pepper (piper spp.)	83,758
8	Pepper (piper spp.)	22,737	Food prep nes	46,282	Food prep nes	82,726
9	Bran, wheat	19,360	Tobacco, unmanufactured	42,199	Tobacco products nes	66,777
10	Cloves	19,069	Tobacco products nes	39,952	Food wastes	60,801
11	Food prep nes	13,898	Nuts, prepared (exc. groundnuts)	38,487	Crude materials	54,771
12	Copra	12,941	Crude materials	31,101	Cloves	46,980
13	Feed, compound nes	12,526	Nutmeg, mace and cardamoms	20,060	Oil, essential nes	46,034
14	Fat nes, prepared	11,261	Cloves	18,335	Areca nuts	38,170
15	Oil, essential nes	9,306	Bran, wheat	17,863	Tobacco, unmanufactured	37,037

Source: FAO (2018)

2) Top products by import value

The top products by import value in 2017 were wheat, rice, milk, processed rice, and refined sugar in that order.

[Table 2-18] Top products by import value

Unit: 1000 US\$

	2007		2012		2017	
	Item	Value	Item	Value	Item	Value
1	Wheat	262,161	Wheat	367,364	Wheat	303,164
2	Oil, palm	254,259	Sugar refined	316,831	Rice - total (Rice milled equivalent)	300,816
3	Milk, whole dried	195,223	Milk, whole dried	260,947	Milk, whole dried	274,383
4	Sugar refined	107,351	Cake, soybeans	84,935	Rice, milled	273,690
5	Sugar Raw Centrifugal	62,549	Lentils	70,186	Sugar refined	232,893
6	Lentils	57,219	Oil, palm	67,180	Oil, palm	147,917
7	Rice - total (Rice milled equivalent)	52,172	Tobacco, unmanufactured	65,642	Lentils	114,276
8	Cake, soybeans	46,439	Fatty acids	46,313	Cake, soybeans	92,353
9	Chillies and peppers, dry	39,692	Chillies and peppers, dry	46,129	Onions, dry	87,875
10	Tea	31,671	Food prep nes	37,653	Rubber natural dry	83,102
11	Milk, skimmed dried	31,462	Rubber natural dry	37,411	Food prep nes	67,390
12	Onions, dry	30,653	Onions, dry	32,411	Tobacco, unmanufactured	61,194
13	Tobacco, unmanufactured	28,262	Rice - total (Rice milled equivalent)	30,661	Chillies and peppers, dry	51,705
14	Food preparations, flour, malt extract	24,671	Milk, skimmed dried	29,731	Maize	49,475
15	Food prep nes	18,803	Crude materials	28,481	Food wastes	38,446

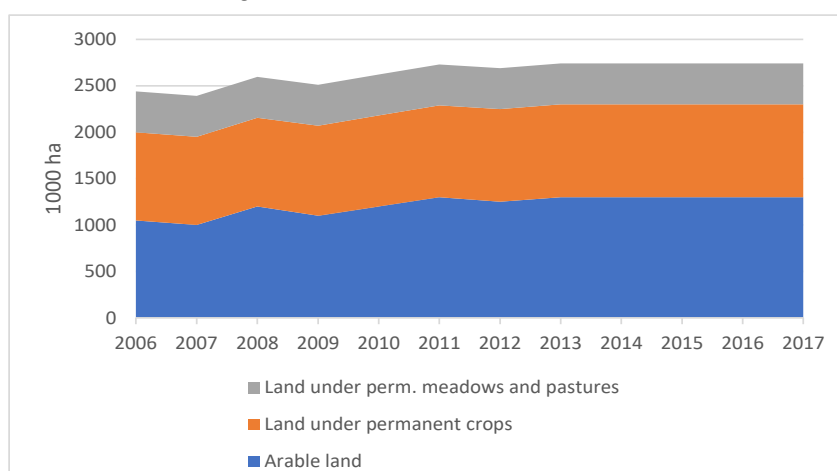
Source: FAO (2018)

1.4 Status of other agricultural factors

1.4.1 Arable land

Sri Lanka's arable land increased from 2.44 million hectares in 2006 to 2.74 million hectares in 2017. Arable land for crop cultivation, excluding permanent crops and permanent grassland, increased from 1.05 million hectares in 2006 to 1.3 million hectares in 2017.

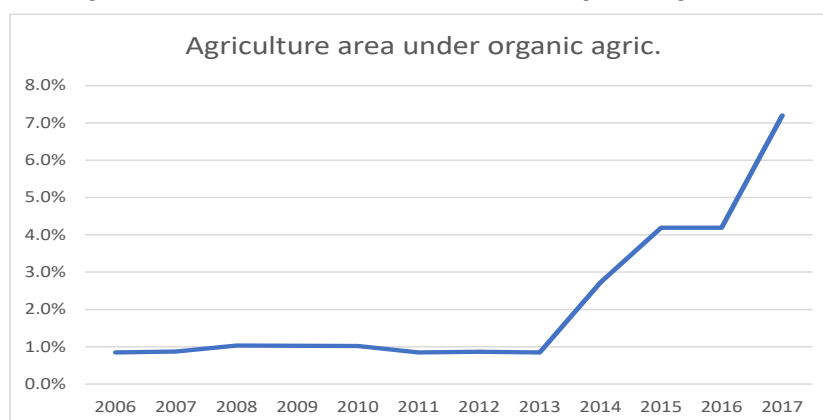
[Figure 2-20] Trends in arable land



Source: FAO (2019a)

Arable land for organic agriculture in Sri Lanka also saw a dramatic increase from 20,000 hectares in 2013 to 165,000 hectares in 2017.

[Figure 2-21] Trends in arable land for organic agriculture



Source: FAO (2019a)

1.4.2 Workers of agricultural industry

The number of workers in Sri Lanka's agriculture industry decreased slightly from 2.26 million in 2011 to 2.14 million in 2017.

[Table 2-19] Trends in workers of agricultural sector

Unit: 1000 persons

	2011	2014	2017	CAGR
Employment in agriculture, female	890.2	847.4	860.2	-0.6%
Employment in agriculture, male	1,367.1	1,375.7	1,280.0	-1.1%
Employment in agriculture	2,257.3	2,223.1	2,140.2	-0.9%

Source: FAO (2020a)

The share of agricultural workers has been declining, and is about 25% at present. The number of agricultural workers decreased slightly from 2.26 million in 2011 to 2.14 million in 2017.

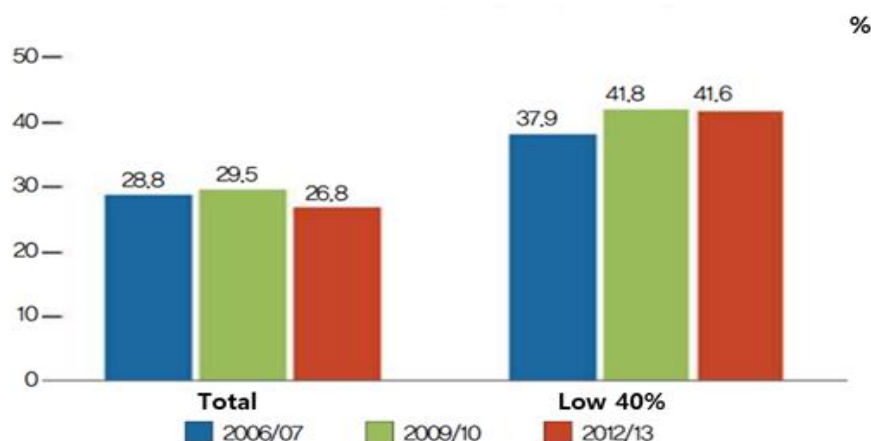
[Table 2-20] Trends in workers by industrial sector

	2016		2017		2018		2019	
Agriculture	2,154	27.1%	2,140	26.1%	2,044	25.5%	2,072	25.3%
Industry	2,098	26.4%	2,331	28.4%	2,239	27.9%	2,258	27.6%
Services	3,696	46.5%	3,737	45.5%	3,732	46.6%	3,850	47.1%
Total Employment	7,948	100.0%	8,208	100.0%	8,015	100.0%	8,180	100.0%

Source: Central Bank of Sri Lanka Annual Report (2020b)

The share of agricultural workers is increasing among the low-income class, which reflects the growing severity low-income problems faced by agricultural households.

[Figure 2-22] Share of Sri Lankan agricultural workers in relation to income



Source: Selynn Shin(2016)

1.5 Implications

Sri Lanka's agriculture accounts for only 7 ~ 8% of the total GDP but takes up a larger share of 20 ~ 25% of exports. Imported products may be substituted by increasing the production of domestic crops.

The change in production volume due to climate change is a serious issue, and there is a need to expand production and distribution infrastructure for fruits and vegetables, which have seen an increase in demand. Appropriate measures should be implemented to increase the productivity and expand the market for products with growing export volume, such as coconuts and spices. In addition, substitutes should be considered for export-dependent products like wheat and milk.

The problem of higher production costs of major crops is presumed to have been caused by increased wages, and measures should be established not only to improve productivity but also to maximize agricultural profits through the expansion of distribution and development of the processed food industry. Accordingly, advanced technology should be developed and utilized.

2. Major Agricultural Policies in Sri Lanka

2.1 Overview of agricultural policies

[Table 2-21] Changes in agricultural policies in Sri Lanka

Year	Policy	Goals
1948	Guaranteed Price Scheme	<ul style="list-style-type: none"> Expanded rice production by guaranteeing rice prices
1950–1970s	6-year national development plan (1951) 6-year investment program (1954) 10-year development plan (1959)	<ul style="list-style-type: none"> Expanded arable land for paddies, and developed irrigation infrastructure Enhanced productivity Established financial institutes and cultivation institutes for farmers Amended agricultural land and tenancy laws Provided production subsidies
1962	Fertilizer subsidy policy	<ul style="list-style-type: none"> Increased productivity and stabilized agricultural sector by expanding use of fertilizers
1984	National agriculture, food, and nutrition strategy	<ul style="list-style-type: none"> Increased domestic supply of rice, milk, sugar, and fish Achieved trade balance through agricultural exports Created jobs through agricultural development Improved citizens' nutritional status
1986	New comprehensive rural credit scheme	<ul style="list-style-type: none"> Expanded credit support for small farms Up to 50% of bank loan losses covered by central bank Lowered interest in years of bad harvest
2005	2006–16 10-year development policy (Mahina Chintana)	<ul style="list-style-type: none"> Expanded irrigation facilities in northern region Expanded marketing, including establishment of agricultural export areas
2006	National Plantation Industry Policy	<ul style="list-style-type: none"> Utilized plantation industry as engine for pro-poor growth Expanded cooperation between private and public sectors Diversified profits Promoted eco-friendly farming

Year	Policy	Goals
2010	Development policy framework (Mahinda Chintana – Vision for the future)	<ul style="list-style-type: none"> • Acquired food security • Achieved agricultural modernization • Increased delivery efficiency • Promoted use of improved varieties, and efficiently managed water resources

Source: G.M. Henegedara (2002), Sri Lanka Ministry of Finance and Planning (2006, 2010), Ministry of Agriculture(2016, 2018), Ministry of Agriculture Development & Agrarian Services(2007), Ministry of Finance and Planning(2006), Ministry of Finance and Planning(2010), Ministry of Agriculture

Sri Lanka focused on plantation crops for export under the colonial rule and had no policies for food security. It began to cultivate crops for domestic distribution after gaining its independence at the end of the 1940s. The enactment of the 1958 Paddy Land Act marked the start of its food security policy.

In 1972, Sri Lanka enacted the Land Reform Law, which nationalized plantation farms and limited private holdings of land to 50 acres. This law was what allowed the country's agricultural structure to be centered on small farms. Due to significant financial burdens, however, plantation farms were privatized in the 1990s.

In relation to food security, the country has implemented import substitution policies since the 1950s and has strictly regulated imported food since the 1970s. It has banned the import of certain products, imposed tariffs, and implemented an import license policy for potatoes and other specific crops. Other efforts to stabilize the agricultural sector include fertilizer subsidies and agricultural loans. Since the 2000s, farmers have been encouraged to increase value-added products and to practice eco-friendly farming for sustainable development.

[Table 2-22] Institutes/organizations related to Sri Lanka's agriculture

Institute/sector	Sub-institute by sector	Goal and activities
Ministry of Agriculture		General agricultural affairs, food security policies, food pricing policies
	National Food Promotion Board	

Institute/sector	Sub-institute by sector	Goal and activities
	Department of Export Agriculture	
	Sri Lanka Council for Agriculture Research Policy (SLCARP)	ational agricultural research policy and priority-setting
Export Development Board		Policies related to agricultural exports
Department of Census and Statistics		Collection of agricultural statistics including agricultural production goals
Consumer Affairs Authority		Protection of consumers of agricultural products and foods
Sri Lanka Standards Institution		Standards related to agricultural products and foods
Sri Lanka Accreditation Board for Conformity Assessment		Conformity assessment for individuals and businesses
Tea	Sri Lanka Tea Board	Use of Ceylon Tea Lion logo on 100% pure Ceylon tea produced in Sri Lanka and satisfying quality requirements
	Tea Research Institute	Research on sustainability and profitability of Ceylon tea
Coconuts	Coconut Development Authority	Research aimed at improving coconut productivity
	Coconut Cultivation Board	
	Coconut Research Institute	
Rubber	Rubber Research Institute	Stimulating rubber industry through economic, eco-friendly efforts for sustainable innovation
Livestock and poultry	National Livestock Development Board	

Source: Gunawarda, A.(2018)

2.2 Overarching Agricultural Policy

In August 2019, the Sri Lankan government prepared a draft version of “Sri Lanka Overarching Agricultural Policy” for the purpose of agricultural development. The

principles and thematic areas of Sri Lanka's agricultural policy are provided below. Each thematic area has an agenda. For instance, the section on border measures discusses tariffs and surcharges as a strategy of replacing imports. However, the discussions fail to cover agendas or plans concerning research and development policies.

Vision: Globally competitive agriculture sector for national prosperity

Principles

Prosperous farmer community

Energizing market linkages

Revitalizing rural economy

Reaching to Global Value chain

Ensuring food and nutrition security and food safety

10 Thematic Areas

Reserving natural resources

Land use planning, land administration and land degradation

Agriculture water management

Climate change

Food security

Border (trade) measures

Effective governance

Development subsidies for value chain actors

Production support and service delivery

Strengthening education-research-extension

Source: Ministry of National Policies & Economic Affairs(2019)

[Table 2-23] STI related theme of Overarching Agricultural Policy in Sri Lanka

9. Agricultural production support and service delivery

Status and key issues

- Direct input subsidies for agricultural products and indirect subsidies for irrigation water and insurance have been provided for farmers.
- Farmers' growing dependence on government subsidies caused limited development of production quality, quantity, and capacity
- Decreased subsidies for export and high-value crops led to weaker activity in such areas
- Incentives were skewed toward production of staple food crops

	<p>with farmers' increasing dependence on public assistance programs</p> <ul style="list-style-type: none"> * Subsidies for six major crops provided through a dedicated fund of the Ministry of Agriculture, while subsidies for plantation crops were supported by export tax profits
Issues to be addressed	<ul style="list-style-type: none"> • Lack of a proper institutional structure to strengthen business orientation of farmer organizations • Inadequate efforts to promote commercialization and competitive functioning of markets in agricultural sector • Inadequate resources including affordable credit for commercialization and modernization of agricultural sector through mechanization and technology application • Lack of a coordinated approach among statutory bodies to provide inputs and services to agricultural sector • Weak and inadequate private-public partnerships in agriculture service provision
Policy thrust areas	<ul style="list-style-type: none"> • Ensure efficiency and effectiveness of production support and service delivery to enhance competitiveness in agriculture • Strengthen effective functioning and efficiency of regulatory and institutional mechanisms to ensure timely availability and accessibility of high-quality inputs • Undertake necessary reforms in governance structure for input and service supply in agricultural sector to strengthen functioning under competitive market environment • Support private sector where it has comparative advantage to provide accountable, responsive service delivery systems • Encourage investment to enhance competition in agriculture value chains and promote exports
10. Strengthening education-research-extension	
Status and key issues	<ul style="list-style-type: none"> • More than 750 graduates per annum produced by faculties of agriculture in universities of Sri Lanka • Majority of agriculture graduates employed in non-agricultural sector due to limited prospects and acceptance of degree as entry-level qualification • National research and development expenditure of Sri Lanka as a share of GDP in 2010 was 0.16%, extremely poor compared to neighboring countries • * India (0.81%), Pakistan (0.33%), Nepal (0.30%) • All agricultural research institutes remain under the purview of central government ministries as agricultural research is designated as a national government function

	<ul style="list-style-type: none"> • Agricultural research expenditure as a percentage of agricultural GDP dropped steadily from 0.66% in 1981 to 0.36% in 2003 to 0.34% in 2009
Issues to be addressed	<ul style="list-style-type: none"> • Large gap in human resources in public-sector organizations responsible for research and advisory services delivery • A highly fragmented national agricultural research system that fails to respond to ground realities • Absence of a standard blueprint for national agricultural research • Inadequate funding for agricultural research and lack of public-private partnerships in research and development • Inefficient mechanism for conversion of agricultural innovations
Policy thrust areas	<ul style="list-style-type: none"> • Promote appropriate agricultural innovation and technology transmission through investments in research, education, training and partnerships for sustainable agricultural production • Take measures to strengthen public-private partnership in agriculture research and investment • Put in place an agricultural knowledge and information system for effective transfer of innovative practices • Increase resource allocation for agricultural research system • Restructure national agricultural research system for greater effectiveness • Develop a comprehensive human resource and capacity building program covering all national and provincial agricultural institutions • Prioritize all agricultural research programs based on return on investment criteria

Source: Ministry of Agriculture(2019)

2.3 Policies by production sector

In 2018, Sri Lanka's Ministry of Agriculture established the "National Agriculture Research Policy and Strategy 2018-2027" to develop agricultural research policies under the Sri Lanka Council for Agricultural Research Policy(SLCARP, 2018). The proposed strategies are focused on common agendas such as higher production volume and quality enhancement, but do not cover specific issues by industrial sector.

2.4 Implications

The key agendas of Sri Lanka's agricultural policies are increasing productivity, enhancing

added value, and developing related markets. Productivity related to agricultural research and development can be improved through agricultural technology education and agricultural machine development, development and implementation of IT and AI-based cultivation and land management technology, climate prediction and countermeasures, and establishment of management systems. Added value can be enhanced by developing processed agricultural products and expanding high-value crops and conducting research to diversify crops through the development of cultivation technology. For market development, some possible solutions are conducting agricultural economy research for market stabilization, establishing a platform for sharing agricultural resources (Hello Tractor IoT), and developing agricultural business platforms to promote small farming businesses.

The agendas needed for research and development must be analyzed by policy area. Specific technical issues, including problems attributable to the unique characteristics of each sector, should also be discussed.

[Table 2-24] Overall analysis of Sri Lanka's agricultural policy

- Sri Lanka's agricultural status and issues are well-analyzed in general
 - Three major areas to be addressed, namely, production yield, lack of business orientation, and lack of high-value products obtainable through processing, are clearly identified
- Policy directions are adequately established, but lack specific goals and measures, and are not supported by a solid governance system
 - Measures are declaratory or simply express a willingness to improve
 - Lack of measures to mobilize resources and manpower

Source: Kim Youngjin (2020)



CHAPTER 3

Science, Technology and Innovation Action Plan for Agriculture Sector Fruits and Vegetable Crops Sri Lanka - 2021-2025

2020 STEPI-NASTEC STI Policy Consultation Project on
“Supporting the Improvement of Science, Technology
and Innovation (STI) Policy and Institutional
Framework for Sri Lanka”

Chapter 3. Science, Technology and Innovation Action Plan for Agriculture Sector Fruits and Vegetable Crops Sri Lanka 2021-2025

1. Future Vision 2030

Improved quality of life through science, technology and innovation initiatives

2. Four Strategies

Strategy 1. Diffusion of STI instruments to promote a sustainable agricultural economy in the country

Strategy 2. Development of an enhanced mechanism for technology transfer and knowledge sharing thereby increase the market share of agriculture economy

Strategy 3. International exports through value added products driven by advanced technologies

Strategy 4. Reduce youth unemployment through Agro entrepreneurship

1. Overview

With total land mass of 62,705 km² and inland water bodies covering an extent of 2,905 km², Sri Lanka is a lower middle-income country with GDP per capita of USD 3,853 (2019) and total population of 21.8 million. The overall Gross Domestic Product (GDP) of Sri Lanka was reported as USD 84 billion (2019), a 4.9% decrease of the approximately 0.04% compared to that of 2018. The country's economy grew at an average of 5.3 % during the period 2010-2019.

In 2019, the economy of Sri Lanka grew at a mere 2.3%, only marginally higher than Pakistan (1.9%) in the SAARC region, owing to the setback arising from the Easter bombing in April of said year. The forecast by the World Bank estimates a negative economic

growth of 3.2 % in 2020 due to the COVID-19 impact experienced this year. The major economic pillars of the country's economy, namely agriculture, industry, and service sectors, showed a growth rate of 0.6%, 2.7%, and 2.3%, respectively, in 2019. The contribution of those three sectors to the GDP was 7%, 26.4%, and 57.4%, respectively, in 2019.

The cumulative projected investment during the period 2017-2020 for agriculture is shown in [Table 3-1].

[Table 3-1] The Public Investment Plan 2017-2020

Sub sector	Cumulative Investment Plan (2017-2020) Rs Million	% of total public investment
Agriculture	58,101.62	1.64
Plantations	41,549	1.18
Livestock	32,798.0	0.92
Fisheries	30,516	0.86
Technology & Research	16,166	0.46

Source: Department of National Planning & Ministry of National Policies and Economic Affairs (2016)

1.1 The agriculture sector in Sri Lanka

The agriculture sector in Sri Lanka mainly consists of food crops (rice, maize and other cereals, other food crops), major plantation crops (tea, rubber, coconut, sugarcane, and palmyra), export agricultural crops (spices including cinnamon, black pepper, etc. and other beverage crops including cocoa, coffee, etc.), forestry, livestock and poultry, and fisheries subsectors. The growth of each subsector in agriculture and their contribution to the GDP are shown in [Table 3-2]. The data clearly indicates that the growth of majority of the subsectors in 2019 has either contracted or stayed the same as in 2018; thus resulting in a lower contribution of the overall agriculture sector (in terms of primary production) to the GDP.

Chapter 3. Science, Technology and Innovation Action Plan for Agriculture Sector Fruits and Vegetable Crops Sri Lanka - 2021-2025

[Table 3-2] Gross Domestic Product by industrial origin in Sri Lanka

Economic Activity	Growth (%)		Contribution to Change (%)		As a Percentage of GDP (%)	
	2018 (c)	2019	2018 (c)	2019	2018 (c)	2019
Agriculture, Forestry and Fishing	6.5	0.6	13.5	1.8	7.1	7.0
Growing of cereals (except rice)	2.0	- 9.5	0.1	- 0.5	0.1	0.1
Growing of rice	44.7	- 0.3	7.0	- 0.1	0.7	0.7
Growing of vegetables	4.0	1.5	0.7	0.4	0.6	0.6
Growing of sugar cane, tobacco and other non-perennial crops	- 10.9	8.4	- 0.1	0.1	0.0	0.0
Growing of fruits	11.4	8.5	1.8	2.1	0.6	0.6
Growing of oleaginous fruits (coconut, king coconut, oil palm)	7.1	18.2	1.2	4.7	0.6	0.7
Growing of tea (green leaves)	0.4	- 1.3	0.1	- 0.4	0.7	0.7
Growing of other beverage crops (coffee, cocoa, etc.)	25.6	- 23.4	0.1	- 0.2	0.0	0.0
Growing of spices, aromatic, drug and pharmaceutical crops	5.9	- 1.0	1.2	- 0.3	0.7	0.7
Growing of rubber	- 0.3	- 9.5	- 0.0	- 1.0	0.2	0.2
Growing of other perennial crops	- 2.5	- 0.3	- 0.1	- 0.0	0.2	0.2
Animal production	8.0	3.2	1.5	0.9	0.7	0.7
Plant propagation and support activities to agriculture	0.2	- 6.3	0.0	- 0.3	0.1	0.1
Forestry and logging	- 0.8	- 4.8	- 0.2	- 1.4	0.6	0.6
Fishing	0.2	- 4.3	0.1	- 2.3	1.2	1.1

Source: Central Bank of Sri Lanka(2020)

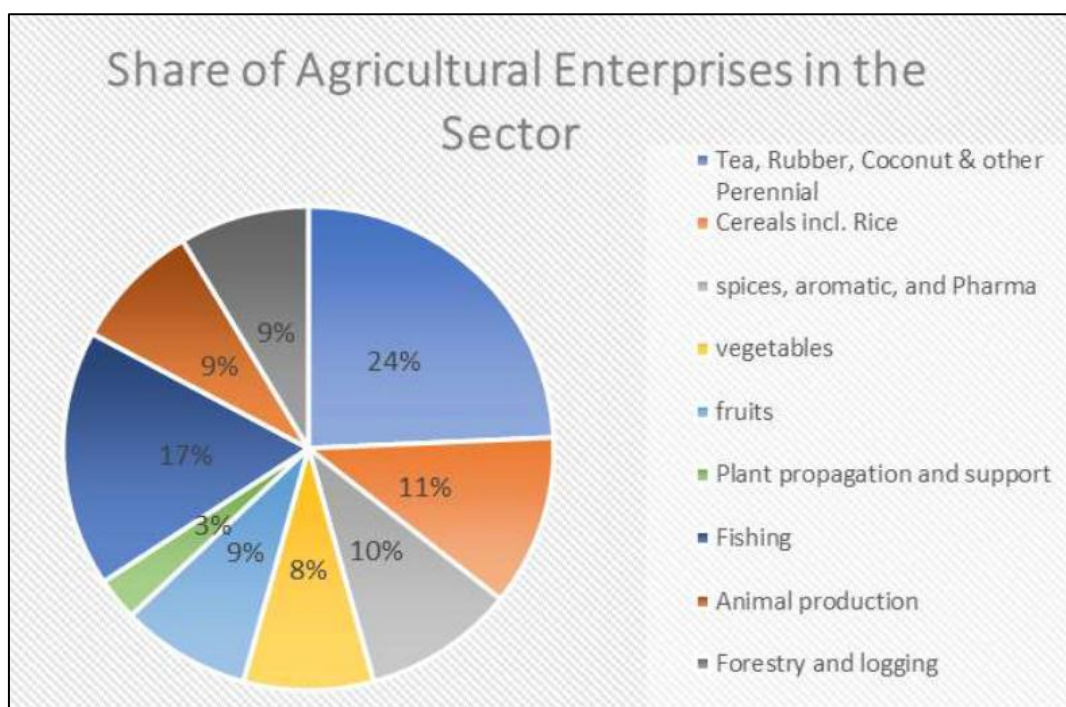
The agriculture sector consists mainly of the crop subsector made up of the plantation and non-plantation crop segments, livestock and poultry, and fisheries and aquaculture subsectors. Of the 7.0% contributed by the agricultural sector to the national GDP in 2018, the crops subsector contributed 4.6%, fisheries, 1.2%, animal production, 0.6%, and forestry and logging, 0.6%. Figure 1 illustrates the percentage contribution of major agricultural enterprises to the agricultural gross domestic product in 2018. The figure shows that tea, rubber, coconut, and other perennials contributed 24% of the value of agricultural GDP in 2018, with fisheries contributing 17%, and cereals including rice, 11%. As estimated, 25% of the total workforce of the country is engaged in agriculture.

Sri Lanka is self-sufficient in the production of rice, its staple food, and nearly self-sufficient in the production of other important food items such as meat, fish, eggs, vegetables, and fruits. However, the country relies on imports for many essential food commodities. In 2018, Sri Lanka imported USD 2.28 billion (Sri Lanka Rs 422.5 billion) of food and beverages (11.8% of the total imports).

At the sectoral level, the agriculture sector in Sri Lanka has experienced trends that are in line with the experience of other countries, e.g., declining share of the labor force in agriculture and declining contribution of the primary production to national income. These trends are part of the economic structural transformation experienced by all countries as they develop and shift toward manufacturing and services. The challenge for Sri Lanka, as

for all other countries, is to make the needed investments so that agricultural production, foreign exchange earnings, and farm incomes do not collapse as a consequence of the loss of labor in the process of economic structural transformation. Meeting the challenges will mean adopting technology to increase labor productivity, improving farm-market linkages, investing in value chains, and generating off-farm employment to absorb the excess labor in the rural areas.

[Figure 3-1] Share of various enterprises comprising the agriculture sector



Source: Ministry of Agriculture, Ministry of National Policies and Economic Affairs (2019).

1.2 Structural and administrative arrangement for agricultural operations in Sri Lanka and policy influence

All agriculture policies of Sri Lanka since it gained its independence have equally affected both crop and animal agriculture during most parts of the post-independence era until 1978, as both sectors came under the purview of the same Ministry (Ministry of Agriculture) and working Department (Department of Agriculture). The amalgamation and separation of the two subject areas (crop agriculture and animal agriculture) occurred consecutively under several subsequent governments. However, the two main components representing agriculture were finally separated into two ministries and to two working departments in 1979. In the non-plantation crop production sector, the institutional arrangement is mainly focused on the Department of Agriculture managed by the ministry that deals with agriculture.

The 13th Amendment to the Constitution of Sri Lanka in 1987 and Provincial Councils Act No. 42 of 1987 made a dramatic change in the administration of agricultural operations in Sri Lanka. These changes led to the constitutional and legal provision for the establishment of Provincial Councils (PCs), within Sri Lanka's unitary constitution. With these changes, the Department of Agriculture is mandated to carry out research and extension of the major food crops including rice, other field crops (coarse grains), food legumes, root tuber crops, oil crops, vegetables, and fruit crops via the Provincial Department of Agriculture located in each of the nine provinces of the country. The establishment of the Mahaweli Authority of Sri Lanka (MASL) to look after the interest of the agriculture programs under the Mahaweli Development Programme made MASL responsible for agricultural extension in this major irrigation scheme.

1.3 Food crop production in Sri Lanka

The scattered nature of production makes exploiting economies of scale and maintenance of quality assurance rather difficult. They are also vulnerable to changes in weather and climate. The increasing demand for labor by the non-agricultural sectors and increasing tendency for the youth leaving the farming sector have reduced the availability of labor for agricultural production, increased wage rates, and reduced the competitiveness of farm production. The collective action among farmers working as groups is weak, undermining their bargaining power. Village-level suppliers provide inputs to farmers mainly on credit, with a significant share of produce (mainly rice) bought back by them (because of the linked markets, and owing to missing markets for credit and insurance). Credit-bound relationships are also found to exist between farmers and commission agents operating in dedicated economic centers, bringing about both positive and negative implications for the governance of vegetable supply chains.

Within this context, the present government's policy framework, "Vistas of Prosperity and Splendors," was introduced and adopted in 2020, identifying key economic sectors for development. As one of the sectors given priority in this National Policy Framework (NPF), agriculture has been identified with priority programs under Chapter 5 of the NPF, whose overall objective is to create a "People-Centric Economy."

Moreover, the NPF clearly identifies the introduction of a "New National Agricultural Policy" after an in-depth review of the present policies. In keeping with this approach, the Department of National Planning (DNP) has already taken steps to develop an "Overarching Agriculture Policy" aligned with the NPF, and it is likely to be submitted soon for the approval of the Cabinet of Ministers.

Meanwhile, the economic policies in Sri Lanka post-COVID-19 have also concentrated on encouraging import substitution and export expansion to ensure higher profits for farmers while maintaining a sustainable agricultural practice. In response to the pandemic situation, and with a long-term vision of promoting import substitution and export orientation, the government of Sri Lanka has focused on developing 16 field crops

(including spice crops) focusing on import substitution and 33 crops to be supported through the New Comprehensive Rural Credit Scheme (NCRCS) approved on April 16, 2020 [Table 3-3] up to the maximum value of LKR 504,000 (depending on the crop). The NCRCS also supports home gardening (max LKR 40,000) and plant nurseries (max LKR 500,000). Eligible borrowers are farmers with land for cultivation.

In line with this NPF, NASTEC is in the process of revisiting the Science and Technology Policy formulated in 2008 so as to align Science, Technology, and Innovation (STI) perspectives with national priorities through innovation and modern technologies. The agriculture sector has also been identified as one of the priority areas by NASTEC for inclusion into the new STI Policy. Accordingly, NASTEC will actively engage in identifying policy needs, gaps, and scientific instruments to improve agricultural productivity, process, and entrepreneurship development.

[Table 3-3] Crops identified for import substitution and those eligible for the New Comprehensive Rural Credit Scheme (NCRCS)

Sixteen Crops (16) identified for Import Substitution	Thirty-Three (33) Crops eligible for New Comprehensive Rural Credit Scheme (NCRCS)
Maize, Potato, Big onion, Cluster onion, Green gram, Black gram, Ground nut, Dried chilli, Soybean, Finger millet (kurakkan), Cowpea, Sesame, Horse gram (kollu), Turmeric, Ginger, and Garlic	Paddy, Chillies, Onion, Cowpea, Green Gram, Black Gram, Soya bean, finger millet (Kurakkan), Maize, Ground Nut, Gingelly, Sun Flower, Potato, Sweet Potato, Cassava (Manioc), Taro (Kiri ala), Eggplant (Brinjal), Ladies fingers, Drumsticks, Beet root, Beans, Cabbage, Carrot, Capsicum, Tomato, Leeks, Radish, Knoch Khol, Luffa, Bitter Gourd, Snake Gourd, Pumpkin, Ginger, and Sugarcane

1.4 Fruits and Vegetables Sector in Sri Lanka

1.4.1 Fruit crops sector in Sri Lanka

Sri Lanka has been known to produce a large variety of tropical fruits that are in demand worldwide. Fruit cultivation on a commercial scale is confined to 7 out of 25 districts in Sri Lanka, namely, Kurunegala, Moneragala, Badulla, Rathnapura, Hambantota, Gampaha, and Kalutata . Furthermore, the local markets have experienced an influx of fresh fruit products during the harvest seasons. Sri Lanka exports nearly 33,000 mt of fruits, with 90% of the production being exported to the Middle East and Maldives, earning an income of US\$ 35.7 million (2015). Fruits including apples mandarins, oranges, and grapes have been imported at a volume of 45,000 mt valued at US\$ 38.8 million (2015). Despite the recent shift in the principal export market from the Europe market to the Middle East, foreign exchange earnings are expected to increase due to the volume supplied.

Fruit and vegetable crop production needs to be promoted aimed at increasing export earnings for the country. The government of Sri Lanka has created a new State Ministry to cover the specific subjects of Paddy and Cereals, Organic Food, Vegetables, Fruits, Chilis, Onions and Potatoes, Seed Production, and Hi-Tech Agriculture, highlighting the priority given by the government to adopt new technologies in crop production as well as the specific attention given to the fruit and vegetable sectors of the country.

The most popular fresh fruits exported include bananas, melons, mangoes, mangosteen, avocado, soursop, pineapple, papaya, lemon, ripe jack, star fruit, and rambutan . The fruit crop sector has contributed 0.35% of the merchandise exports (2016), showing a steady increase highlighting the expansion of the sector (Tables 4 and 5).

[Table 3-4] Production statistics of major fruit crops cultivated in Sri Lanka

Fruit Crop	2017		2018		2019	
	Extent (ha)	Production (Mt)	Extent (ha)	Production (Mt)	Extent (ha)	Production (Mt)
Banana	49,307	750,588	45,968	679,432	44,671	673,655
Mango	28,272	151,733	28,440	172,735	27,460	155,448

Fruit Crop	2017		2018		2019	
	Extent (ha)	Production (Mt)	Extent (ha)	Production (Mt)	Extent (ha)	Production (Mt)
Papaw	6,975	86,219	6,271	72,781	6,178	78,843
Pineapple	4,783	52,786	5,543	43,313	4,665	44,793
Total	89,337	1,041,326	86,222	968,261	82,974	952,739

Source: Department of Census and Statistics (2020)

[Table 3-5] Major exports of fruit crops from Sri Lanka

Fruits	2017		2018		2019	
	Quantity (mt)	Value (Rs million)	Quantity (mt)	Value (Rs million)	Quantity (mt)	Value (Rs million)
Banana (Fresh)	15,018	2,561	17,378	2,489	17,926	2,552
Banana (other)	4,875.18	744.28	156.80	121.87	211	152
Mango (Dried)	2.14	4.73	7.97	13.61	46	103
Mango (Fresh)	222.16	89.96	310.45	141.49	528	272
Papaw	5,072.15	532.29	5,857	573.8	10,011	1,029
Pineapple (Dried)	204.07	419.26	107.25	178.96	51	105
Pineapple (Fresh)	1,001.72	347.18	688.08	264.15	592	260
Total	26,396	4,699	24,505	3,783	29,366	4,473

Source: Department of Census and Statistics (2020)

Sri Lanka has also adjusted well to the stringent ISO 22000 series and to the health and safety regulations stipulated by the European Community. Farmers are constantly being educated to practice Good Agricultural Practices (GAP) at the nurseries, and some farms are certified under the GLOBAL GAP certification. The processing/manufacturing facilities owned by the export companies comply with Sri Lankan Standards (SLS) as well as International Quality Standards such as ISO, HACCP, and EU Standards. Traceability throughout the supply chain is monitored with the help of reputed exporting companies in Sri Lanka to guarantee a safe product to the consumers.

However, limited availability and access to advanced technology and relatively poor logistics and infrastructure in cultivation and post-harvest processing lower the scale of

production while increasing the cost of production. In addition, insufficient cold chain facilities to support the supply chain, limited storage and handling facilities, lack of improved germplasm and continuous production, limited skilled and knowledgeable labor force to support the industry, and heavy post-harvest losses amounting to 30-40% are the key issues plaguing the fruit crop industry in Sri Lanka.

1.4.2 Vegetable crops sector in Sri Lanka

Vegetable production plays a key role in agriculture and forms an important part of a healthy human diet. In 2015, Sri Lanka has earned USD 37.2 million from exporting vegetables (edible vegetables and certain roots and tubers), ranking 81st in world exports. At present, however, the country's vegetable exports have declined to a share of 0.1% from the world export. The most popular vegetable exports from Sri Lanka include chili, gherkin, red onion, bread fruit, young jackfruit, ladies' fingers, drumsticks, pumpkin, and bitter gourd. Maldives (16-20%) has been a major importer of vegetables from Sri Lanka, with the United Arab Emirates (approx. 15%) as the second largest buyer in 2015. In the last few years, UK, Malaysia, and USA have recorded a gradual increase in the market share of vegetable imports from Sri Lanka. Sri Lanka also imports vegetables from India and Australia with import share of more than 50%. Tables 6 and 7 present the production and export volumes of selected vegetables grown in Sri Lanka.

[Table 3-6] Production of selected vegetables in Sri Lanka 2017 – 2019

Vegetable Crop	2017		2018		2019	
	Extent (ha)	Production (mt)	Extent (ha)	Production (mt)	Extent (ha)	Production (mt)
Beans	7,723	87,385	7,344	83,966		
Capsicum	3,208	26,952	3,675	32,307		
Cucumber	2,446	31,446	3,228	43,942		
Tomato	5,329	80,839	6,712	101,404	5,869	77,916
Red Pumpkin	6,159	82,934	8,469	123,261	6,863	97,473

Source: Karunaratne et al. (2020)

[Table 3-7] Export of selected vegetables in Sri Lanka 2017 – 2019

Vegetable Crop	2017		2018		2019	
	Quantity (mt)	Value (Rs '000)	Quantity (mt)	Value (Rs '000)	Quantity (mt)	Value (Rs '000)
Beans	32	12,609	141	71,818		
Capsicum	18	7,974	82	31,977		
Cucumber	8	2,124	13	4,169		
Tomato	63	30,362	14	2,231	1.6	396
Red Pumpkin`	77	9,760	459	44,835	873	65,629

Source: Karunaratne et al. (2020)

Major drawbacks to improving vegetable crop production in Sri Lanka include: poor economies of scale; high cost of production; absence of continuous supply; poor quality of the products; high air freight and high cost of export services; limited private sector investment and foreign investment in larger projects of vegetable production; weak implementation of policies to broaden the vegetable exports of the country along with the improvement of advanced technology; less attention paid to vegetable breeding programs; non-use of appropriate agronomic practices; poor post-harvest handling; and weak extension services.

1.4.3 Major issues and concerns related to the Fruits and vegetable Industry in Sri Lanka:

The fruit and vegetable sector in Sri Lanka is plagued by fragmented and small production units, involvement of small and marginal farmers, absence of continuity in supply, lack of awareness of quality standards, lack of infrastructure, inadequate supply of quality produce, high cost of production, high cost of labor, poor packaging, costly transport and air freight services, high cost of electricity, inadequate supply of high-quality seed materials, high cost of investments in new technology, inadequate research, relatively high interest rates, and labor scarcities.

The total vegetable production of the country declined by as much as 11.8% due to pest damage and extreme weather conditions, from 1,698,698 mt in 2018 to 1,497,733 mt in 2019 . Similarly, fruit production also declined 3.1% in 2019 compared to the notable growth of 28.8% in 2018. However, average household expenditure for food in relation to total expenditure is around 30-40% (2016). The average monthly household expenditure on fruits and vegetables (2018) is 11.9% in urban areas and 13.5% in rural areas. Fruit cultivation in Sri Lanka is mostly confined to backyard or home garden level, with some of the fruit varieties such as banana, mango, pineapple, papaya, passion fruit, and rambutan commercially grown in orchards. The local demand for such crops is mainly met only by local production; hence the importance of expanding the cultivation to meet the international demand.

Furthermore, post-harvest losses reached a staggering 30-40% due to the lack of proper knowledge on post-harvest handling, packaging, and right storage methods. Thus, with the introduction of new post-harvest handling techniques, cold storage, preservation, and packaging methods to farmers, an unprecedented increase in the volume and variety of fruit exports has been recorded during the past decade. The government has initiated the Fruit Village Development Program to strengthen small-scale farmers. Policy-level decisions need to be made to penetrate the European markets where unit prices will be higher and which will bring in more foreign revenue to the country. Branding of products will give enormous capacity to become a significant contributor in the world fruit market.

1.5 Processing of Fruits and vegetables in Sri Lanka

Value addition via agro-processing is a high-priority intervention expected by the government of Sri Lanka through national and foreign investment support. The fruit and vegetable sector is only second to the paddy sector in the country. Many vegetable growers are scattered nationwide, making every effort to support the year-round production of vegetables. On the other hand, fruits and vegetables play a significant role in human nutrition as well. Increase in production and productivity of fruits and vegetables is vital as they are filled with essential vitamins, minerals, fiber, and disease-fighting

phytochemicals and antioxidants. Thus, increase in consumption of fruits and vegetables would lead to protecting humans from heart diseases, high blood pressure, type II diabetes, and certain cancers.

The daily consumption of fruits and vegetables in Sri Lanka (150 g per day), however, is far below the FAO-recommended consumption rate (400g per day). The prevalent high post-harvest losses of fruits and vegetables in the country, ranging between 30 and 40% of the harvested crop as stated previously in this report, could be partially responsible for the high retail price and low consumption rate of such commodities. By establishing different agro- processing industries, the country could greatly reduce the post-harvest losses through the transformation of perishable produce into more shelf-stable products; thus ensuring food security. Demand for processed and convenient food products increases constantly due to urbanization and changing lifestyle and food habits of people in the country. Furthermore, agro-processing creates more employment opportunities especially for women labor force, and it will promote women economic empowerment of the country. Agro-processing offers new market opportunities in local and export markets and allows capturing new value-added niche markets, too. However, lack of innovation and adoption of appropriate technology will hinder the agro-processers from attaining the upper markets where quality and safety of food processing are extremely important.

The statistics presented in Tables 4-7 clearly indicates that the cultivation and production of fruit crops such as banana, papaya, mango, and pineapple and vegetables such as pumpkin and tomato are comparatively high. Furthermore, there is high local demand for these 6 crops for fresh consumption and nutritious food development. Apart from that, the fresh and processed forms of these selected crops have huge export potential. However, the post-harvest losses of these commodities are also high (Table 8), necessitating technological intervention in value chain development and value addition as well as agribusiness ventures. The perishable value chains of most fruits and vegetables in the country can be said to be very complex, with a chain of intermediaries' involvement leading to more post-harvest handling.

[Table 3-8] Postharvest losses of major fruit crops in Sri Lanka

Crop	Field	Collector	Whole seller	Retailer	Total
Banana	5.27	7.58	3.25	14.13	30.23
Pineapple	7.21	8.53	2.89	12.53	31.16
Papaya	5.78	10.12	4.95	15.28	36.12
Mango	5.5	3.3	12.6	11.3	32.7

Source: Industrial Technology Institute

1.6 Processed Food Industry in Sri Lanka:

As one of the important sectors of the country, the food processing sector is a sunrise industry with its immense contribution to innovation in the food system, important role played in the local economy, and contribution to improving the rural economy and living standards of people of the country. The food industry, which has grown fast throughout the past two decades, has contributed immensely to the economy of Sri Lanka.

A significant contribution has been made by the food industry to the overall industrial component, which is one of the major components of Sri Lanka's GDP. Processed food industries were established to cater to both local and export markets. According to the Annual Survey of Industries done by the Department of Census and Statistics of Sri Lanka (2018), 5,057 small-scale establishments were identified for the manufacturing of food and beverage products in which nearly 200,000 people are engaged.

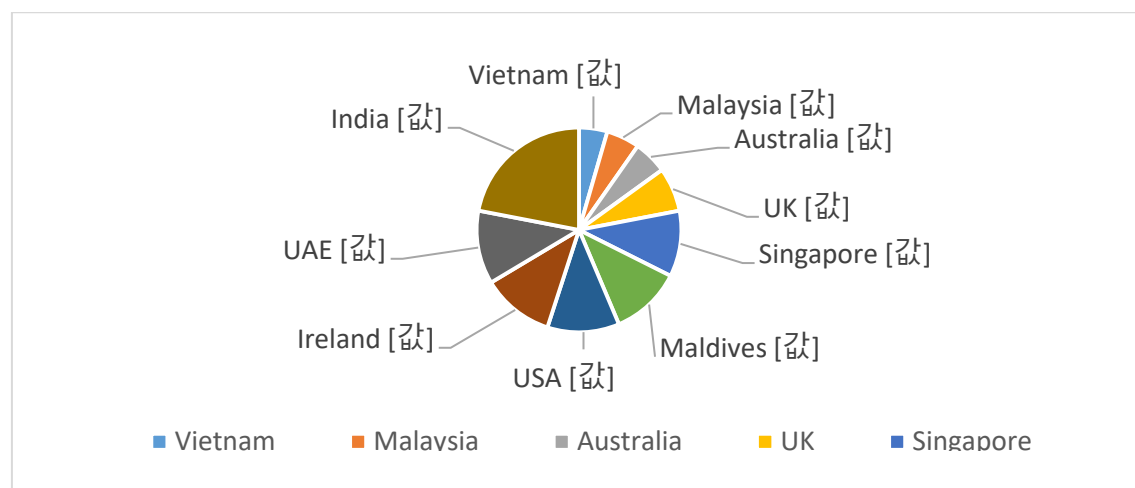
The number of medium- and large-scale food industries also increased during the last few years, providing more employment in this sector. Most medium- and small-scale industries operate based on practical experience, and the adoption of new and advanced food processing techniques and quality management system is limited due to lack of resources, which affects improvement in multiple ways. The cottage industry subsector expanded during the last few years, benefitting from the initiative taken by the government to develop entrepreneurship in the country. Much effort has been made to transform the current "resource-based, labor-intensive" manufacturing industry into a "knowledge-

based, technology-intensive industry” by developing the technology base of the industrial sector and encouraging the production of internationally competitive high value-added branded products. Furthermore, increased focus was placed on developing Small and Medium Enterprises (SMEs) through technology infusion, women entrepreneurship development, and greater financial inclusion. The proposed project will enable bridging the gap between the industry and R&D institution in order to transfer new innovation and technologies to the relevant industries in the most effective manner.

1.6.1 Export of fresh and processed fruits and vegetables:

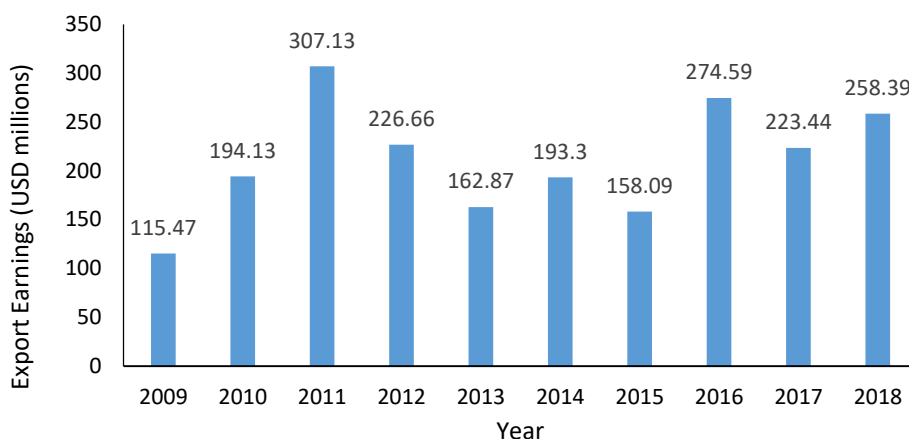
Fruits and vegetables grown in Sri Lanka are exported in fresh and processed forms to many countries including UAE, Maldives, United Kingdom, USA, India, Malaysia, etc. Figure 3-2 presents Sri Lanka’s major markets in terms of foreign exchange earnings (USD million) in 2018, with the country’s export performance in food and beverage from 2009 to 2018 illustrated in Figure 3-3.

[Figure 3-2] Sri Lanka’s major markets in terms of USD (Mn) in 2018



Source: Department of Census and Statistics (2020)

[Figure 3-3] Export performance of food and beverages (2009-2018)



Source: Department of Census and Statistics (2020)

1.7 Collaborative Project between NASTEC and STEPI

Within this context, the collaborative project supported by STEPI, therefore, is a timely initiative in contributing to the achievement of national goals. The 16 food crops identified by the government of Sri Lanka are mainly focused on import substitution, and considerable funding and manpower have been earmarked for the island-wide programs. Among the 33 crops identified under the NCRCS, including crops targeted for import substitution, however, several vegetable and fruit crops are included and aimed at boosting local production and focusing on export markets. Thus, the NASTEC-STEPI collaboration would focus more on the long-term targets in achieving local production and targeting export orientation while incorporating the latest Korean technologies into the production and value chain of such crops, mainly in the broad categories of fruits and vegetables.

The pilot project proposed through this collaborative project will be a landmark program to improve the agriculture sector in the country. As illustrated in previous sections, the 6 crops selected for the pilot project have high export potential while recording increasing harvest. Therefore, with the infusion of new STI-based interventions mainly from our research institutes as well as through Korean technology transfers, the results of the proposed pilot project will be lessons learned for the entire sector where the entire value

chain will be pilot-tested for productivity, process, and entrepreneurship improvement. Accordingly, the six crops below are selected for pilot implementation based on their potential.

[Table 3-9] Crops selected for the pilot project

Crop	Justification for selection
Fruit Crops	
Banana	A crop with a good local demand and export market, but has shown a marginal decline in production extents and production and an increasing trend in exports shown in Tables 4 and 5. The full potential of the banana crop is still to be harnessed in Sri Lanka using novel technologies
Pineapple	A crop with a good export market and local demand, but with a dramatic reduction in export quantities and earnings in 2019 (Table 5). The gaps and deficiencies in the value chain need to be identified and addressed well to regain and further promote the fruit crop in the export market.
Papaya	A popular fruit crop for local consumption, while having an export market with the highest growth rate among fruits crops that have been export from Sri Lanka in 2019 (Table 5). The trends identified need to be catered by increasing high quality produce locally by infusing novel technologies.
Mango	With trademark varieties developed in Sri Lanka, this fruit crops have shown lots of promise in terms of local and export markets. The crops have shown a steady growth in terms of export demand (Table 5) and requires production-oriented technologies and value-added products to boost the income generation further.
Vegetables	
Tomato	A popular vegetable crop among the consumers and farming communities with seasonal production in Sri Lanka with huge production gluts and minimum value addition. The crop has shown a steady decline in export, both in terms of quantities and values (Table 7). The crop requires novel technologies for harnessing its maximum potential with a continuous supply of high-quality production.
Red Pumpkin	A popular vegetable crop among the consumers and farming communities with seasonal production in Sri Lanka with huge production gluts and minimum value addition. The crop has shown a dramatic increase in export quantities and values (Table 7) and requires further attention with novel technologies for harnessing its maximum potential with a continuous supply of high-quality production

Source: author

1.8 Agro-entrepreneurship

With the issues and challenges discussed in this report, there is obviously a shift in the agriculture sector's job orientation toward more lucrative and convenient avenues to a certain extent toward manufacturing and service sectors. The complex individual preferences for diverse employment avenues and multifaceted socio-economic factors as well as rapid changes in the market behavior are among the major drivers of this paradigm shift. Under these circumstances, available opportunities to utilize the full potential of the agriculture sector particularly for agriculture development are challenging.

Unless comprehensive policy and plan are developed at the national level to utilize young entrepreneurs fully in the agricultural sector, the development goals will become unrealistic for the government. Therefore, grasping the full advantage of knowledge and expertise to trigger agricultural development should be a priority concern. Furthermore, it is important to note that strengthening the link between agricultural education and agriculture-related technological know-how is a timely investment with the existing agricultural growth in meeting the local and export markets.

However, the agricultural sector is increasingly becoming unpopular as an employment specially among the young people, which has become a global trend. On the other hand, despite the steady progress in poverty reduction (4.1% lived below the national poverty line in 2016), most families still live in some degree of income insecurity. Nearly a million Sri Lankans live within 20% of the national poverty line (i.e., 8.7% of the population). Moreover, living standards remain low, meaning the majority will likely find it challenging to withstand economic shocks brought about by COVID-19. Income inequality remains stubbornly high, with Gini measurements recording 0.45 in 2016 (compared to 0.48 in 2012) and the income share of the richest 20% of households hardly changing at 50.8 (compared to 52.9 in 2012). The impact of COVID-19 is acutely felt by those underserved by the ongoing social protection schemes, having further knock-on effects on the aggregate demand and consequently the economy.

In order to address this challenging situation within a closed economy as a result of COVID, local entrepreneurship development specially targeting the youth at the rural level has become a dynamic and attractive option. Many rural families are engaged in agriculture for their survival, and there is a dire need to mobilize the rural youth immediately on Agri-entrepreneurship with a promising pathway to retain the youth so as to maintain sustainable livelihood development.

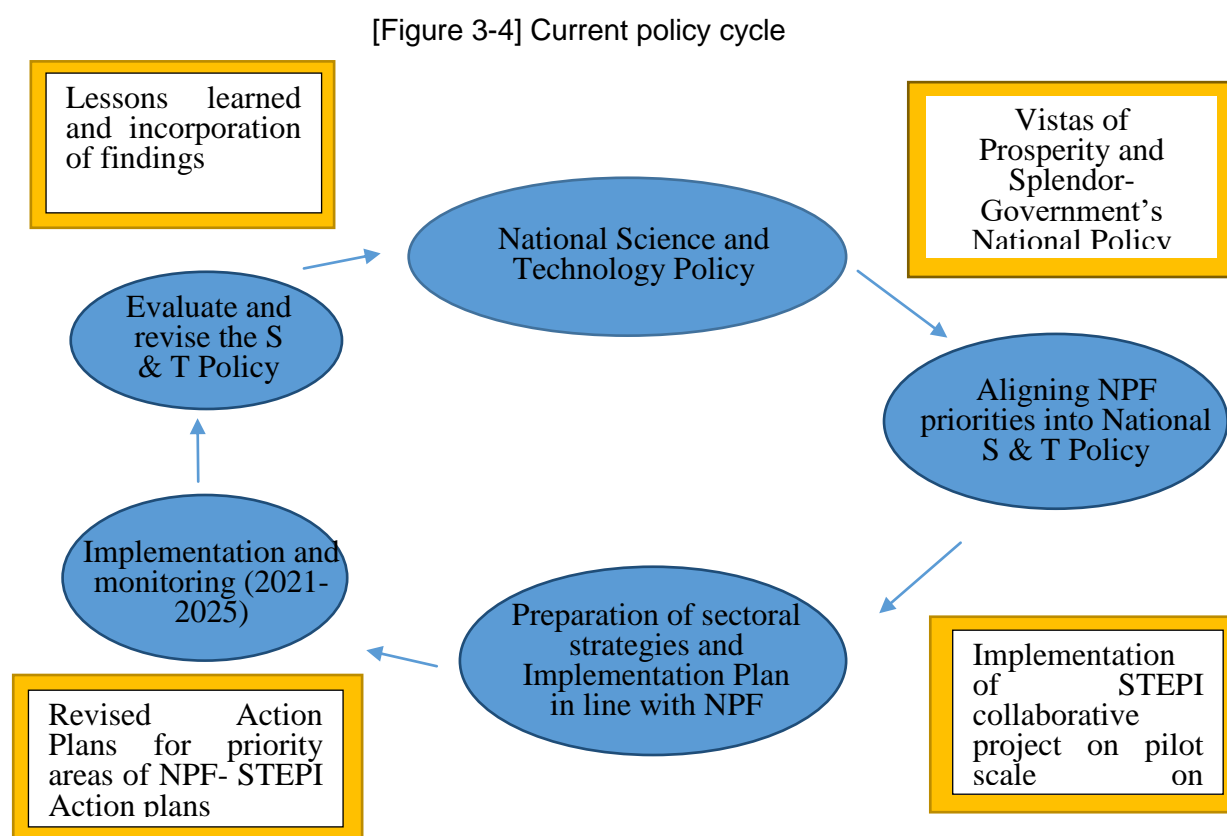
The term “entrepreneurship” is often recognized as a creative, innovative activity that accepts risks and adapts to the changing environment with swift changes in business strategies. Agri-entrepreneurship can be said to be one of the promising avenues that allows the youth to take full advantage of their knowledge, expertise, and skills while boosting economic and social development in the country. Evidence shows that the advancement of entrepreneurial activities has resulted in economic prosperity in most developing countries. The term “agripreneurship” is also interchangeably used as an innovative business activity related to agriculture.

The current government has already initiated several measures to attract the youth to agro-entrepreneurship by allocating lands, providing low-interest loans, and making low-cost technologies, etc. available. Within this context, the proposed pilot project that will facilitate one common platform to pilot-test the entire value chain will be a great opportunity for the agriculture sector to see the possibilities of replication and to assess the cost-benefit analysis of such initiatives. By initiating and completing this pilot project, this is going to be the first-ever investment in a pilot project for a value chain-oriented Agro-entrepreneurship development.

Similarly, improvement of food supply and nutrition, value addition to underutilized agricultural products or crops, technological development, expansion of commercial orientation of farming activities, re-branding of agriculture through high-quality products, and grabbing of export market opportunities are among the possible avenues to explore for those young entrepreneurs.

1.9 Current policy cycle aligning with the government NPF

Figure 3-4 illustrates the current policy cycle including the National Science and Technology Policy and its alignment with the National Policy Framework of the present government.



Source: author

1.10 The proposed Action Plan will be supported by following S&T related policies and acts

The Overarching Policy for all economic sectors of the country will be in line with the “Vistas of Prosperity and Splendor: the National Policy Framework” where the Agriculture sector has been identified as one of the key sectors. As elaborated, the current Science

and Technology Policy, which is being revised to incorporate innovation perspectives in line with NPF, will be the highest-level sectoral Policy for this program. Meanwhile, as indicated above, the highest-level authorities are already in the process of finalizing the “New National Agriculture Policy”. Therefore, the proposed Action Plan is guided by both existing S& T Policy (2008) and Agriculture Policy while incorporating the required changes in line with the proposed amendments to both policies. In addition, the existing SME Policy and related strategies and new programs such as declaration of “Skills Development Decade”, Agro -Industrialization, building up of youth agricultural entrepreneurship, etc. will also be guiding strategies in initiating this Action Plan.

Furthermore, the following sectoral policies and Acts are identified as relevant to this initiative:

- National Agricultural Research Policy and Strategy (CARP) 2018 – 2027 (2018)
- Sri Lanka National Agricultural Policy (2007)
- National Seed Policy (1996)
- National Policy for the Primary Industries of Sri Lanka (2018)
- National Climate Change Policy of Sri Lanka (2012)
- National Export Strategy of Sri Lanka – 2018-2022
- National Policy and Strategy on Cleaner Production for the Agriculture Sector (2012)
- Food Safety Policy (establishment of Food Safety Authority – Draft 2019)
- National Policy Framework for SME Development
- National Nutrition Policy 2010
- National Policy on Alien Invasive Species (IAS) in Sri Lanka, Strategies and Action Plan 2016

1.11 Related Acts and legislations

- Seed Act No. 22 of 2003 – Department of Agriculture
- Export Development Board Act No. 40 of 1979 – Export Development Board

- Food Act No. 26 of 1980 – Ministry of Health (Food controller)
- Consumer Affairs Authority Act No. 9 of 2003 – Consumer Affairs Authority
- Imports and Exports (Control) Act No. 1 of 1969 – Department of Imports and Exports Control
- Science and Technology Development Act No. 11 of 1994 -
- Control of Pesticides Act (as amended) No. 33 of 1980 – Department of Agriculture
- Soil Conservation (Amendment) Act No. 24 of 1996 – Department of Agriculture
- Board of Investment of Sri Lanka (Amendment) Act No. 3 of 2002 – Board of

1.12 Planning directions (Step-by-step procedure of this action plan to be implemented (who, when, what))

The Action Plans for the relevant components are prepared in consultation with the relevant main agencies including the Ministry of Agriculture, Department of Agriculture, Department of National Planning, National Youth Council, etc. Once the consent of the STEPI is given, the detailed implementation mechanism will be discussed. During this discussion, the overall Action Plan will be categorized into short- and medium-term programs to facilitate their implementation. All identified programs will be expanded to specific actions with a time line, and responsible organizations with a lead agency will be identified against each program. This Action Plan is intended to be implemented from 2021 to 2025. The overall implementation will be the responsibility of the Ministry of Agriculture in collaboration with the Department of Agriculture, whereas NASTEC will engage in facilitating the implementation by having discussions with the relevant stakeholders and supporting the formulation of national policies where required. NASTEC will also engage in implementing a pilot project to promote productivity, process, and agri-entrepreneurship in collaboration with the Ministry of Agriculture, Ministry in charge of Youth Affairs, and Ministry of Lands. The detailed targets on the pilot project are highlighted under the Entrepreneurship Section of this report.

2. Science and Technology Future Vision 2030

2.1 Trend analysis of changes in the future society

Sri Lanka is a lower- to middle-income country with GDP per capita of USD 3,853 (2019). The Sri Lankan economy is undergoing its worst-ever recession in 2020 but is expected to stage a gradual recovery in 2021. Sri Lanka's GDP is expected to contract by 5.5% in 2020, mainly due to the impact of the COVID-19 pandemic, and grow by 4.1% in 2021. Such growth is expected to be supported by strengthening demand for goods' exports and through technology and innovation. Through the STI policy, acquiring global competitiveness in key aspects is targeted by investing in R & D and innovations. Thus, agriculture has been identified specially for value addition and to reduce post-harvest losses. In spite of the ambitious targets set by the industry and research institutes, however, Sri Lanka is currently unable to reach its full capacity due to lack of efficient and advanced technology adoptions. One of the main reasons is inadequate funding for R & D on advanced technologies both by public and private sectors.

Nonetheless, the ministry in charge of STI has already taken steps to introduce a tax exemption system for private sector investment in R & D while increasing the budget government investment. Further STI interventions are also proposed to improve the Global Innovation Index. The key performance indicators proposed for the period 2021-2025 are illustrated in the table below.

Key Criteria	Current ranking/Status (2019/2020 GII & GCI)	Forecasted Indicators by 2025
Global Innovation Index (GII)	101 th position	80 th position
Global Competitiveness Index (GCI)	84 th position	50 th position
Research Institution Prominence Index (RIPI)	71 th position	50 th Position
Researchers, FTE/per million population	106	1300

Key Criteria	Current ranking/Status (2019/2020 GII & GCI)	Forecasted Indicators by 2025
Patent application per million population	87 th position	60 th position
High and medium high-tech manufacturing % of total trade	92 nd position	80 th position
High-tech net exports % of total trade	87 th position	70 th position
Government funding on R & D	0.1% of GDP	1% of GDP
Private sector investment on R & D	0.037% of GDP	0.045% of GDP
R & D based products in the market	126	160

Source: Ministry of Higher Education, Technology and Innovation (2019)

Therefore, countries like Sri Lanka need to find space to expand their economies by relying on science and pushing the formation of technology capabilities, health capacity, and knowledge to respond to the current crisis if they are to sustain and improve society. A wave of innovation needs to be scaled up to support the response on multiple fronts to enhance capacity for future generations.

2.2 What people expect from STI

The year 2020 has put aside many innovations that have aided in the survival of human beings and planet. While acknowledging all the achievements in the past, the need for and importance of making timely forecasts using effective science and technological tools has become the priority, especially to solve climate-related issues and human health-related concerns. Agriculture, a major contributor that feeds nutritious food to human beings, is no exception. The people, especially the younger generation, expect attempts to be made at least to predict more general trends and to imagine what to expect from the point of view of science and technology. Achieving the much needed food and nutrition security, meeting the climate challenge, having access to new frontier developments in medicines, and using artificial intelligence and precision agriculture in providing food to feed the

nation are highly likely to be priorities in the years to come.

2.3 STI future vision 2030

Improving the quality of life through Science, Technology, and Innovation

2.4 Envisioning the future world driven by STI

A technology-based society adopting new frontier tools and technologies while recognizing and respecting indigenous technologies and cultural, social, and environmental values

3. The Science, Technology and Innovation Plan for Agriculture Sector - (2021-2025)

3.1 The S & T policy directions for the realization of future vision

The current S & T policy is organized under 10 objectives with a set of strategies. Meanwhile, the National Research and Development Framework developed in 2016 has identified 10 priority sectors and 10 priority interventions. Agriculture has been identified as one of the priority areas for which interventions such as technological transformation including Nano technology and biotechnology, policy interventions, etc. are given priority. Meanwhile, the development of new policies such as having a Domestic Seed Policy facilitate the local growth of agriculture targeting a large-scale export market has been identified in the National Policy Framework as well.

In addition, promoting agriculture-based entrepreneurship has been given prominence in the NPF.

3.2 Structure of the Plan

This Plan is prepared in line with the vision of “Vistas of Prosperity and Splendors” (Saubhagya Dekma) for the agriculture sector’s development as envisaged by the National Policy Framework (NPF) and organized into three components. Strategies are identified with the relevant objectives. Accordingly, the Action Plans will deal with the following three components:

- Proposed STI programs for productivity improvement
- Proposed STI programs for process improvement
- Proposed STI programs for agri-entrepreneurship development

Action programs are identified against each component under the four main strategies: People-Centric Economic Development; Technology-Based Society; Sustainable Environment; and Productive Citizen and Happy Family.

4. Implementation Measures

Implementing ministries and organizations are identified for each program with a tentative budget estimate. The implementation of the proposed STI Plan will be in two phases: immediate implementation (2021) and short-term implementation (2021-2025). A detailed action plan will be developed annually based on the programs identified against each objective under three components.

NASTEC will be directly involved in facilitating the relevant line ministries and organizations in relation to the required policy development. It will also explore both government and foreign funding in order to secure financial commitment to implement the Plan.

The third component of the Plan (agri-entrepreneurship development) as an emerging concept requires commitment and continuous flow of funding as a model initiative. It is intended to implement a pilot project putting all three facilities/categories (productivity/process/entrepreneurship) in one location to assess the success/failures of the initiatives. NASTEC will discuss with the Ministry of Lands and Ministry of Youth Affairs to identify a land area and to provide training for the youth in promoting entrepreneurship together with the private sector.

A monitoring mechanism through the establishment of a Steering Committee will be established for the regular monitoring of the programs. This will be represented by all key line ministries, chambers, private sector, and research institutes.

Based on the lessons learned through the pilot project, the concept can be promoted island-wide which will help achieve the strategies and objectives identified and formulate new policies where necessary.

5. Stakeholders

5.1 Cabinet and State Ministries of the Central Government

- Ministry in charge of Finance
- Ministry in charge of Agriculture – Fruit and vegetable cultivation / value addition
- Ministry in charge of Lands
- Ministry in charge of Trade – Corporative / Consumer protection
- Ministry in charge of Education
- Ministry in charge of Skills Development, Vocational Education, Research, and Innovation
- Ministry in charge of Health – Food safety and food quality
- Ministry in charge of Industries – Food Quality, international trade, foreign investment
- Ministry in charge of Environment – Waste management, sustainable consumption and production

5.2 Government Authorities:

- Department of Agriculture
- Department of Agrarian Development
- Department of Census and Statistics
- Department of Export Agriculture
- Consumer Affairs Authority
- Industrial Technology Institute (ITI)
- Sri Lanka Institute of Nano Technology (SLINTEC)

- National Engineering Research and Development Centre (NERD)
- Institute of Post-Harvest Technology (IPHT)
- National Institute of Education (NIE)
- Universities
- National Apprentices Industrial Training Authority (NAITA)
- Export Development Board
- Board of Investment (BoI)
- Sri Lanka Standards Institution
- Sri Lanka Accreditation Board
- Central Environmental Authority
- Department of Meteorology
- Hector Kobbekaduwa Agrarian Research and Training Institute
- Department of National Planning
- Sri Lanka Council for Agriculture Research Policy
- Information and Communication Technology Agency

5.3 Provincial Set up and Local Government

- Provincial Ministry of Agriculture
- District Secretariat
- Divisional Secretariat

5.4 Provincial Agencies

- Provincial Department of Agriculture

- District Agriculture Directorates

5.5 Local associations of farmers

- Chambers – Chamber of Commerce/Chamber of Industries at national and regional levels
- Chamber of Exporters
- Sri Lanka Institute of Agriculture
- Sri Lanka Food Processor Association
- Fruit and Vegetable Producers, processors and Exporters Association
- Nutrition Society
- Institute of Food Science and Technology
- Exporters' Association
- Association of Testing Laboratories
- Private Input suppliers
- Private millers and processors
- Super Market Chains
- Warehouse and transport operators

6. Action Plan (2021-2025)

6.1 Action Plan for Productivity Improvement

6.1.1 6.1.1. Strategies and Objectives

- **Strategy 1: Establishment of basic infrastructure to enhance the productivity**

Objective 1:

6.1.1.1 Development of methodology to maximize natural resources consisting of lands, soil, and water for the sustainable and productive use of crop-based production by 2022

Objective 2:

6.1.1.2 Promote the use of organic matter to improve physical, chemical, and biological properties of soil and quality of crop harvest

Objective	Actions	Ministries/Agencies	Budget (Mn)
Objective 1 Development of a methodology to bring the natural resources comprising lands, soil and water for sustainable and productive use of 06 crops production	<ul style="list-style-type: none"> • Identify barren and abounded lands for crop production 	Ministry of Lands Ministry of Agriculture	
	<ul style="list-style-type: none"> • Introduction of an integrated soil fertility management system 	Horticultural Crop Research and Development Institute - Department of Agriculture	
	<ul style="list-style-type: none"> • Develop measures to minimize use of chemical inputs 	Department of Agriculture Industrial Technology Institute Sri Lanka Institute of Nano Technology	

Objective	Actions	Ministries/Agencies	Budget (Mn)
	<ul style="list-style-type: none"> Assessment of effective water conserving farming system 	Ministry of Irrigation and Water Resources Management Department of Agriculture	
Objective 2 Promote the use of organic matter to improve physical, chemical and biological properties in soils and quality of crop harvest	<ul style="list-style-type: none"> Conduct farmer extension programmes for the production of quality assured bio-fertilizer and organic fertilizer using native soil microorganisms, and agricultural, urban and homestead waste 	Extension division of Department of Agriculture	
	<ul style="list-style-type: none"> Develop home gardening-based projects using organic fertilizers 	Fertilizer Secretariat – Ministry of Agriculture State Ministry of Production and Supply of Fertilizer and Regulation of Chemical Fertilizer and Insecticide Use	
	<ul style="list-style-type: none"> Convert traditional farming villages into users of only organic fertilizer 	Ministry of Agriculture Provincial Councils	

- **Strategy 2: Ensure provision of good seed and planting material for increased productivity**

Objective 1:

6.1.2.1 Enhance productivity of selected crops by 50% by 2023 via providing good quality seeds and planting materials

Objective 2:

6.1.2.2 Development of new integrated pest management packages by 2025

Objective 3:

6.1.2.3 Introduction of seasonal climate forecasting technologies for crop production by 2025

Objective	Actions	Ministries/Agencies	Budget (Mn)
Objective 1 Enhance productivity of selected crops by 50% by 2023 via providing good quality seeds and planting materials	<ul style="list-style-type: none"> Re-visiting the existing Seed Policy - Review the existing policy to incorporate national interest and public need. 	Ministry of Agriculture NASTEC Department of National Planning	
	<ul style="list-style-type: none"> Formulation of regulations for effective implementation of the Seed Act to assure good quality seeds for farmers 	Ministry of Agriculture	
	<ul style="list-style-type: none"> Enhance the capacity to carry out seed research 	Horticultural Crop Research and Development Institute Plant Genetic Resource Centre Fruit Research Institute	
	<ul style="list-style-type: none"> Create farmer awareness on producing and use of good quality seeds and planting materials 	Seed Certification Services Extension services of Department of Agriculture	
	<ul style="list-style-type: none"> Continuous availability of quality breeder seeds and planting materials in adequate quantities at an affordable price or through credit facilities at with low interest rate (4%) 	Ministry of Agriculture	

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Objective	Actions	Ministries/Agencies	Budget (Mn)
	<ul style="list-style-type: none"> Establishment of an insurance scheme for seed and planting materials production and storage 	Ministry of Agriculture	
Objective 2 Development of new integrated pest management packages by 2025	<ul style="list-style-type: none"> Conduct research on environment-friendly bio-pesticides and integrated pest management 	Plant protection services Industrial Technology Institute	
	<ul style="list-style-type: none"> Update Plant Protection Act No 35 of 1999 with regulations by 2022 with more strength to implement plant protection activities in Sri Lanka 	Ministry of Agriculture	
	<ul style="list-style-type: none"> Revisit the National IAS Policy, Strategies and Action Plan of 2016 in conjunction with the National Plant Protection Act No 35 of 1999 and its regulations to strengthen the M&E system entry of invasive alien species to Sri Lanka. 	Ministry of Agriculture Ministry of Environment	
Objective 3 Introduction of seasonal climate forecasting technologies for crop production by 2025	<ul style="list-style-type: none"> Establishment a programme to examine seasonal variations in the climatic parameters and develop seasonal climate with an adequate lead time 	Department of Agriculture Department of Meteorology	

▪ **Strategy 3: Increase production of crops through advanced technological applications**

Objective 1:

6.1.3.1 Increase investment on using advance technologies for precision agriculture by 50% in 2022

Objective 2:

6.1.3.2 Establish support mechanisms for production of agricultural machinery as a local industry by 2022

Objective 3:

6.1.3.3 Develop a farm-market linkage using ICT application by 2022

Objective 4:

6.1.3.4 Increase high-value crop production under protected houses for target local and international markets by 2022

Objective	Actions	Ministries/Agencies	Budget (Mn)
Objective 1 Increase investment on using advance technologies for precision agriculture by 50% in 2022	• Create awareness on the precision agriculture technologies at all levels as a means of high input use efficiency for higher productivity	Extension services of Department Agriculture Farm Mechanization Research center	
	• Promote and adopting precision technologies in all Agribusinesses to increase labour productivity and profits	Ministry of Agriculture Ministry of Industries	

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Objective	Actions	Ministries/Agencies	Budget (Mn)
	<ul style="list-style-type: none"> • Introduce a method to engage educated and high skilled youth in adopting precision technology-driven modernization of the crop production sector 	State Ministry of Skills Development, Vocational Education, Research & Innovations Ministry of Youth Affaires Ministry of Agriculture	
	<ul style="list-style-type: none"> • A method to increase high level coordination and harmonization effort to attract PPP for R&D and technological know-how and transfers (TT) in precision agriculture technologies 	Ministry of Agriculture Ministry of Industries	
	<ul style="list-style-type: none"> • Increasing the competitiveness in agricultural products on global markets by exploring technology gaps, high investments and adequate quantities of high-quality inputs 	State Ministry of Skills Development, Vocational Education, Research & Innovations Export Development Board	
	<ul style="list-style-type: none"> • Introduction of an attractive incentive scheme for relevant investors engaged in smart agriculture 	Ministry of Finance Board of Investment of Sri Lanka	
Objective 2 Establish support mechanisms for production of agricultural machinery as a local industry by 2022	<ul style="list-style-type: none"> • Increase R & D on agriculture machinery/infrastructural facilities. • Encourage inventors/Innovators to develop low cost, high quality agriculture machinery suitable for local conditions • Provide financial incentives such as low interest loans (4%) for investments to development the agricultural 	Ministry in charge of the subject of Agriculture and relevant state Ministry State Ministry of Skills Development, Vocational Education, Research and Innovation (NASTEC)	

Objective	Actions	Ministries/Agencies	Budget (Mn)
	machinery producing industry		
Objective 3 Develop a farm-market linkage using ICT application by 2022	<ul style="list-style-type: none"> Introduce a market information system to feed farmers on the market-demand for crops to decide on their production and supply 	Department of Agriculture Information and Communication Technology Agency Hector Kobbekaduwa Agrarian Research and Training Institute	
	<ul style="list-style-type: none"> Create a program to strengthen informed-decision making process in agriculture and to disseminate knowledge in facilitating production of competitive and commercially-oriented crops 	Ministry of Agriculture	
	<ul style="list-style-type: none"> Capacity building and training programs on ICT based agriculture technologies for field level agriculture extension officers 	Department of Agriculture Information and Communication Technology Agency	
Objective 4 Increase high value crop production under protected houses for target markets at local and international by 2022	<ul style="list-style-type: none"> Strengthen R&D programmes on high-valued crop production under protected houses 	Horticultural Crop Research and Development Institute Fruit Research Institute Sri Lanka Institute of Nano Technology National Engineering Research and Development Centre	
	<ul style="list-style-type: none"> Promote branding of crop products to secure niche and global marketplace 	Export Development Board Ministry of Agriculture	

6.2 Action Plan for Process Improvement

6.2.1 Strategies and Objectives

- **Strategy 1: Increase the contribution of export-oriented agriculture economy through enhancing self-reliance**

Objective 1:

6.2.1.1. Introducing a new National Agriculture Policy in line with the existing policies in the sector by incorporating Science, Technology, and Innovation Perspectives into the Policy by 2022

Objective 2:

6.2.1.2 Increase the contribution of international export business through new technologies and value addition in the 6 selected crops by 15% from the current level by 2025 and by 50% of fruits and vegetables by 2030

Objective 3:

6.2.1.3 Ensure proper distribution mechanisms for crops by introducing novel technologies and innovative process by 2022

Objective 4:

6.2.1.4 Sri Lanka becomes self-sufficient on certain identified crops by 2022

Objective 5:

6.2.1.5 Increase the average farmer income of identified crops by 15% from the current level by 2025

Objective	Actions	Ministries/Agencies	Budget (Mn)
Objective 1 Introducing a new National Agriculture Policy in line with existing policies in the sector in terms of incorporating Science, Technology and Innovation Perspectives to the Policy by 2022	<ul style="list-style-type: none"> • Revisit and align the draft Overarching Agriculture Policy (OAP) of the Department of National Planning (DNP) to meet the objectives of the National Policy Framework • Develop a set of implementation guideline in line with National Policy Framework (Saubhagyaye Dekma) 	Ministry in charge of the subject of Agriculture and relevant state Ministry State Ministry of Skills Development, Vocational Education, Research and Innovation National Science and Technology Commission (NASTEC) Sri Lanka Council for Agriculture Research Policy Department of National Planning	
Objective 2 Increase the contribution of International export business through new technologies and value addition in identified six crops by 15% from the current level by 2025, and by 50% of fruits and vegetables by 2030.	<ul style="list-style-type: none"> • Conduct a detailed baseline survey to identify clear targets to increase the income level • Develop and introduce low-cost post-harvest handling methods • Introduce energy efficient post-harvest processing methods to reduce high electricity cost • Conduct Research and Development on new post-harvest technologies and packaging systems • Establish export processing villages on the selected crops • Introduce conducive packages for foreign direct investment opportunities 	Ministry of Industries Ministry of Trade Department of Commerce Department of Agriculture Industrial Technology Institute Post-Harvest Technology Institute Board of Investment Export Development Board Sri Lanka inventors commission Department of Export Agriculture Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI)	

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Objective	Actions	Ministries/Agencies	Budget (Mn)
Objective 3 Improve proper distribution mechanisms for crops through introducing novel technologies and innovative process by 2022	<ul style="list-style-type: none"> • Provide new railway coaches and improved railway infrastructure to expand appropriate post-harvest crop distribution system • Provide proper storage / cold chain facilities for priority crops • Develop sorting / grading / packaging facilities in district /regional level or at farm gate level 	Ministry of Agriculture Ministry of Transport Industrial Technology Institute Department of Railway	
Objective 4 Sri Lanka becomes self-sufficient on certain crops by 2022	<ul style="list-style-type: none"> • Introduce an efficient methodology to utilize the lands enhance the productivity • Introduce a new integrated soil fertility management system • Provide tax free importation of machinery and equipment related to novel technologies of value addition and processing • Develop a market intelligence information system for better pricing / demand driven crop processing 	Ministry of Lands Ministry of Agriculture Ministry of Economic affairs Department of National Planning Sri Lanka Council for Agriculture Research Policy Department of census and Statistics Information and Communication Agency of Sri Lanka (ICTA) HARTI	
Objective 5 Increase Average farmer income of six identified crops by 15% from the current level by 2025	<ul style="list-style-type: none"> • Promote modern agricultural practices at domestic farms/ local producers on post-harvest technologies • Introduce demonstration plots to disseminate the technology to farmers' clusters and food processors (exporters) • Establish a direct 	Department of Agriculture Export Development Board Department of Export Agriculture Private sector partners Export Development Board Local food chain companies Consumer Affairs Authority Sri Lanka Standards	

Objective	Actions	Ministries/Agencies	Budget (Mn)
	channel between farmers and processors through a virtual supply chain system • Introduce shorter value chains/marketing sequences • Promote pre-contracts system along value chains • Bridge to encourage private sector investments particularly in areas of seed and planting material production, agriculture research and development • Strengthen and expand e-marketing / door to door delivery systems with guaranteed food quality and safety	Institution Chamber of Commerce ICTA SLCARP	

▪ **Strategy 2: Enhance the self-reliance on Post Harvesting and value addition technologies on selected crops**

Objective 1:

6.2.2.1 Provide training for 10000 youths (male and female) on post-harvest management, value addition, and processing, quality, and food safety with an NVQ-level certificate by 2025

Objective 2:

6.2.2.2 Introduce at least 3 selected crops to penetrate the international market with proper Branding by 2024

Objective 3:

6.2.2.3 Introduce 3 new innovative process and value addition technologies to the farmers for the 6 selected crops by 2024

Objective 4:

6.2.2.4 Develop and introduce Sri Lanka Standards a in relation to storing and packaging for process foods of six crops by 2023

Objective 5:

6.2.2.5 Make available modern infrastructure facilities (at least 3 state of the art clod chain facilities, 25 regionals economic centers, 100-acre cultivation lands) with modern process technologies to farmers by 2025

Objective	Actions	Ministries/Agencies	Budget (Mn)
Objective 1 Provide training for 10000 youths (male and female) on post-harvest management, value addition and processing, quality and food safety with a NVQ level certificate by 2025	<ul style="list-style-type: none"> • Provide wider opportunity to existing workforce with special focus to youth engaged in agriculture sector (six crops) to upgrade their skills to NVQ level • Introduce building youth agricultural entrepreneurship to secondary level education curricula • Promote research on developing sustainable business model and partnership arrangements for small farmer participation in agribusiness • Develop training modules for industry operators on post-harvest management. • 	State Ministry of Skills Development, Vocational Education, Research and Innovation NAITA NIE Industrial Technology Institute Institute of Post-Harvest technology	
Objective 2	• Establish an	Department of Agriculture	

Objective	Actions	Ministries/Agencies	Budget (Mn)
Introduce at least 3 identified crops (Vegetable/fruit) to the international market with proper branding	<ul style="list-style-type: none"> internationally accepted product quality inspection system • Develop a Health Food Factory to become centre of excellence in the region with identified 6 crops • Establish a unique Sri Lanka brand for identified three crops 	Department of Export Agriculture Chamber of Commerce Ministry of Health Ministry of industry and commerce Institute of Post-Harvest Technology	
Objective 3 Introduce 3 new innovative process and value addition technologies to the farmers on identified six crops by 2024	<ul style="list-style-type: none"> • Encourage researchers and scientists to undertake research in value addition and technological innovation • Undertake R & D to introduce state of the art food processing machinery /system to reduce labour and to increase the production efficiency • Introduce processing technologies to increase economies of scale with new technology • Introduce alternative sources of energy • Promote agriculture modernization by pursuing innovation through the value chain (drone technology, precision tech etc) • Implement a national budget pooling system for stable management and utilization of public research facilities for demand-based innovation and technologies 	Department of Agriculture State Ministry of skills development, Vocational education, Research and Innovation Department of National Planning Industrial Technology Institute	
Objective 4 Develop and introduce Sri Lanka Standards in relation	<ul style="list-style-type: none"> • Introduce an internationally accepted organic product certification system • Develop a set of standards to meet international quality 	Sri Lanka standard institute Department of Agriculture Sri Lanka Accreditation Board for Conformity	

Chapter 3. Science, Technology and Innovation Action Plan for Agriculture Sector Fruits and Vegetable Crops Sri Lanka - 2021-2025

Objective	Actions	Ministries/Agencies	Budget (Mn)
to storing and packaging for process foods of six crops	requirement for storing and packaging • Upgrade national quality certification process to international standard	Assessment	
Objective 5 Make available modern infrastructure facilities (at least 3 state of the art cold chain facilities, 25 regional economic centers, 100-acre cultivation lands) with modern process technologies to farmers by 2025	Introduce green energy utilization at cold storages through installing the solar energy system • Develop Capacity building in R&D institutions / Universities for new innovations • Provide R&D institutional support for SMEs via establishment of industry incubation centers at regional and district level • Establish Public-Private partnerships / funding for proper technology development and transfer / Intellectual property protection (IP) • Establish a national system to ensure food safety and quality to attract more investment internationally • Implement a mechanism for continuous supply of quality raw material in adequate quantity through a virtual supply chain system • Introduction of a farming quota system based on demand to reduce post-harvest losses and to maintain the storage facilities- organized production	Ministry of Environment University Grant Commission Ministry of Education State Ministry of skills development, Vocational education, Research and Innovation Sri Lanka Sustainable Energy Authority National Intellectual Property office Chamber of Commerce ICTA NAITA Department of Agriculture SLCARP Ministry of Health	

- **Strategy 3: Enhance the contribution of export of agriculture products through sustainable value chain on post-harvest and value addition on selected crops**

Objective 1:

6.2.3.1 Reduce the current post-harvest loss from 30-40% to 10% by 2025 through the adoption of sustainable consumption and production

Objective 2:

6.2.3.2 Introduce new value-added products (from waste) to the market by 2024

Objective 3:

6.2.3.3 Increase the Per capita fruit and vegetable consumption of Sri Lanka from 37% (from the FAO requirement) in 2021 to 50% in 2024.

Objective	Actions	Ministries/Agencies	Budget (Mn)
Objective 1 Reduce the post-harvest losses of 30-40% to 10% by 2025 through practicing sustainable consumption and production	<ul style="list-style-type: none"> • Introduce proper packaging and transport system to reduce losses related to post harvest handling • Impose rules and regulation for household food waste • Introduce incentives to encourage to reduce food waste 	State Ministry of Skills Development, Vocational Education, Research and Innovation NAITA NIE Industrial Technology Institute	
Objective 2 Introduce 3 new products (from waste) to the market by 2024	<ul style="list-style-type: none"> • Introduce 3 new products using crop wastes to industries • Introduce market-based instruments (incentives, tax relief) for waste-based food production industries 	Consumer affairs authority Institute of Post-Harvest Technology	
Objective 3 Increase Per capita fruit and vegetable	<ul style="list-style-type: none"> • Inculcate scientific thinking among the society on changing the fruit and 	Ministry of Education Ministry of Health	

Objective	Actions	Ministries/Agencies	Budget (Mn)
consumption of Sri Lanka from 37% (from the FAO requirement) in 2021 to 50% in 2024.	vegetable consumption pattern • Promote consumption of processed fruits and vegetables • Develop awareness programmes on sustainable food consumption targeting for School children • Introduce functional food to combat with non-communicable diseases	Consumer affairs authority National Science Foundation Department of Agriculture	

6.3 Action Plan for Agri Entrepreneurship development

6.3.1 Strategies and Objectives

- **Strategy 1 – Facilitate agriculture entrepreneurship education and training activities**

Objective 1:

6.3.1.1 Review & amendment of policies that are inconsistent with initiation and promotion of agri-enterprises of selected 6 crops by 2023

Objective 2:

6.3.1.2 Undertake teaching and capacity building initiatives related to agri-entrepreneurship development of 6 crops by 2022

Objective 3:

6.3.1.3. Organize stakeholder consultation programmes for each 6 crop sectors to find constraints and gaps for each sector by 2021

Objective	Actions	Ministries/Agencies	Budget (Mn)
Objective 1 Review & amendment of policies that are inconsistent with initiation and promotion of agri-enterprises of selected 6 crops by 2023	<ul style="list-style-type: none"> • Identification of gaps & constraints relevant to agri-entrepreneurship and selected 6 crops in existing policies 	Ministry of Agriculture, Ministry of Industries, Sri Lanka Council for Agriculture Research Policy	
	<ul style="list-style-type: none"> • Amendment of the policies based on identified constraints and gaps 	Ministry of Agriculture, Ministry of Industries, Sri Lanka Council for Agriculture Research Policy (SLCARP)	
	<ul style="list-style-type: none"> • Prioritization agri-enterprises of selected crops that have highest potential for development by Agri Authorities 	Ministry of Agriculture, Ministry of Industries, Dept. of Export Agriculture	
Objective 2 Undertake teaching and capacity building initiations related to agri-entrepreneurship development of 6 crops by 2022	<ul style="list-style-type: none"> • Introduction of an Entrepreneurship course in Agriculture and Agribusiness to all Agriculture training institutes 	Ministry of Higher Education Ministry of Agriculture, Department Agriculture, State Ministry of Skills Development, Vocational Education, Research and Innovation	
	<ul style="list-style-type: none"> • Identify capable entrepreneurial youth to engage in selected 6 crops 	Ministry of Agriculture, Ministry of Youth, National Youth Services Council	
	<ul style="list-style-type: none"> • Organize local and foreign entrepreneurship skill development programmes relevant to 6 selected fruit and vegetable crops to agricultural scientists 	Ministry of Agriculture, State Ministry of Skills Development, Vocational Education, Research and Innovation, Ministry of Youth,	

Objective	Actions	Ministries/Agencies	Budget (Mn)
	and farmers	National Institute of Business Management (NIBM), Vocational Education Authority (VTA), National Apprentices Industrial Training Authority (NAITA)	
	<ul style="list-style-type: none"> • Creation of a data platform to facilitate information dissemination and sharing related to 6 crop sectors between all state research institutes, universities and private sector R&D institutes 	Ministry of Agriculture, Ministry of Higher Education, Information & Communication Technology Agency (ICTA) Dept. of Census and Statistics	
Objective 3 Organize stakeholder consultation programmes for each 6 crop sectors to find constraints and gaps for each sector by 2021	<ul style="list-style-type: none"> • Value chain analysis of 6 crops to identify entrepreneurship opportunities in each step 	Ministry of Agriculture, Ministry of Industry	
	<ul style="list-style-type: none"> • Arrange separate stakeholder meetings of all identified sections in the value chain 	Ministry of Agriculture, Ministry of Industry	

▪ **Strategy 2 – Facilitate domestic agriculture entrepreneurs**

Objective 1:

6.3.2.1 Provide monetary and credit facilities to entrepreneurs of selected 6 crops by 2022

Objective 2:

6.3.2.2 Provide business consultancy and technological facilities to entrepreneurs of selected 6 crops by 2022

Objective 3:

6.3.2.3 Initiate a pilot project for 6 selected crops for field observation to identify the constraints and opportunities for each crop sector from 2021 - 2025

Objective	Actions	Ministries/Agencies	Budget (Mn)
Objective 1 Provide monetary and credit facilities to entrepreneurs of selected 6 crops by 2022	<ul style="list-style-type: none"> • Provide investment incentives for agri-enterprises in 6 sectors that have high potential for productivity improvement, value addition & export potential 	Ministry of Finance, Ministry of Agriculture, Ministry of Industry, Board of Investment	
	<ul style="list-style-type: none"> • Provide a low interest loan schemes for identified agri-entrepreneurs in 6 crop sectors 	Ministry of Finance, Ministry of Agriculture, Ministry of Industry,	
	<ul style="list-style-type: none"> • Develop a system with the banks to provide more time for the agri-entrepreneurs to repay their debts 	Ministry of Finance, Ministry of Agriculture, Ministry of Industry,	
Objective 2 Provide business consultancy and technical/technological facilities to entrepreneurs of selected 6 crops by 2022	<ul style="list-style-type: none"> • Establishment of district level agro-enterprise centers in each district to facilitate and link agri-entrepreneurs of each of 6 crops 	Ministry of Agriculture, Department of Agriculture, District Agriculture Directorates	
	<ul style="list-style-type: none"> • Create online/onsite systems to provide business consultancy, technology transfer and marketing opportunities to entrepreneurs of 6 crops 	Ministry of Agriculture, Ministry of Youth, National Youth Services Council, ICTA	
	<ul style="list-style-type: none"> • Identify and set up Youth Clubs to provide farm machinery services 	Ministry of Agriculture, Ministry of Youth	

Chapter 3. Science, Technology and Innovation Action Plan for Agriculture Sector Fruits and Vegetable Crops Sri Lanka - 2021-2025

Objective	Actions	Ministries/Agencies	Budget (Mn)
	<ul style="list-style-type: none"> • Create an App to share real-time product, process, market information between all participants of the supply chain 	Ministry of Agriculture, Ministry of Industries, ICTA, Dept. of Census and Statistics	
Objective 3 Initiate a pilot project for 6 selected crops for field observation to identify the constraints and opportunities for each crop sector from 2021 - 2025	<ul style="list-style-type: none"> • Identify total 100, 000-acre land blocks in 6 selected districts for each of 6 crops 	Ministry of Agriculture, Ministry of Land, Ministry of Youth	
	<ul style="list-style-type: none"> • Establish 20,000 young farmers as entrepreneurs in 100,000 acres of farms for 6 crops by 2025 	Ministry of Agriculture, Ministry of Youth, National Youth Services Council	
	<ul style="list-style-type: none"> • Establish 48 in 12 district level farm machinery and input supplying entrepreneurs by 2025, for machinery, organic fertilizer, irrigation systems, etc. 	Ministry of Agriculture, Department of Agriculture, District Agriculture Directorates, Farm Mechanization Research Centre	
	<ul style="list-style-type: none"> • Provide training, knowledge transfer to selected entrepreneurs 	Ministry of Agriculture, Ministry of Youth, National Youth Services Council, Federation of Youth Clubs	
	<ul style="list-style-type: none"> • Give monetary loans to the entrepreneurs to initiate their farming/agribusiness in the relevant steps of value chain 	Ministry of Agriculture, Ministry of Youth, Ministry of Finance	

▪ **Strategy 3 – Increase youth and female participation in agriculture entrepreneurship**

Objective 1:

6.3.3.1 Mainstream youth participation in agri-entrepreneurship activities in 6 crops by 2022

Objective 2:

6.3.3.2 Increase the contribution of the women in economic activities related to selected 6 Agri crops in 50% by 2022

Objective	Actions	Ministries/Agencies	Budget (Mn)
Objective 1 Mainstream youth participation in agri-entrepreneurship activities in 6 crops by 2022	<ul style="list-style-type: none"> Organize agri-entrepreneurship promoting programmes to attract youth 	Ministry of Finance Ministry of Agriculture Ministry of Youth	
	<ul style="list-style-type: none"> Device a rewarding system to encourage young entrepreneurs for promoting agri-business in selected crops 	Ministry of Agriculture Ministry of Youth, National Youth Services Council	
	<ul style="list-style-type: none"> Organize skill development training programmes (NVQ level 2) for young entrepreneurs who are willing to engage in agribusiness of selected crops each year 	Ministry of Agriculture Ministry of Youth, Tertiary and Vocational Education Commission	
	<ul style="list-style-type: none"> Form a Young Farmers Association to actively participate in selected crop related agri-business ventures 	Ministry of Agriculture Ministry of Youth	

Chapter 3. Science, Technology and Innovation Action Plan for Agriculture Sector Fruits and Vegetable Crops Sri Lanka - 2021-2025

Objective	Actions	Ministries/Agencies	Budget (Mn)
Objective 2 Increase the contribution of the women in economic activities related to selected 6 Agri crops in 50% by 2022	<ul style="list-style-type: none"> • Provide training to women entrepreneurs of selected crops especially in export-oriented value-added industries 	Ministry of Agriculture, State Ministry of Women and Child Development	
	<ul style="list-style-type: none"> • Provide small scale machinery to woman entrepreneurs for their agri business in selected crops 	Ministry of Agriculture, State Ministry of Women and Child Development	
	<ul style="list-style-type: none"> • Facilitate home gardening of selected crops (mango & banana) by woman entrepreneurs 	Ministry of Agriculture, State Ministry of Women and Child Development, Fruit Research & Development Institute	

[Annexure] Pilot Project

Specific Objective:

To develop 20, 000 young agricultural entrepreneurs by 2025 (5000 each for 4 years with 5 acre cultivated lands for each) by utilizing 100,000 acres of cultivated lands with the value-added product of 6 identified crops targeting export market

Pilot project: 1200 acres, 240 young farmers, 6 districts, 6 crops in 2022

Embilipitiya -	200 acres	- Banana	- 40 young farmers
Vaunia -	200 acres	- Mango	- 40 young farmers
Moneragala -	200 acres	- Pineapple	- 40 young farmers
Pollonnaruwa -	200 acres	- Papaya	- 40 young farmers
Anuradapura -	200 acres	- Pumpkin	- 40 young farmers
Matale -	200 acres	- Tomato	- 40 young farmers

Ministries involved:

Ministry of Agriculture

State minister office task - To form Young farmer association with 40,000 Farmers

Ministry of Lands

State Minister task - To identify 100, 000 acres land blocks and distribute young entrepreneurial farmers facilitating banks and technology support to start cultivation

Ministry of Youth

To facilitate providing required land area and training facilities

Action plan for pilot project

Submit a joint proposal (2021) by Ministry of Agriculture, Ministry of Lands and Ministry of Youth to National Planning Department, facilitated by NASTEC & Ministry of Skills Development, Vocational Education, Research & Innovation

The Ministry of Youth will facilitate providing required land area through National Youth Services Council in identified districts. Approximately this will be 40 acre 6 blocks of land in each district (October 2021)

Select entrepreneurs from the list of youth registered with National Youth Services Council (NYSC)

ARTI / NIBM - to conduct basic 3 Residential weeks course / training on “application Modern agricultural technologies and developing entrepreneur skills” at ARTI Colombo - Residential –

January December 2021

The training facilities available at the National Youth Services Council Centers will be made available to provide training and building capacities of youth on agro entrepreneurship

Developing project proposal - by selected young farmers for each block - January 2022

Obtaining banking facilities - January 2022

Commence project - February 2022

Identify value addition - March 2023



CHAPTER 4

Revised STI Action Plan for Agricultural Sector Sri Lanka by Korean Experts

2020 STEPI-NASTEC STI Policy Consultation Project on
“Supporting the Improvement of Science, Technology
and Innovation (STI) Policy and Institutional
Framework for Sri Lanka”

Chapter 4. Revised STI Action Plan for Agricultural Sector Sri Lanka by Korean Experts

1. Action Plan for Productivity Improvement

1.1 Structure diagram

1.1.1 Projects of productivity

Improve productivity of fruits & vegetables by developing technology to solve problems in farmers' fields

1-1 Productivity & Quality Improvement of fruits in response to climate change	1-2 Improvement productivity of vegetable crops by developing technology to solve problems in farmers' fields	1-3. Establishment of eco-friendly farming technology	1-4 Policy, Law and Extension services
1-1-1. Development of fruit varieties suitable for Sri Lanka	1-2-1. Development of new varieties of vegetable crops	1-3-1. Soil & fertilizer	1-4-1 Policy, Law and Regulation
1-1-2. Development of technology for disease & pest control	1-2-2. Increase quality of vegetables	1-3-2. Establishment of eco-friendly cultivation method for major crops in Sri Lanka	1-4-2. Extension Services

1-1-3. Research on reducing production cost in fruit production	1-2-3. Development of Cultivation Technology for high yield	1-3-3. Development of biological control technology and eco-friendly agricultural materials	1-4-3. Infrastructure
1-1-4. Introduction of seasonal climate forecasting technologies for crop production			

* The name of the research project and the sub-project should be more detailed and, if possible, select a high priority project for each crop.

1.1.2 Responsible department & Budget

(1,000 US\$)

Department of Agriculture	Department of Export Agriculture	Ministry of Agriculture	Ministry of Lands
2330 \$	1560 \$	5000 \$	4500 \$

1.1.3 Outcome Indicator

Outcome	2021	2022	2025
New varieties developed	1	2	3
Yield increase rate (compared to 2019)	5 %	10%	20%
Distribution of new varieties	14 ha	20 ha	100 ha
New technologies for field difficulties	2/year	3/year	3/year

Outcome	2021	2022	2025
Damage rate by pest & disease	20%	15%	10%
Labor time reduction rate (compared to 2019)	10%	20%	40%
Production cost (compared to 2019)	95%	90%	80%

* The content of outcome depends on the planned research project.

1.2 Action Plan by Project in Agenda

1.2.1 Productivity Improvement

1-1. Productivity & Quality Improvement of fruits in response to climate change

▪ Background of research

- Sri Lanka has been known to produce a large variety of tropical fruits that are in demand worldwide. Fruit production in commercial scale is confined to 7 out of 25 districts in Sri Lanka,
 - Sri Lanka exports nearly 33,000mt of fruits with 90% of the production being exported to the Middle East and the Maldives, earning an income of US\$ 35.7 million (2015). Though there is a recent shift in the principle export market from Europe market to the Middle East, foreign exchange earnings is expected to increase due to the quantity supplied.
- The Sri Lankan government is planning to expand fruit as well as organic food, vegetables, fruit and potatoes, seed production and high-tech agriculture to introduce new technologies in crop production and invest in fruit production in priority order.

The most popular fresh fruits that are exported include bananas, mangoes, pineapple, and papaya. The fruit crop sector has contributed 0.35% of the merchandise exports, which have shown a steady increase that highlights the expansion of the sector. Of the 7.0%

contributed by the agricultural sector to the national GDP in 2018, the fruit subsector contributed 11.4%.

- Fruit cultivation in Sri Lanka is mostly confined to backyard or home garden level, whereas some of the fruit varieties such as banana, mango, pineapple, papaya, passion fruit, and rambutan are commercially grown in orchards. The local demand for such crops is mainly met only by local production; hence the importance of expanding the cultivation to meet the international demand.

▪ **Research achievements**

- Development of cultivation technology to improve productivity
- Development of technology to prevent physiological disorders
- Trademark variety of Mango was developed in DOA of Sri Lanka
- Development of technology to prevent diseases and pests
- Development of technology for safe cultivation suitable for new varieties

▪ **Technology demand expected in the future**

- Create a foundation for development of new excellent fruit varieties adaptable in Sri Lanka
- Development of low-cost, high-quality viable culture technology
- Need to develop high-yield and high-quality production technology
- Research on safe cultivation of fruit trees for climate change
- Improvement of cultivation management manual in response to climate change
- Selection of suitable varieties by main production area

▪ Strategy

Strength (S)	Weaknes (W)
<ul style="list-style-type: none"> • Large variety of tropical fruits, huge demand worldwide • Low illiteracy rate in rural areas due to the high education fever • High adaptability to new agricultural technologies • Food and crop consumption increase due to development of the tourism industry • Excellent agricultural talents (7 agricultural colleges, 10 agricultural high schools) • Many excellent researchers in government research institutes • Sri Lankan government's aspiration for the transfer of Korean agricultural technology • 	<ul style="list-style-type: none"> • Limited availability and access to advanced technology, inadequate supply of quality products, inadequate supply of high-quality seed materials • Poor logistics and infrastructure in cultivation and post-harvest processing, Loss due to lack of post-harvest storage management facilities • Small production units • Involvement of small and marginal farmers, poor packaging • Absence of continuity in supply • High production cost, high labor cost, costly transport and air freight services, high cost of electricity • Lack of awareness of quality standards • Inadequate research, lack of improved germplasm • Relatively high interest rates • Delayed introduction of new technologies due to the poverty of farmers • Agricultural competitiveness decreases due to uncertain government policy • Lack of water and land used in agriculture
Opportunity (O)	Threat (T)
<ul style="list-style-type: none"> • Fruit production needs to be promoted aimed at increasing export earnings for the country • Increased food consumption diversity due to changes in eating habits • Consumer interest in food safety and quality • High possibility of improving the value of agricultural products through the development of the processing industry • Recognition of the importance of agriculture and food business • Expected high growth potential of 	<ul style="list-style-type: none"> • Gradual increase in the market share of vegetable imports from Sri Lanka • Decrease in exports of agricultural products • Reduced research investment in agriculture • Low competitiveness with cheap imported agricultural products • Import of all chemical fertilizers and pesticides • Environmental pollution due to misuse of livestock manure and pesticides • Difficulties due to complicated export procedures

horticultural crops • Agricultural GDP 7.9%, agricultural population 33%	
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Source: author

Development of new varieties optimized for various uses
Development of high-quality agricultural product production technology in response to changes in consumer preferences and expansion of export markets

▪ Priority Research projects and implementation schedule

Research Projects	2020	2021	2022	2023	2024	2025
Development of new tomato varieties						
Development of new pumpkin varieties						
Distribution of new varieties						

▪ Organizing Agencies and Budget

- Host organization: Vegetable Research Team, HORDI, DOA
- Related organization: Ministry of Agriculture

Budget

(thousand US\$)

Budget	2021	2022	2023	2024	2025	Total
HORDI	200	210	230	250	270	1160
DEA	100	110	120	130	140	600

1.2.2 Development of fruit varieties suitable for Sri Lanka

▪ The need for research

- Export of fresh fruits : 7,871(thousand US\$)
Export of dried fruits : 2,625(thousand US\$)

- Banana

A crop with a good local demand and export market, but has shown a marginal decline in production extents and production and an increasing trend in exports. The full potential of the banana crop is still to be harnessed in Sri Lanka using novel technologies.

- Production quantity of banana is 673,655Mt in 44,671ha in 2019.
- No data of area harvested, yield and production quantity in FAO statistics.

- Pineapple

A crop with good export market and local demand but dramatic reduction in export quantities and earnings in 2019. The gaps and deficiencies in the value chain need to be identified and addressed well to regain and promote further the fruit crop in the export market.

	Pineapples			
	Fresh	juice	Juice (concentrated)	canned
Area harvested(ha)	5,543			
Production quantity (t)	34,651			
Yield (hg/ha)	62,513			
Value of agricultural production (million US\$)	9.9			
Import(t)	0	58	357	29
Import value (1000 US\$)	0	31	416	90
Export(t)	3,758	9	10	466
Export value (1000 US\$)	6,488	23	19	1,642

- Papaya

A popular fruit crop for local consumption, with an export market enjoying the highest growth rate among fruits crops that have been exported from Sri Lanka in 2019. The identified trends need to be addressed by increasing high-quality produce locally through the infusion of novel technologies.

- Export amount : 3492 thousand US\$
- No data of area harvested, yield and production quantity

	Papayas
Area harvested(ha)	
Production quantity (t)	
Yield(hg/ha)	
Value of agricultural production(million US\$)	
Import quantity (t)	1
Import value (1000 US\$)	0
Export quantity (t)	8,761
Export value (1000 US\$)	6,394

- Mango

With trademark varieties developed in Sri Lanka, this fruit crop has been promising in terms of local and export markets. It has shown steady growth in terms of export demand, but production-oriented technologies and value-added products are required to boost income generation further.

	Mangoes, mangosteens, guavas
Area harvested(ha)	30,313
Production quantity (t)	516,210
Yield (hg/ha)	170,293
Value of agricultural production (million US\$)	145
Import quantity (t)	416

	Mangoes, mangosteens, guavas
Import value (1000 US\$)	378
Export quantity (t)	1,693
Export value (1000 US\$)	3,361

▪ Research trends of fruits in Sri Lanka and abroad

- Sri Lanka
 - Trademark variety of Mango was developed.
 - Fruit production for export
- Foreign Countries
 - Development of varieties by target traits such as resistance to disease and pest, functionality, export, etc.
 - Establishing breeding methods applying biotechnology such as developing markers that can be selected early
 - Research on disaster tolerance cultivation in response to climate change
 - Development of eco-friendly cultivation technology by biological control
 - Expand application of global GAP certification
 - Research on the stable cultivation of high-quality fruits in response to climate change
 - Disease-free seedlings of banana are produced and distributed

▪ Research Plan

- Development of new Mango varieties with high-sugar contents(sugar contents : more than 15 Brix)
- Development of new pineapple varieties with resistance to diseases
- Development of high yield varieties of banana
- Development of high yield varieties of papaya
- Evaluation of genetic resources collected in Sri Lanka and other countries
- Distribution of new high-yielding varieties(2000ha)

▪ Goals for the project

Performance Indicator	2020	2022	2025
Development of new varieties	0	1	2
Distribution of new varieties	200 ha	1000	2000
Distribution of disease-free seedlings	200 ha	2000 ha	5000 ha

1.2.3 Development of technology for disease & pest control

▪ The need for research

- Due to pest damage and extreme weather conditions, the total vegetable production of the country declined considerably by 11.8% from 1,698,698 mt in 2018 to 1,497,733 mt in 2019. Similarly, the production of fruits also declined 3.1% in 2019 compared to the notable 28.8 % growth in 2018.
- Development of crop protection technology using chemical pesticides
- Development of GAP-certified agricultural product production technology

▪ Research trends of fruits in Sri Lanka and abroad

- Sri Lanka
 - Development of eco-friendly pest control technology

- Foreign Countries
 - Development of navigation for pest control
 - Introduction of breeding techniques using disease resistance markers
 - Development of MAS(Marker-Assisted Selection) technology and its automation

▪ Research Plan

- Time and frequency of pest control
- Development of new integrated pest management packages
- Development of disease-free production technology
- Distribution of disease-free seedlings (5000ha)
- Development of eco-friendly control technology

▪ Goals for the project

Performance Indicator	2020	2022	2025
Development of new technologies	2	5	10
Distribution of disease-free seedlings	200 ha	2000 ha	5000 ha

1.2.4 Research on reducing production cost in fruit production

▪ Need for research

- Major drawbacks to improving fruit production in Sri Lanka include: poor economic of scale, high cost of production, absence of continuous supply, poor quality of the products, high air freight and high cost of export services, limited private sector investment and foreign investment in larger fruit production projects, weak implementation of policies to broaden the fruit exports of the country along with the improvement in advanced technology, less attention to fruit breeding programs, non-

use of appropriate agronomic practices, poor post-harvest handling, and weak extension services.

▪ **Research trends of fruits in Sri Lanka and abroad**

- Sri Lanka
 - Development of cultivation technology suitable for the rural environment in Sri Lanka
- Foreign Countries
 - Development of production technology suitable for mechanization to reduce labor

▪ **Research Plan**

- Labor reduction, agricultural mechanization, and development of low-input production technology
- Improvement and dissemination of manuals for high-quality large-scale production
- Development of technology to solve problems in high-quality fruit production and farming fields
- Fruit productivity improvement and development of cultivation technology
- Development of production technology for fruits for export
- Development of fruit production technology suitable for export

▪ **Goals for the project**

Performance Indicator	2020	2022	2025
Reduction rate of working hours per ha	5 %	10	20
Production cost reduction rate	5 %	10	20
Productivity increase rate	10 %	20%	50

1.2.5 Introduction of seasonal climate forecasting technologies for crop production

▪ The need for research

- Increasing frequency of abnormal weather due to climate change
- Need to reduce damage by predicting weather changes in advance and delivering them to farms

▪ Research trends of fruits in Sri Lanka and abroad

- Sri Lanka
 - No results
- Foreign Countries
 - Analysis of damage factors for abnormal weather and development of disaster stability improvement model
 - Growth management application technology and rational nutrient management technology according to global warming

▪ Research Plan

▪ Goals for the project

Performance Indicator	2020	2022	2025
Development of new technologies	0	5	10

1.3 **Improve productivity of vegetable crops by developing technology to solve problems in farmers' fields**

▪ **Background of research**

- Sri Lanka has earned USD 37.2 million from exporting vegetables (edible vegetables and certain roots and tubers), placing the country at the 81st spot in world exports. At present, however, the country's vegetable exports have declined to a share of 0.1% from the world's export.
- The most popular vegetable exports from Sri Lanka include chili, gherkin, red onion, bread fruit, young Jackfruit, ladies' fingers, drumsticks, pumpkin, and bitter gourd.
- Maldives (16-20%) has been a major importer of vegetables from Sri Lanka, with the United Arab Emirates (approx. 15%) as the second largest buyer in 2015. In the last few years, UK, Malaysia, and USA have shown a gradual increase in the market share of vegetable imports from Sri Lanka.
- Sri Lanka also imports vegetables from India and Australia with import share of more than 50%.
- Major drawbacks to improving vegetable crop production in Sri Lanka include: poor economies of scale, high cost of production, absence of continuous supply, poor quality of the products, high air freight and high cost of export services, limited private sector investment and foreign investment in larger vegetable production projects, weak implementation of policies to broaden the vegetable exports of the country along with the improvement in advanced technology, less attention to vegetable breeding programs, non-use of appropriate agronomic practices, poor post-harvest handling, and weak extension services.
- The fruits and vegetable sector in Sri Lanka is plagued with fragmented and small production units, involvement of small and marginal farmers, absence of continuity in supply, lack of awareness of quality standards, lack of infrastructure, inadequate supply of quality produce, high cost of production, high cost of labor, poor packaging, costly transport and air freight services, high cost of electricity, inadequate supply of

high- quality seed materials, high cost of investments for new technology, inadequate research, relatively high interest rates, and labor scarcities.

- Due to pest damage and extreme weather conditions, the total vegetable production of the country declined considerably by 11.8% from 1,698,698 mt in 2018 to 1,497,733 mt in 2019.
- However, average household expenditure for food in relation to total expenditure is around 30-40% (2016). The average monthly household expenditure of fruits and vegetables (2018) is 11.9% in urban areas and 13.5% in rural areas. Fruit cultivation in Sri Lanka is mostly confined to backyard or home garden level, with some of the fruit varieties such as banana, mango, pineapple, papaya, passion fruit, and rambutan commercially grown in orchards. The local demand for such crops is mainly met only by local production; hence the importance of expanding the cultivation to meet the international demand.

- Tomatoes

A popular vegetable crop among consumers and farming communities with seasonal production in Sri Lanka, with huge production gluts and minimum value addition. The crop has shown steady decline in export, both in terms of quantity and value. The crop requires novel technologies for harnessing its maximum potential with a continuous supply of high-quality production.

- Red Pumpkin

A popular vegetable crop among consumers and farming communities with seasonal production in Sri Lanka, with huge production gluts and minimum value addition. The crop has shown a dramatic increase in export quantities and values, requiring further attention with novel technologies to harness its maximum potential with a continuous supply of high-quality production.

- Tomatoes are a high-income crop, and their cultivation area is increasing.

- Cultivation area (ha): ('00)300 → ('10)500 → ('19) 1000

- Consumption (kg/capita): ('00)3 → ('10)5 → ('19) 10

- As for tomato, 90% of foreign varieties are grown, so it is necessary to develop domestic varieties.
- A popular vegetable crop among consumers and farming communities with seasonal production in Sri Lanka, with huge production gluts and minimum value addition
- The crop has shown a steady decline in export, both in terms of quantity and value.
- The crop requires novel technologies for harnessing its maximum potential with a continuous supply of high-quality production.
- Increasing difficulties in agricultural fields such as physiological disorders, pests, and changes in cultivation methods according to climate change
- Recently, the demand for GAP certification and eco-friendly agricultural products has been growing, but the spraying of chemicals due to the occurrence of pests is increasing.
- The severe changes in productivity and vegetable quality according to the weather environment necessitate developing environment management control technology for greenhouses.

▪ **Research achievements**

- Three varieties of tomatoes are developed by DOA of Sri Lanka.
- Development of tomato cultivation technology such as sowing timing and amount of fertilization

▪ **Technology demand expected in the future**

- Create a foundation for development of new excellent tomato and pumpkin varieties
 - High sugar content and disease-resistant varieties
 - Development of new varieties by use
 - Development of various breeding technologies using biotechnology
 - Selection of varieties suitable for regional environment
 - Regional Yield trial

- Need to develop high-yield and high-quality production technology
 - Development of a model of cultivation facilities for establishing an annual production system
 - Establish a comprehensive model for reducing production costs
- Development of cultivation methods in response to climate change and research on reduction of physiological disorders
- Increase high value crop production under protected houses for target markets at local and international by 2022

▪ **Strategy**

Strength (S)	Weaknes (W)
<ul style="list-style-type: none"> • Large variety of tropical fruits, huge demand worldwide • Low illiteracy rate in the rural areas due to the high education fever • High adaptability to new agricultural technologies • Food and crop consumption increase due to development of the tourism industry • Excellent agricultural talents (7 agricultural colleges, 10 agricultural high schools) • Many excellent researchers in government research institutes • Sri Lankan government's aspiration for the transfer of Korean agricultural 	<ul style="list-style-type: none"> • Limited availability and access to advanced technology • Poor logistics and infrastructure in cultivation and post-harvest processing • Lower scale of production • Increasing cost of production • Lack of improved germplasm • Heavy post-harvest losses • Reduced crop cultivation area due to urban industrialization • Delayed introduction of new technologies due to the poverty of farmers • Agricultural competitiveness decreases due to uncertain government policy • Lack of water and land used in agriculture • Loss due to lack of post-harvest storage management facilities • Lack of awareness of resource recycling technology

Opportunity (O)	Threat (T)
<ul style="list-style-type: none"> • Fruit and vegetable crop production needs to be promoted aimed at increasing export earnings for the country • Introduction of a “New National Agricultural Policy” • Increased food consumption diversity due to changes in eating habits • Consumer interest in food safety and quality • High possibility of improving the value of agricultural products through the development of the processing industry • Recognition of importance of agriculture and food business • Expected high growth potential of horticultural crops • Agricultural GDP 7.9%, agricultural population 33% 	<ul style="list-style-type: none"> • Gradual increase in the market share of vegetable imports from Sri Lanka • Decrease in exports of agricultural products • Reduced research investment in agriculture • Low competitiveness with cheap imported agricultural products • Import of all chemical fertilizers and pesticides • Environmental pollution due to misuse of livestock manure and pesticides • Difficulties due to complicated export procedures

Source: author

Development of new varieties optimized for various uses

Development of high-quality agricultural product production technology in response to changes in consumer preferences and expansion of export markets

▪ Priority Research projects and implementation schedule

Research Projects	2020	2021	2022	2023	2024	2025
Development of new tomato varieties	0	0	1		1	1
Development of new pumpkin varieties	0	0	1		1	1
Distribution of new varieties(ha)	50	200	500	1500	3000	5000



▪ Organizing Agencies and Budget

- Host organization : Vegetable Research Team, HORDI, DOA
- Related organization : Ministry of Agriculture

Budget

(thousand US\$)

Budget	2021	2022	2023	2024	2025	Total
HORDI	200	210	220	240	250	1120
DEA	100	110	120	130	140	600

1.3.1 Development of new varieties of vegetable crops**▪ The need to study****< Tomato >**

- The level of development of tomato varieties is very high in foreign countries but insufficient in Sri Lanka due to the lack of professional manpower.
- The tomato genetic resources owned by Sri Lanka are not diverse.
- Since many foreign tomato varieties are cultivated, production costs increase as expensive foreign varieties are grown.

< Pumpkin >

- The crop has shown a dramatic increase in export volumes and values.
- It requires further attention with novel technologies for harnessing its maximum potential with a continuous supply of high-quality production.
- Since many foreign tomato varieties are cultivated, production costs increase as expensive foreign varieties are grown.
- No evaluation of the pumpkin genetic resource.

▪ Research trends of tomato and pumpkin in Sri Lanka and abroad

- Sri Lanka
 - Development of cultivation technology to improve productivity
- Foreign Countries

- In India and China, high-yielding tomato varieties are developed, and in Europe, high-quality and functional varieties are being developed.
- Linkage analysis of tomato genes are being studied jointly in 11 countries including the United States.
- Development of disease-resistant varieties using DNA markers

▪ Research Plan

- Development of new tomato varieties with high-sugar contents(sugar contents : more than 10 Brix)
- Development of new tomato varieties with resistance to TYLCV(Tomato Yellow Leaf Curl Virus) and TSWV(Tomato Spotted Wilt Virus)
- Development of big pumpkin varieties
- Evaluation of genetic resources collected in Sri Lanka and other countries
- Distribution of new high-yielding varieties(3000ha)
- Enhance productivity of selected crops by 50% by 2023 via providing good quality seeds and planting materials
- Strengthen R&D programmes on high-valued crop production under protected houses

▪ Goals for the project

Performance Indicator	2020	2022	2025
Development of new varieties	0	1	2
Distribution of new varieties	200 ha	1500	3000

1.3.2 Increase quality of vegetables

▪ The need for research

- Low sugar content and poor quality
- Low productivity, high production cost, low international competitiveness

▪ Research trends of fruits in Sri Lanka and abroad

- Sri Lanka
- Foreign Countries
 - Development of tomato varieties with high sugar content and improvement of disease resistance
 - Development of production technology with high quality for domestic and export

▪ Research Plan

- Increasing the competitiveness in agricultural products on global markets by exploring technology gaps, high investments and adequate quantities of high-quality inputs
- Development of cultivation technologies for high-quality

▪ Goals for the project

Performance Indicator	2020	2022	2025
Development of new technologies	1	2	10
Sugar contents	8 Brix	9	10

1.3.3 Development of Cultivation Technology for high yield

▪ Need for research

- Major drawbacks to improve tomato and pumpkin production in Sri Lanka include the high cost of production and poor quality of the products of

vegetable production, non-use of appropriate agronomic practices, poor post-harvest handling, and weak extension services.

▪ **Research trends of fruits in Sri Lanka and abroad**

- Prediction and control timing of fungal disease
- Nutrient solution management technology for safe production
- Technology development to improve productivity and reduce physiological disorders
- Moisture and nutrition management technology of crops to respond to climate change such as water shortage
- Tomato in Sri Lanka

	Tomatoes			
	Fresh	juice	Paste	Peeled
Area harvested(ha)	6712			
Production quantity (t)	101404			
Yield (hg/ha)	151079			
Value of agricultural production (million US\$)	44.2			
Import(t)	3	31	2651	131
Import value (1000 US\$)	17	22	2301	110
Export(t)	533	1	70	2
Export value (1000 US\$)	1212	1	33	3

- Pumpkin in Sri Lanka

	Pumpkin(squash and gourds)
Area harvested(ha)	8469
Production quantity (t)	123261
Yield(hg/ha)	145544
Value of agricultural production(million US\$)	30.5

	Pumpkin(squash and gourds)
Import Quantity(t)	3
Import value (1000 US\$)	2
Export Quantity(t)	1366
Export value (1000 US\$)	1089

- Foreign Countries
 - Productivity of tomato in France: 14t/ha
 - Productivity of pumpkin in France : 13t/ha

▪ Research Plan

- Introduction of seasonal climate forecasting technologies for crop production by 2025
- Establishment of a program to examine seasonal variations in the climatic parameters and adapt to seasonal climate with adequate lead time
- Establish support mechanisms for the production of agricultural machinery as a local industry by 2022

▪ Goals for the project

Performance Indicator	2020	2022	2025
Development of new technologies	0	1	2
Productivity	15t/ha	16	20

1.4 Establishment of eco-friendly farming technology

▪ Background of research

- Sri Lanka has also adjusted well to the stringent ISO 22000 series and to the health and safety regulations stipulated by the European Community. Farmers are constantly being educated to practice Good Agricultural Practices (GAP) at the nurseries, and some farms are certified under the GLOBAL GAP certification. The processing/manufacturing facilities owned by the export companies comply with Sri Lankan Standards (SLS) and International Quality Standards such as ISO, HACCP, and EU Standards. Traceability throughout the supply chain is monitored with the help of reputed exporting companies in Sri Lanka to guarantee safe products to the consumers.
- Due to climate change, pests including sudden pests are increasing. The productivity of agricultural products decreases, and the cost for crop protection is higher due to difficulties in controlling pests.
- Demand for GAP certification and eco-friendly agricultural products is growing, but the spraying of chemicals for pest control is increasing. It is necessary to develop crop protection materials for alternative chemicals to produce safe agricultural products from pesticide residues by strengthening food safety management.

▪ Research achievements

- No data available

▪ Technology demand expected in the future

- Establishment of eco-friendly cultivation method for major crops in Sri Lanka
- Development of biological control technology and eco-friendly agricultural materials
- Development of technologies for utilizing natural enemies and microorganisms
- Agricultural technology development using natural products and eco-friendly agricultural material development

▪ Strategy

Strength (S)	Weaknes (W)
<ul style="list-style-type: none"> • Large variety of tropical fruits, huge demand worldwide • Low illiteracy rate in rural areas due to the high education fever • High adaptability to new agricultural technologies • Food and crop consumption increase due to development of the tourism industry • Excellent agricultural talents (7 agricultural colleges, 10 agricultural high schools) • Many excellent researchers in government research institutes • Sri Lankan government's aspiration for the transfer of Korean agricultural technology 	<ul style="list-style-type: none"> • Limited availability and access to advanced technology • Poor logistics and infrastructure in cultivation and post-harvest processing • Lower the scale of production • Increasing the cost of production • Lack of improved germplasm • Heavy post-harvest losses • Reduced crop cultivation area due to urban industrialization • Delayed introduction of new technologies due to poverty of farmers • Agricultural competitiveness decreases due to uncertain government policy • Lack of water and land used in agriculture • Loss due to lack of post-harvest storage management facilities • Lack of awareness of resource recycling technology
Opportunity (O)	Threat (T)
<ul style="list-style-type: none"> • Fruit and vegetable crop production needs to be promoted aimed at increasing export earnings for the country • Introduction of a "New National Agricultural Policy" • Increased food consumption diversity due to changes in eating habits • Consumer interest in food safety and quality • High possibility of improving the value of agricultural products through the development of the processing industry • Recognition of importance of agriculture and food business • Expected high growth potential of horticultural crops • Agricultural GDP 7.9%, agricultural population 33% 	<ul style="list-style-type: none"> • Gradual increase in the market share of vegetable imports from Sri Lanka • Decrease in exports of agricultural products • Reduced research investment in agriculture • Low competitiveness with cheap imported agricultural products • Import of all chemical fertilizers and pesticides • Environmental pollution due to misuse of livestock manure and pesticides • Difficulties due to complicated export procedures

Source: author

Pest diagnosis and forecasting technology development using ICT
 Comprehensive manual for eco-friendly cultivation technology adapted to Sri Lanka
 Use of eco-friendly organic materials using useful microorganisms
 Reduce the use of pesticides and preserve the environment through detailed soil diagnosis and comprehensive management of crop nutrients

▪ Priority Research projects and implementation schedule

Research Projects	2020	2021	2022	2023	2024	2025
Development of new tomato varieties						
Development of new pumpkin varieties						
Distribution of new varieties						

▪ Organizing Agencies and Budget

- Host organization : Vegetable Research Team, HORDI, DOA
- Related organization : Ministry of Agriculture

Budget

(thousand US\$)

Budget	2021	2022	2023	2024	2025	Total
HORDI	100	110	120	130	160	620
DEA	50	60	70	80	100	280

1.4.1 Soil and Fertilizer

▪ The need for research

- It is necessary to monitor agricultural land and develop technology to maintain a sustainable agricultural environment.
- Comprehensive management of crop nutrients by scientific prescription of fertilizer use
- Cultivation of crops for a long period reduces the productivity and quality of crops and decreases soil fertility.

- Due to changes in the agricultural environment caused by climate change, it is necessary to diversify cropping and soil management measures.

▪ Research trends of fruits in Sri Lanka and abroad

- Sri Lanka
 - Production of fertilizer(P2O5 13,845 tonnes)
 - Import of fertilizer
(N 109,750 tonnes, P2O5 5,619 t, K2O 25798t)
 - Agricultural use(N 68829 t, P2O5 40973, K2O 79884)
 - Use per area of crop land : N 29kg/ha, P2O5 17, K2O 34)
 - Cultivation of Organic Soils : 14782ha
- Foreign Countries
 - Setting the appropriate range of inorganic nutrients for each stage of growth
 - Construction of soil environment information system such as soil characteristics and soil quality of agricultural land
 - Fertilization management for each crop according to soil characteristics
 - Analysis of river water quality and use of agricultural water according to characteristics

▪ Research Plan

- Introduction of an integrated soil fertility management system

▪ Goals for the project

Performance Indicator	2020	2022	2025
Development of new varieties	0	1	2
Distribution of new varieties	200 ha	1000	2000
Distribution of disease-free seedlings	200 ha	2000 ha	5000 ha

1.4.2 Establishment of eco-friendly cultivation method for major crops in Sri Lanka

▪ Need for research

- Given the growing demand for GAP-certified agricultural products and eco-friendly agricultural products, there is a need to develop techniques to support the production of eco-friendly and safe agricultural products.
- The occurrence of diseases and pests is increasing due to abnormal weather caused by global warming.
- The basis for safe agricultural production to secure consumer confidence is weak.

▪ **Research trends of fruits in Sri Lanka and abroad**

- Sri Lanka
 - Development of eco-friendly cultivation technology
 - Selection of pesticides for GAP cultivation guidelines
 - Analysis of types and status of pests occurring in tomatoes
- Foreign Countries
 - Development of eco-friendly comprehensive control technology
 - Establishment of disease outbreak prediction system using ICT
 - Eco-friendly pest control technology in response to climate change
 - Disease and pest prevention technology using trap
 - Knowledge-based pest management strategy
 - Development of sensing technology for rapid and accurate real-time disease diagnosis
 - Development of real-time pest diagnosis sensor

▪ **Research Plan**

- Conduct research on environment-friendly bio-pesticides and integrated pest management
- Development of disease diagnosis technology using RT-PCR
- Development of biological control technology for soil infectious diseases
- Development of diagnosis technology for rapid and accurate disease prediction
- Monitoring of new pests and quarantine pests

- Development of organic farming technology
- Establishment of crop protection and selection of pesticides and fungicides

▪ **Goals for the project**

Performance Indicator	2020	2022	2025
Development of new varieties	0	1	2
Distribution of new varieties	200 ha	1000	2000
Distribution of disease-free seedlings	200 ha	2000 ha	5000 ha

1.4.3 Development of biological control technology and eco-friendly agricultural materials

▪ **Need for research**

- Although biological pesticides have the advantages of safety and lower costs compared to chemical pesticides, their response in the market is not high due to problems such as unstable effects and short shelf life. As the need for eco-friendly control increases, research on microbial agents is developing microbial agents that are relatively easy to input and require less cost than microbial pesticides.
- The global bio-pesticide market is valued at \$1.5 billion, growing at an annual average of 16%. The bio-pesticide market is expected to grow rapidly due to the increase in the organic farming market, resistance and persistence of chemical pesticides, low development cost, and ease of registration.

▪ Research trends of fruits in Sri Lanka and abroad

- Sri Lanka
 - Pesticide (2,260tonnes), Herbicides(1,174), Fungicides(818), Insecticides(255)
- Foreign Countries
 - Development of biological pesticides such as microbial pesticides and natural enemies
 - Development of natural substances such as antibiotics and plant extracts
 - Research on the use of pheromones for pest control
 - Development of organic farming materials such as patent strain development
 - Development of eco-friendly agricultural technology using natural enemies and safety evaluation of natural enemies against fungicides and pesticides

▪ Research Plan

- Search and use of eco-friendly useful microorganisms
- Develop measures to minimize use of chemical inputs
- Assessment of effective water conserving farming system
- Development of new integrated pest management packages by 2025
- Development of pest repellent substances and natural enemies attracting substances
- Development of trapping crops for attracting pests using pests' host preference
- Pheromone, pest control using attractant trap(Mass trapping method)
- Scientific verification of the efficacy of organic farming materials used by farms

▪ Goals for the project

Performance Indicator	2020	2022	2025
Development of eco-friendly agricultural materials	1	1	8
Eco-friendly agricultural material treatment area	20 ha	50	200

1.5 Policy, Law and Extension services

▪ Background

- The agriculture sector in Sri Lanka has seen trends that are in line with the experience of other countries, e.g., declining share of the labor force in agriculture and declining contribution of the primary production to national income. The challenge for Sri Lanka, as for all other countries, is to make the necessary investments so that agricultural production, foreign exchange earnings, and farm income do not collapse as a consequence of the loss of labor in the process of economic structural transformation. Meeting the challenges will mean adopting technology to increase labor productivity, improving farm-market linkages, investing in value chains, and generating off-farm employment to absorb the excess labor in the rural areas.
- The current government has already initiated several measures to attract the youth toward agri-entrepreneurship by allocating lands, providing low-interest loans, and making low-cost technologies, etc. available. In this context, the proposed pilot project, which will facilitate one common platform to pilot-test the entire value chain, will be a great opportunity for the agriculture sector to see the possibilities of replication and to assess the cost-benefit analysis of such initiatives. By initiating and completing this pilot project, this is going to be the first-ever investment in a pilot project for a value chain-oriented agro-entrepreneurship development. The current Science and Technology Policy, which is being revised to incorporate innovation perspectives in line with NPF, will be the highest-level sectoral Policy for this program.

▪ Strategy

Strength (S)	Weaknes (W)
<ul style="list-style-type: none"> • Large variety of tropical fruits, huge demand worldwide • Low illiteracy rate in rural areas due to the high education fever • High adaptability to new agricultural technologies • Food and crop consumption increase due to development of the tourism industry • Excellent agricultural talents (7 agricultural colleges, 10 agricultural high schools) • Many excellent researchers in government research institutes • Sri Lankan government's aspiration for the transfer of Korean agricultural technology 	<ul style="list-style-type: none"> • Limited availability and access to advanced technology • Poor logistical and infrastructure in cultivation and postharvest processing • Lower the scale of production • Heavy post-harvest losses • Reduced crop cultivation area due to urban industrialization • Delayed introduction of new technologies due to poverty of farmers • Agricultural competitiveness decreases due to uncertain government policy • Lack of water and land used in agriculture • Lack of awareness of resource recycling technology
Opportunity (O)	Threat (T)
<ul style="list-style-type: none"> • Fruit and vegetable crop production needs to be promoted aimed at increasing export earnings for the country • Introduction of a "New National Agricultural Policy" • Increased food consumption diversity due to changes in eating habits • Expected high growth potential of horticultural crops • Agricultural GDP 7.9%, agricultural population 33% 	<ul style="list-style-type: none"> • Gradual increase in the market share of vegetable imports from Sri Lanka • Decrease in exports of agricultural products • Reduced research investment in agriculture • Low competitiveness with cheap imported agricultural products • Import of all chemical fertilizers and pesticides • Environmental pollution due to misuse of livestock manure and pesticides • Difficulties due to complicated export procedures

Source: author



Development of new varieties optimized for various uses

Development of high-quality agricultural product production technology in response to changes in consumer preferences and expansion of export markets

▪ Organizing Agencies and Budget

- Host organization: Ministry of Agriculture
- Related organization: Ministry of Land

Budget

(thousand US\$)

Budget	2021	2022	2023	2024	2025	Total
Min. of Agriculture	1000	1000	1000	1000	1000	5000
Min. of Land	1000	1000	1000	1000	1000	5000

1.5.1 Policy, Law and Regulation

▪ The need for Agricultural Development

- The cumulative projected investment during the period 2017-2020 for agriculture is 58,102 Rs Millions, which is 1.64% of total public investment.
- In spite of the ambitious targets set out by the industry and research institutes, Sri Lanka is currently unable to reach its full capacity due to a lack of efficient and advanced technology adoptions. One of the main reasons is inadequate funding for R & D on advanced technologies both by public and private sector.

▪ Plan

- Establishment of basic infrastructure to enhance the productivity
 - Development of methodology to maximize natural resources consisting of lands, soil, and water for the sustainable and productive use of crop-based production by
 - Identify barren and abounded lands for crop production
- Re-visiting the existing Seed Policy - Review the existing policy to incorporate national interest and public need.

- Formulation of regulations for effective implementation of the Seed Act to assure good quality seeds for farmers
- Enhance the capacity to carry out seed research
- Continuous availability of quality breeder seeds and planting materials in adequate quantities at an affordable price or through credit facilities at with low interest rate (4%)
- Establishment of an insurance scheme for seed and planting materials production and storage
 - Update Plant Protection Act No 35 of 1999 with regulations by 2022 with more strength to implement plant protection activities in Sri Lanka
- Revisit the National IAS Policy, Strategies and Action Plan of 2016 in conjunction with the National Plant Protection Act No 35 of 1999 and its regulations to strengthen the M&E system entry of invasive alien species to Sri Lanka.
- Increase investment on using advance technologies for precision agriculture by 50% in 2022
- A method to increase high level coordination and harmonization effort to attract PPP for R&D and technological know-how and transfers (TT) in precision agriculture technologies
- Introduction of an attractive incentive scheme for relevant investors engaged in smart agriculture
- Increase R & D on agriculture machinery/infrastructural facilities.
- Provide financial incentives such as low interest loans (4%) for investments to development the agricultural machinery producing industry

1.5.2 Extension Services

▪ Need for extension services

- Limited availability and access to advanced technology
- Delayed introduction of new technologies due to the poverty of farmers
- Reduced research investment in agriculture

▪ Plan

- Create farmer awareness on producing and use of good quality seeds and planting materials
- Create awareness on the precision agriculture technologies at all levels as a means of high input use efficiency for higher productivity
- Promote and adopting precision technologies in all Agribusinesses to increase labour productivity and profits
- Introduce a method to engage educated and high skilled youth in adopting precision technology-driven modernization of the crop production sector
- Capacity building and training programs on ICT based agriculture technologies for field level agriculture extension officers

1.5.3 Infrastructure

▪ Need for infrastructure

- Poor logistical and infrastructure in cultivation and postharvest processing
- Lower the scale of production
- Heavy post-harvest losses
- Reduced crop cultivation area due to urban industrialization
- Lack of water and land used in agriculture

▪ **Plan**

- Encourage inventors/innovators to develop low-cost, high-quality agricultural machinery suitable for the local conditions
- Introduce a market information system to notify farmers of the market demand for crops to decide on their production and supply
- Create a program to strengthen the informed decision-making process in agriculture and to disseminate knowledge in facilitating the production of competitive and commercially oriented crops
- Promote the branding of crop products to secure niche and global marketplace

2. Sri Lanka's status of Post-harvest management technology for fruits and vegetables

2.1 Introduction

Many types of fruit and vegetables can be grown all year round in Sri Lanka. The contribution of the horticulture sector to GDP is 3% and to the agriculture labor force is 28.5%.

There are a number of farmers having lands < 1 ha. Fruits and vegetables are grown mainly for local consumption, with a small proportion exported (only 2%) as both fresh and processed forms. Fruit and vegetable production in the country is especially confined to the availability of water with monsoons. This cultivation practice results in excess supply of fresh produce in the season to the market, which reduces the market demand.

Production of fruits and vegetables in the country is not demand-driven. Perennial fruit crops start producing fruits in response to climatic conditions, resulting in very high seasonality.

However, the Department of Agriculture has performed initiative work to spread the production season by encouraging production through location-specific cultivation that produces off-season and crop forecasting calendar, awareness of the market and farmer, and availability of stocks in the market.

[Table 4-1] Extent, Production, imports and exports of horticultural crops in Sri Lanka

Crop	Extent of cultivation/ ha	Production/ yield/ mt	Imports/ mt	Exports/ mt
Tomato	5,329	80,839	7	63
Cabbage	4,224	99,616	0.07	-
Beans	7,723	87,385	0.64	32
Carrot	3,687	71,607	14	1
Leak	2,214	56,045	-	2
Cucumber	2,446	31,446	-	8
Banana	49,307	750,587	-	15,018
Mango	28,272	151,733	-	224
Papaya	6,975	86,219	-	5,072
Pineapple	4,783	52,786	-	1,206
Passion fruit	470	731	-	-

Source: Department of Agriculture(2017)

Post-harvest loss of horticultural crops in Sri Lanka is excessively high, resulting in poor income of farmers and higher prices for consumers. Production of horticultural crops is high, but post-harvest losses are also high at about 20-40% due to technical and non-technical factors. Reduction of post-harvest losses would mean increase in available food and sustaining environment. Fruit and vegetable consumption of Sri Lankans is half the WHO recommendation (only 94 g of fruits and 105 g of vegetables).

Crop	Farmer %	Collector %	Wholesaler %	Retailer %	Total %
Banana	2	3	12	5	22
Mango	4	6	20	12	42
Tomato	4	3	12	12	31
Pineapple	1	3	8	3	15
Papaya	2	4	22	8	36
Avocado	3	4	15	3	25
Bean	2	4	10	2	18
Carrot	2	4	8	3	15
Cabbage	2	5	9	4	20
Cucumber	2	5	6	2	15
Leeks	2	6	12	2	22

Source: Department of Agriculture(2017)

Mango is the target crop, and its post-harvest loss is about 35-40%. Use of improper maturity indices, poor harvesting practices such as time, harvesting tools, inadequate packing house operations, improper packaging, and poor handling practices from farm gate to consumer are the major causes of this significant loss. Research has been done, and manuals regarding improved post-harvest practices have been developed. The manual is implemented through field application at each step of the post-harvest handling chain. The major beneficiaries of this project are farmers, collectors, packing house operators, transporters, wholesalers, distributors and retailers in the Dambulla area of Sri Lanka.

The objectives of this project are the production of post-harvest manuals and introduction of improved post-harvest management practices for horticultural crops specially mango to reduce the post-harvest loss.

2.2 Methodology

2.2.1 Project description

Existing post-harvest practices and post-harvest loss of fruits and vegetables were identified through a baseline survey to get the information to apply improvements (Table 4-1).

The steps, procedures, and parties of the supply chain were identified, and improved pre- and post-harvest management practices were applied to Mango as the target crop in the Dambulla/Anuradhapura area. Cultural practices-improved technologies were applied in the farmer fields and, for the stakeholders of the supply chain, through trainings for targeted groups, trainers training, and value addition practices. Specially packing house operation practices were applied at the field level to improve farmer income. Crop manuals, Books, Booklets, Hand bills, Leaflets, and Posters were produced and introduced to stakeholders and education institutions. Research works were also conducted to improve pre- and post-harvest technology improvements and post-harvest loss reduction. Finally, post-harvest loss evaluation was also conducted to forecast application to other crops and get the outcome of the application of these upgraded practices.

[Table 4-2] General cultural practices and Improvements used in the supply chain to upgrade it to make the value chain

Postharvest procedure	Conventional method	Applied improved technology
Pre harvest practices	Poor field management, Tree height not maintain, no bagging (can't reach), fruits of whole tree to the ground	Good field management, pruning and bagging,
Harvesting Index	Farmer shape, size and skin and pulp color Collector No	Days after fruit set, shape, size and skin color
Harvesting indices	None results high immature harvesting and mechanical damages	Improved picking pole

Postharvest procedure	Conventional method	Applied improved technology
Harvesting & time	All	10 am ~ 2 pm
Field packing container	Gunny bags, wooden crates	Plastic crates
Weight/ pack for field container	25<kg	15 ~ 20 kg
Cleaning	None	Remove latex, wash, wipe and dry the fruits
Sorting	Field Removal of damaged and diseased fruits Collector color, even size (or none) Whole seller color, even size	Size, maturity stage, shape, damages, diseases color and quality at all the steps of the supply chain
Grading	Field No (Time wasting) Collector Size Whole seller Size, color	Size, maturity stage and other at all the steps of the supply chain
Storage Temperature	Ambient T/°C	12 ~ 15°C
Packing material (transportation)	Gunny bags, wooden boxes	Plastic crates and line with paper or foam net, corrugated carton box for export market
Weight/ pack	25< kg	10 kg
Transportation	Open Truck and lorries, tight packing and over loading	Covered trucks with ventilation, refer trucks
Postharvest loss	30 ~ 40%	??

Source: author

2.2.2 Activities

Improved post-harvest operations were expanded up to the introduction of packing house maintenance practices and value-added product development through trainings for the stakeholders of the supply chain to upgrade it to create a value chain.

▪ **Specific trainings conducted for target groups**

- Pre-harvest operations such as pruning (open canopy) and sanitation to reduce inoculums and bagging of mango at egg size stage to get better appearance and reduce attack by fruit flies and other pests
- Methods of evaluating the readiness of the crop for harvesting like maturity indices, e.g., shoulder formation, maximum size, days after fruit set, color, etc.
- Actual technique to be employed in harvesting produce, e.g., breaking the stem with the fingers in a suitable place (above natural falling point) or plucking with the end, clipping and cutting with picking poles, scissors, and secateurs
- Time of the day for harvesting; early morning or late afternoon (mango 10am~1pm)
- Use of harvesting sacks and containers; plastic crates, transfer of the produce to field or marketing containers and eventual grading when emptying the sacks, by introducing different grades in different containers; this operation is important when a field assembly point does not exist for filling with the produce ready for the market
- Selection of marketable produce at the field assembly point and grading for color, size, and quality, if applicable at packing houses such as lorry deck, small hut in the field
- Correct application of post-harvest treatments when necessary
- Method of packing market packaging or other containers
- Recommended induced ripening technology
- Value-added food product development, labeling, packaging, quality evaluation, and marketing

▪ **Postharvest loss evaluation**

Qualitative and quantitative postharvest loss evaluation was conducted with fruits and vegetables.

▪ **Equation used to evaluate the postharvest loss**

- $Loss \% = Decay Rate/\% + \frac{(100 - DecayRate/\% \times Weightloss/\%)}{100}$
- $Weight loss/\% = \frac{Initial weight/kg - Final weight/kg}{Initial weight/kg} \times 100$
- $Decay Rate/\% = \frac{No. of Decay fruits}{Total fruits} \times 100$

Year	Description
1 st Year	<ul style="list-style-type: none"> • Identification of improved postharvest practices • Production of manuals
2 nd Year	<ul style="list-style-type: none"> • Application of improved practices, through training conference • Production of books, leaflets, posters etc.,
3 rd Year	<ul style="list-style-type: none"> • Postharvest loss evaluation • Project Impact assessment

2.3 Results

2.3.1 Overall framework

Inputs	Activities	Outputs	Results or Outcomes
Printed technical materials	Trainings	No. of technical guidelines, trainings	Postharvest loss reduction amounts
Dissemination of technology	Technological knowhow	Policy suggestions	Increase farmer income, increase consumption
Improved technologies	Surveys, assessment	Field applications of improved technology	Smart agricultural practices

2.4 Project Outputs

Output	Quantitative Data	Description
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Publication of postharvest handling manual	24	Book 4, Booklet 3, Poster 5, Leaflet 12
Field application	4	Mango: 2 (Dambulla) Mango: Anuradhapura 1, Monaragala 1
Policy reflection/suggestion	1	New government policy on improvement of postharvest infrastructure especially packing house with cold room facility and handover plastic crates.
Publication of paper	6	Heat treatments and microwave treatments research on mango products results and others were published.
Presentation at Conference	1	2017 Asia Postharvest poster 1
Media PR	4	Radio 4 (Kandurata sewaya, Wayamba guwanviduliya, Guwan viduli govi sewawa, Rangiri dambulu sewaya).
Value added product development practices	5	Small and medium scale processors 5.
Total	45	Postharvest loss reduction of target area.

2.5 Project Outcome

Outcome	After field application			Details
	Crops	Conventional	Improvement	
Reduction of postharvest losses (%)	Mango	38	27	Dambulla area
	Tomato	34	30	Hanguranketha area
	Cabbage	28	25	Marassana area

[Table 4-3] Average/ % of mango through supply chain

Mango postharvest condition	Average
Postharvest loss before AFACI	38%
Postharvest loss after AFACI	23.6%
% Loss Reduction	37%
Income Increase rate of farmers	20.8%

2.6 Executive summary

The Food Research Unit of the Department of Agriculture is the implementing organization of the project. Several researchers, an agriculture instructor, and a development officer conducted the research and development works of the project.

The second major commercial fruit crop in Sri Lanka is mango, majority of which is produced for local consumption with a very small volume exported in fresh and dried forms. The modification of existing technology exhibited by the collectors and transporters played a significant role in this industry, and they are the most important party to target because they are not aware of harvesting and handling practices at all. Mango records significant post-harvest loss of approximately 38% due to poor post-harvest management practices. Project work was focused on mango crop in Dambulla, where most prominent mango-growing areas are in Sri Lanka. Improved technology including artificial ripening was introduced to supply chain stakeholders through trainings, mass media programs,

dissemination of manuals, leaflets, books, booklets etc., produced by the implementing agency.

Research was also conducted to reduce the post-harvest loss and improve the value chain. The major objective of this project is to reduce the post-harvest loss of mango through the application of improved technology. After a given period to establish the improved technology application by the stakeholders through value chain, impact assessment was conducted, showing significant reduction of post-harvest loss of mango at 26%.

[APPENDIX] Post-harvest management and processing techniques of fruits and vegetables

▪ The importance and necessity of cold chain system

- Fruits can quickly deteriorate in the surrounding environment over time when quality changes.

The harvested fruit should be cooled as soon as possible to reduce metabolic activity and exclude microbial degeneration this is the cold chain system.

- In the united states and Europe most agricultural produce are managed to maintain adequate power throughout the distribution process by lowering rumors immediately after studying.
- In order words, in order to maintain the quality of fruits as much as possible, it is necessary to cool the crop to an appropriate low temperature consistently throughout the next storage and transportation sales.

(1) Economic effect

- Consumer satisfaction increases as they are able to provide fresh, high-quality products to consumers to maintain the fruit lead.
- Small stores and supermarkets want to receive fresh agricultural products with aromas, tastes, colors, and textures that suit consumers' tastes.
- When consumer satisfaction increases by supplying fresh fruit, agricultural product consumption increases.
- The establishment of a cold chain system is becoming a very important task to improve competitiveness by enhancing the quality of domestic agricultural products.
- If the quality of agricultural products changes during the distribution process, communication transactions will become impossible, and it is difficult to reduce distribution costs and advance distribution.

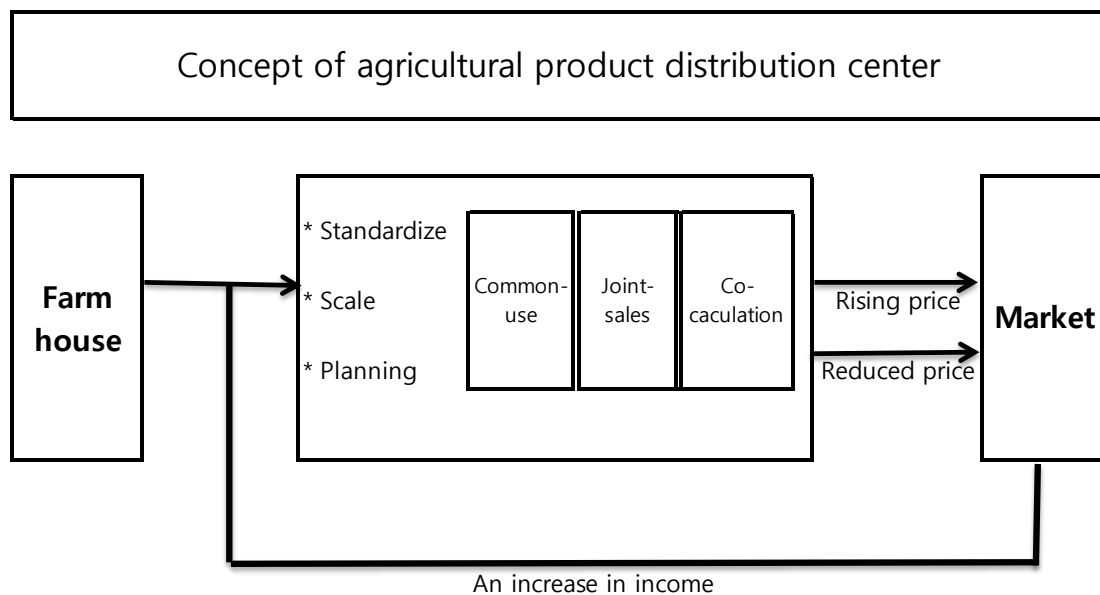
- The introduction of the cold chain system extends the distribution period of agricultural products, thereby contributing to price stability through supply and demand adjustment in the short term.
- The introduction of the cold chain system reduces distribution costs by reducing the amount of reduction in the distribution of agricultural products, and such can be expected to increase production by as much as the reduction of amount of reduction.

(2) Importance of low temperature distribution.

- Even if fruits and vegetables of very good quality are produced, if they are not maintained at an appropriate temperature after harvest, they will spoil within a short period of time, resulting in a problem in distribution.
- In addition, producers can reduce price and sales anxiety caused by rapid changes in agricultural products after harvest.
- Intermediate wholesalers and retailers are guaranteed an appropriate profit as long as the consistent quality of agricultural products is maintained, thereby building mutual trust between producers and merchants.
- With the increase in national income and diversification of dietary structure, the demand for high-quality fresh, safe agricultural products has increased significantly.
- With the introduction of agricultural products and expansion of distribution markets, imports of foreign fresh agricultural products rapidly increase based on an advanced distribution system leveraging the domestic agricultural production base.
- In order to meet consumer demand and protect domestic agriculture, it is necessary to establish an advanced distribution system to support the enhancement of competitiveness through quality upgrading.
- Strengthen quality competitiveness by maintaining agricultural quality and freshness.
- Reduce logistics costs by minimizing the rate of disposal due to the poor quality of fruits or vegetables.

- It is necessary to expand the base of low-temperature distribution for the supply of high-quality agricultural products in terms of improving diet suitable for national health and income levels.
- It is necessary to establish a production and distribution system that can maintain the quality of agricultural products (fruits and vegetables, etc.)
- **Function of the agricultural products distribution center**
 - Collection agricultural products, graded, packaged, shipped and sold.
 - Post-harvest management and shipping efforts and reduction.
 - A strategic hub for the distribution and sale of agricultural products in production area.
 - Agricultural products agricultural product commercialization.
 - Creating added value by putting management technology after harvesting.
 - Branding and minimization of loss rate.
 - Mass processing system corresponding to mass to production distribution consumption.
 - Equipped with machinery and automation equipment for timely work and market shipment.
 - Intangible function
 - Exchange and sharing of farming information
 - Collection of distribution and planned bulk shipment
 - Unity of producers is
- **The terms and conditions of being provided at the agricultural products distribution center.**
 - Scaling
 - Efficient application, stable market shipment, essential to the inventor of selling price.

- Obtain more than break-even supplies to the working machine -> organization of distribution, agreement production sites.
- Standardizing
 - Essential to produce agricultural products
 - * internal quality such as weight, appearance and sugar content.
 - High-quality uniform agricultural production conditions :
 - * Variety intensive composition
 - * Standardization of cultivation techniques, standardized,
 - * Local producer agreement



Source: author

- Planning
 - Focused on producers who sell what is produced
 - Consumer-oriented to produce and sell what to sell
 - Building a consistent production system from production to sales not just a simple sales plan.

▪ **Direction for improvement of agricultural product distribution center**

- Bulk collective screening packaging member value added and distribution cost reduction.
- Increase the rate of house rate and operation rate
 - Composition of a variety of objects suitable for the region
 - Joint use of multiple fruits and vegetable in a single fruit
 - Expanded cold storage installation
- Improved by mechanical ability
 - Mechanics and automation for highly human- dependent processes (for example, primary screening put in the box)
- Scale and work are also improved
 - Measure to improve the level of operations
 - * Carry-in volume planning
 - * Market order planning
 - * Reduce job latency
 - * Eliminate bottlenecks for proper staffing
 - * Selection of appropriate scale and quick A/S
- Thorough quality control and maintenance of production guidance systems in production area.
 - Strict quality standards applied: Dissatisfaction with farmers producing low-quality agricultural products restricted use of facilities.
 - Neglect of quality control -> poor reliability concerns about reduced sales and consumption
 - Establish a production guidance system for consistent production sites from production to sales

▪ **The task of developing the agricultural distribution centers**

Technology development site

- Optional design of sorting and packaging facilities
 - Number of operating days
 - Throughput per day
 - In and out location
 - Travel distance
 - Space clearance and work flow
 - Consider unit machine performance
 - Machinery and automation for bottling processes
 - Development of sorting and packaging facilities suitable for Sri Lanka conditions
 - Find factors for quality evaluation of fruits and vegetables
- Develop a quality prediction model with high accuracy
- selection criteria of physically damaged fruit and diseased fruits

▪ **Government administration side**

- Simplified rating standards.
 - Simplified standard that combines appearance strength and acidity size
 - Improve the compacting work efficiency and space utilization of the screeners
- Uniform national shipping standards and measurement methods
 - Apply tolerance : standard for sugar content $\pm 0.3/^{0.5}$ brix⁹
- Recognition of accuracy in display

▪ **Agricultural machinery production company side**

- Rapid localization of mechanical devices and systems

- Quick after sales service
- User manual preparation and training

▪ **Producer aspects such as farming union**

- Developing measure to deal with agricultural products that do not meet the screening criteria.
 - Sold as high sweetened fruit with excellent appearance
Fruits below the standard sugar level are eliminated
 - Discovering the use of substandard fruit sales
- Selection result used for production guidance
- Securing expert-trained and competent managers
- Co-operation with producers on joint selective packaging
- Contrast for the HACCP

▪ **Consumer and distributor aspects**

- Accurate evaluation of quality and pricing
- Pursuit of rationality in recognizing the limits of understanding of Agricultural products.

▪ **The purpose of fruit and vegetable products management**

- Prevents loss of harvested agricultural products
 - Loss and environmental production
- The preservation of the quality of agricultural products harvested
 - High quality and competitiveness
- Extending the life of fruits and vegetables
 - Shipment control

- Consumer satisfaction with the quality
- Pursuit of profits for farmers and distributors
- Characteristics for post-harvest management of fruit and vegetables
 - Continuous and phased management is required
 - Integrated system management through the cold distribution system

▪ **Development of post-harvest pretreatment and storage technology of major fresh fruits and vegetables.**

Contents of future Research and development

- Evaluation of the current status and technology level of domestic post-harvest management technology development period for fresh fruit
- Contents and utilization plan for post-harvest management technology of major advanced fruit-producing and exporting countries
- Appropriate temperature and humidity of storage and storage period for each major fruit item
- Management technology requirements from the mathematics stage to the consumer sales stage after export
- Evaluation of the difficulty level and priority development of technology ranking after step-by-step development skills
- Set development focus and goals according to the technology to be developed in detail
- Annual development methods and budget required for technology

▪ **Details of the research project**

Research project	Priority
Criteria and procedures for selecting items subject to the intensive development of post-harvest management technology	1
Pre-cooling technology development and distribution system after harvesting by item	1

Research project	Priority
Study on the development of related materials for efficient distribution of post-harvest management technology	2
Long-term storage technology development and storage facility requirements	1
Lowest price conditions and methods after screening standardized packaging and transportation operations	1
Setting the main focus and goal for each item of detailed technology development at each stage	2
Comparing the effects of entertainment according to the amount of ventilation for the type of packaging	1
Detailed technical commercialization test operating system for each step	1
Linked operation and developmental promotion system for each type of detailed technology by target item	2

▪ **Research on the development of fruit processed food export and commercialization technology**

- Study on the world's major fruit processed foods with high foreign market performance
- Survey on the technical level and demand for technical support of export products in the domestic processed food industry
- Plan for global commercialization by grafting famous fruit processed foods in overseas markets and domestic processed foods
- Development of world-class mass-consumption food based on domestic fruits (Banana, Mango, Papaw, Pineapple, etc.) and food additives

▪ **Small- scale fruit processing and storage technology development**

- Home- scale fruit processing and preservation technology development
 - Canning and bottling of fruit
 - Washing, preparation of fruit
 - Filling and syruiping

- Preparation of syrup
 - Exhausting, sealing, pasteurization
 - Cooling and storage
 - Development of small-scale dried fruit processing technology
 - The first stage is the preparation of fruits which involves peeling, cutting, slicing and such other operations. Next is the pre-treatment where fruits are dipped in solutions of some chemical for specific periods. The last two stages are sulphuring and drying.
- Development of small-scale dry fruit dryer technology
- Drying capacity is about 25 to 30kg dryer
- A home drier is ideal for drying fruits and vegetables at home. It consists of a strong box of galvanized iron, sheet (90 cm. x 60 cm. x 90 cm.) with perforated bottom. The sides and top of this box are enclosed in wooden frame work. The box is supported on an iron, stand, 40 cm. high. A kerosene oil stove, charcoal hearth, or electric heater can be used as the source of heat. Moisture is let off through two slits 60 cm. x 4 cm. with collapsible metallic flaps along the length on both sides about 10 cm. below the top. The drier can accommodate 7 trays of 80 cm. x 60 cm. Care is taken to regulate the temperature and outflow of moisture from the drier by adjusting the source of heat and the slits.
- Development of high quality and small quantity fruit jam manufacturing technology
- Selection of fruit
 - Preparation of fruit
 - Addition of sugar, Mixing, Cooking
 - Filling and closing, Cooling and storage
- Development high quality and small quantity fruit syrups manufacturing technology
- Washing preparation of the fruit
 - Extraction of juice
 - Mixing and preserving
 - Bottling and storage

▪ **Preparation of technology guidance for management skills after harvest**

Set key requirements and performance objectives

- Core requirements
 - (1) Before harvesting agri-food, the foundation for producing crop with high quality safety and price competitiveness should be established
 - Production resumption of the cultivation and production process related to quality after harvest shall be ensured.
 - (2) Based on basic research on post-harvest management unit technology such as quality evaluation preprocessing, storage, packaging, and transportation technology should be connected to a chain-type system and appropriate post-harvest management techniques for each item should be systematically applied
- Post-harvest physiology study
 - A study of various physical and chemical reactions and identification of control mechanisms that affect changes in quality factors after harvest by item
- Pretreatment technology
 - Optional packing house facilities by item and the results of on-site adaptation studies supporting this
- Pre-cooling technology

Precooling required of fruits and vegetables
- The method needed for
 - Finding the right packing containers for cold chain systems is required
- Packaging and transport technology
 - Development of packing materials and packing containers for the establishment of a cold distribution system

- Development of transportation equipment and management systems that can minimize logistics costs
- Storage technique
 - Development of precision control equipment that can realize C.A storage and ULO storage
 - And it is necessary to research and develop the technology to operate it
- Quality factor search technique
 - The quality measurement factor should be divided for each crop to establish the grade impact
 - Quality factor and analysis methods should also be standardized
- Identifying sensory and quality factor
 - Capable correlation
 - It is necessary to test whether physicochemical analysis data and sensory evaluation data show a unique correlation
- Prioritizing quality factors
 - Prioritize quality factors from the perspective of consumers or distributors producers
- Developing efficient quality and safety analysis methods
 - Close cooperation with producers should precede (distributor, food manufacturing co, ltd)
- Quality impact factor analysis
 - After conducting factor analysis by item and item through data
 - And The research is carried out in connection with the development of quality grade standardization research

- Research on new functional materials and functions as know functional materials food
In addition, specific efficacy analysis techniques are needed to support scientific verification of the efficacy and safety of these substances
- Through joint research with academic and industrial research institutes the diversification of fruit processing products and the technology of intermediate food materials should be improved

3. STI Action Plan for Agriculture 2012-2025: Entrepreneurship

3.1 Justification

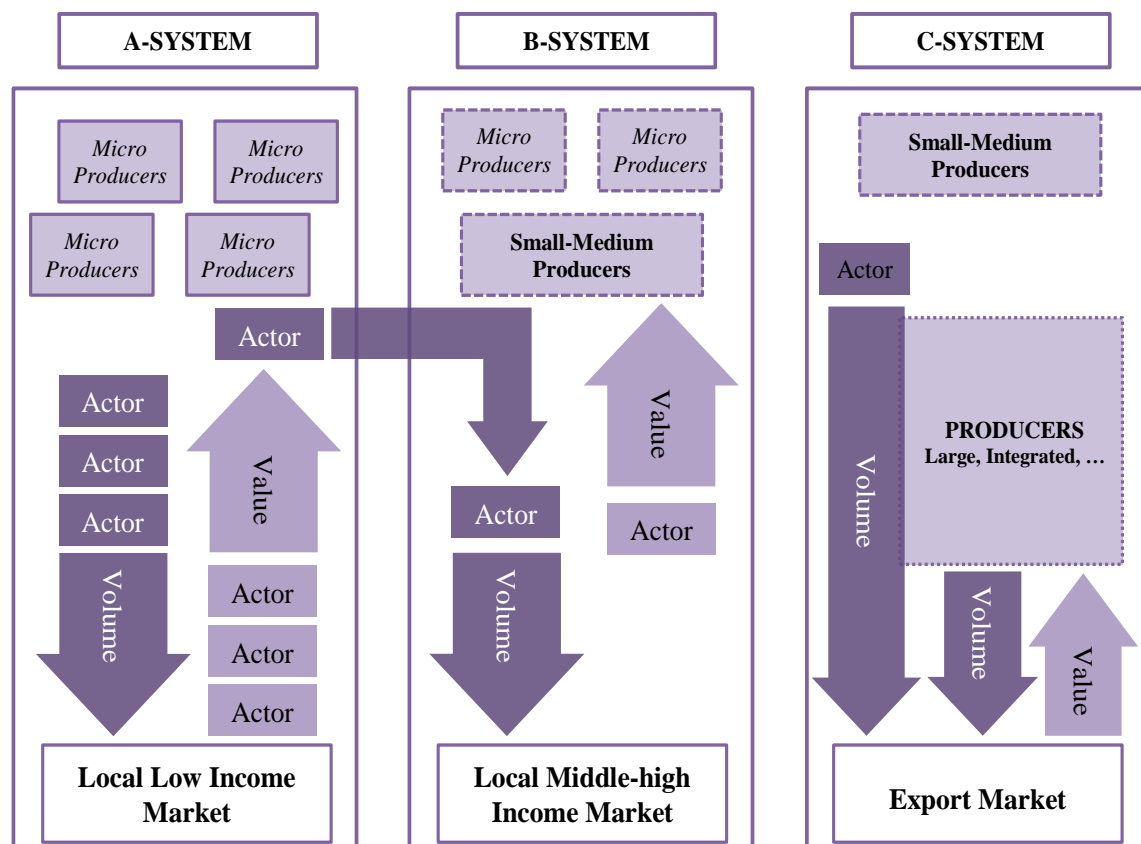
The current agricultural policy objectives in Sri Lanka prioritize increasing farmers' income, which would require various actions by the government. In particular, the modernization of agriculture and establishment of competitive production system targeting both domestic and international markets by upgrading the entire value chain of the industry has been the first priority of the policy, which is not a simple task to achieve in the short term since the main target of a value chain is to promote high value-added commodities in domestic and international markets. Therefore, constraints for value chain development are related to local, regional, and international market access and market orientation, factor conditions such as available resources and physical infrastructures, and regulative institutions, which require long-term transformation.

In general, the agricultural value chain has different characteristics by country because demand in both domestic and international markets is differentiated by commodity. As a result, the supply chain of each commodity needs to consider specific quality and safety measures for particular markets.

For instance, the A-system is characterized as the local low-income value chain. Producers are usually small with traditional production systems. The low-income value chain targets the local markets for staple and various food products. However, the value chains might be related to the low quality of food markets as well. Due to the existence of numerous participants in the chains, the A-system is relatively long, implying limited market information including actors of distribution and transportation. A-systems in Sri Lanka share a high volume of agricultural products, but they may not be able to generate high value at all. Instead, these agricultural products in the systems are distributed within a complex chain to the local markets in various regions.

The B-system is characterized as the local middle- to high-income value chain. The participants in the system mainly focus on a relatively new commercial market such as supermarkets in various developing countries. Most of the agricultural products in the system are distributed by small and medium-size participants such as agricultural cooperatives and farmers' organizations or contract farming. Small-scale farmers utilize inputs on demand to balance market principle in the system. Even though the volume of products produced within the B-systems is smaller than that of A-systems, the value of the products might be higher in B-systems. They recognize the national and international quality and safety standards.

[Figure 4-1] The current value chain in the Sri Lankan Agricultural Industry



Source: Ruben et al.(2007)

Meanwhile, the C-system is characterized as the export value chain in Sri Lanka. It is mainly focused on export, even though low-quality products are distributed to the local and domestic markets. It tends to consider economies of scale and FDI or government public investment as planned by the Sri Lanka government in its policies. The system targeting exports tends to be integrated vertically with few participants. Even though the volume of products distributed by the system is smaller, the value could be much higher.

The systems mentioned above operate independently, even if one could use resources between A- and B-systems as shown in the figure. The co-existence of such systems reveals important implications for the development of a systematic value chain for Sri Lanka. Therefore, the action plan for entrepreneurship should consider various situations for the long term focusing on human capacity building (Trienekens, 2011:p53-55).

The more various and differentiated the consumer markets are, the more market-oriented actions taken within a value chain. This implies that market orientation should be present in multiple actors in the value chain. Therefore, various actors in the chain should have knowledge and capability of meeting the demands in the final consumer market. As such, actors have access to market information and possess the capacity to capitalize them, which can be a part of entrepreneurship.

Conditions related to human capacity, knowledge, technology, infrastructure, and others are necessary to enhance value chains as well as farmers' income in Sri Lanka. These conditions either promote or restrict upgrade of any value chain. General bottlenecks faced in Sri Lanka include lack of skilled labor and lack of accessibility to specific technologies and information, etc. In particular, availability of educated and trained labor and availability of knowledge on the entire value chain are the most important elements for the future management of the agricultural value chain.

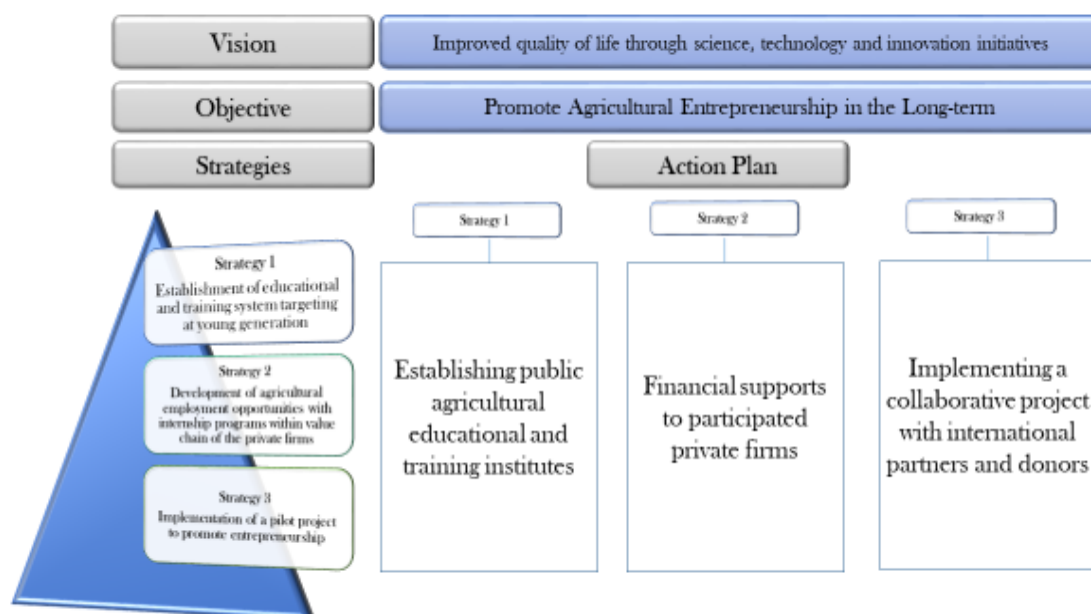
3.2 Actions Plan

Fostering of agricultural human resources is a task faced by Sri Lanka where the role of the agricultural industry is reduced in the course of industrialization and urbanization through economic growth. In Sri Lanka, agriculture is an important sector whose functions is to supply food to the country, employ residents of the community, and maintain the space, society, and environment of the rural areas. Therefore, it is necessary to foster professional farmers who can systematically lead the industry with entrepreneurship. Since the promotion of entrepreneurship for the youth needs a system of proper education and trainings, the following actions should be taken to attract the young generation:

- Establishing as educational and training system targeting at young generation
- Developing agricultural employment opportunities with internship programs within the value chains
- Implementation of a pilot project to promote entrepreneurship for youth

In the case of Korea, the development of agricultural human resources in rural areas has been supported by the government systematically through the rural successor project in order to nurture professional farmers possessing the necessary technologies and expertise in traditional farming to meet the challenges ahead. In addition, educational support should be provided through public school and institutional systems so that young and creative agricultural human resources can adapt to the new agricultural environment. In the long term, such entrepreneurship-educated labor in the agricultural sector can set a good example of accepting innovative and creative ways in the quickly changing economic environment and applying them proactively to raise productivity and value for agricultural products. Therefore, prospective young human resources can be potential targets for fostering, and such should be pursued as a long-term policy in the future. However, the necessary funding to assist them in settling down in farming and becoming self-supportive is lacking; hence the need to have concentrated fostering programs that take the young candidates into preferential consideration while selecting targets for various support programs in the sector.

[Figure 4-2] Action plan for entrepreneurship



Source: author

The development of agricultural human resources with entrepreneurship is a mid- to long-term task, so this must be sufficiently taken into consideration. In other words, goals for developing human resources must be established, and detailed tasks should be divided into mid- and long-term tasks. A short-term task might be to identify matters for institutional improvement that should be pursued in the medium term and to begin preparations to establish the necessary organizations or institutes.

Mid- and long-term goals require investments in software such as education for entrepreneurship and development of curriculum and programs. In particular, a two-phase education program that fosters key farming human resources or leaders and utilizes them as education trainers (training of trainers, ToT) is needed at first. In addition, pursuing institutional reform and establishing educational institutes are necessary for the long-term objectives. In the long-term, the outcomes of the pilot project should be analyzed and scaled up to other regions or nationwide.

Meanwhile, the following details might be potential actions for promoting entrepreneurship for the youth:

3.3 Detailed actions for agricultural entrepreneurship development

Strategy 1. Establishing educational and training system targeting at young generation

Objective 1: Policy Formulation for promotion of agricultural enterprises of selected 6 crops by 2023

Objective 2: Undertaking teaching and capacity building initiations related to agricultural entrepreneurship development of 6 crops by 2022

Objective	Activities	Agencies
Objective 1 Policy Formulation for promotion of agricultural enterprises of selected 6 crops	<ul style="list-style-type: none"> • Identification of problematic issues & constraints relevant to provide educational programs for entrepreneurship with selected 6 crops in existing policies • Policy formulation to provide necessary measure for the educational programs based on identified constraints and issues • Prioritization of the educational program for agricultural enterprises of selected 6 crops 	<ul style="list-style-type: none"> • Ministry of Agriculture, • Ministry of Industries, • Sri Lanka Council for Agriculture Research Policy • Ministry of Higher Education • Ministry of Youth, • State Ministry of Skills Development, • NIBM • ICTA
Objective 2 Undertaking of teaching and capacity building initiations related to agricultural entrepreneurship development of 6 crops	<ul style="list-style-type: none"> • Development of entrepreneurship course in Agriculture and Agribusiness training institutes • Identify the youth to engage in selected 6 crops • Organize special institutes and programs relevant to 6 crops 	

Strategy 2 Developing agricultural employment opportunities with internship programs within the value chains

Objective 1: Providing employment opportunities for the young generation with the internship of the private sector in one of the 6 crops' value chain

Objective 2: Providing business consultancy and technological facilities to entrepreneurs of 6 selected crops

Objective	Activities	Agencies
Objective 1 Providing employment opportunities for the young generation with the internship of the private sector in one of the 6 crops' value chain	<ul style="list-style-type: none"> • Provide investment incentives for the participated private agricultural enterprises in 6 crops • Provide a low interest loan schemes for identified agricultural entrepreneur in 6 crops • Develop a system with the government-sponsored banks to provide financial assistance to the private participants 	<ul style="list-style-type: none"> • Ministry of Finance, • Ministry of Agriculture, • Ministry of Industry, • Board of Investment
Objective 2 Providing business consultancy and technological facilities to entrepreneurs of 6 selected crops	<ul style="list-style-type: none"> • Establishment of district level agro-enterprise centers in each district to facilitate the entrepreneurs of each of 6 crops • Create online/onsite systems to provide business consultancy, technology transfer and marketing opportunities to entrepreneurs of 6 crops • Identify and set up Youth Clubs to provide farm machinery services • Create an App to share real-time product, process, market information between all participants of the supply chain 	<ul style="list-style-type: none"> • Ministry of Youth, • National Youth Services Council, • ICTA • Ministry of Land, • Farm Mechanization Research Centre •

Strategy 3 Implementation of a pilot project to promote entrepreneurship for youth

Objective 1: Preparing for the nationwide extension of the education and training programs for entrepreneurship activities in 6 crops by 2022

Objective 2: Establishing the standard programs for entrepreneurship development of the 6 crops and sharing them with other regions

Objective	Activities	Agencies
Objective 1 Preparing for the nationwide extension of the educational and training programs for entrepreneurship activities in 6 crops	<ul style="list-style-type: none"> • Develop an extension for entrepreneurship development to attract youth • Device a rewarding system to encourage young entrepreneurs for promoting agri-business in selected crops • Organize development training programs for young entrepreneurs who are willing to engage in agribusiness of selected crops each year • Form a Young Farmers Association to actively participate in selected crop related agri-business ventures 	<ul style="list-style-type: none"> • Ministry of Finance • Ministry of Agriculture • Ministry of Youth • National Youth Services Council
Objective 2 Establishing the standard programs for entrepreneurship development of the 6 crops and sharing them with other regions	<ul style="list-style-type: none"> • Provide training to women and young entrepreneurs of selected crops especially in export- oriented value-added industries • Develop the standardized educational program to share with other regions 	



CHAPTER 5

Conclusion

2020 STEPI-NASTEC STI Policy Consultation Project on
“Supporting the Improvement of Science, Technology
and Innovation (STI) Policy and Institutional
Framework for Sri Lanka”



Chapter 5. Conclusion

The 2020 STEPI-NASTEC Project aimed to develop implementable action plans in Sri Lanka's strategic areas, based on the analysis of the status of the national science and technology system and identified barriers of effective STI policy implementation derived from the 2019 Project.

The World Health Organization (WHO) declared COVID-19 as a global pandemic on March 11, 2020, and the Sri Lankan government ordered a national curfew from March 20 to May 11 to prevent the spread of COVID-19. During the same period, NASTEC was also completely suspended; thus, the offline kick-off meeting for the 2020 project scheduled for April was also canceled.

In 2020, it was supposed to support establishing an action plan by selecting the fields of science and technology innovation strategies promoted by the Sri Lanka Ministry of Science and Technology and NASTEC. However, in the aftermath of COVID-19, Sri Lanka's domestic economy was deteriorating, and the food supply for the basic survival of the general public faced a volatile situation. Ministries of the national government were required to develop strategic plans to support and promote agriculture with each specialized field of ministries and affiliated agencies.

NASTEC, which oversees the establishment and consultation of Sri Lanka's national science and technology innovation policy, took the urgent task to establish the STI action plan to promote the agricultural industry in collaborating with the Ministry of Agriculture. Given that STI is an essential tool of economic growth and sustainable development of country, STEPI and NASTEC, therefore, agreed to focus on the agriculture sector for the 2020 Project. We proposed the STI perspective to improve agricultural productivity, increasing added value through product processing, and fostering agricultural entrepreneurship during the 2020 Project.

This year, the STEPI-NASTEC Project offered the opportunity for multi-stakeholders to develop the action plan from the beginning, including policy officials from the Ministry of Agriculture and professors of agricultural colleges from top national universities as well as STI policy experts. As relevant ministries such as the Sri Lanka Ministry of Agriculture and Planning participated in this project initiated by STEPI and NASTEC, cross-cutting efforts were made in planning the Agricultural STI Action Plan in order to increase the feasibility and effectiveness of the plan. As for the implementation stage of the action plan, it was proposed the Ministry of Agriculture, Ministry of Land, and Ministry of Youth were designed to carry out a joint pilot project as well. Furthermore, STEPI has supported NASTEC and Sri Lankan government officials to develop their own action plans in three major agricultural fields by providing feedbacks on the draft action plans.

Despite the COVID-19 pandemic, the project was meaningful for all participants to examine the current challenges facing the Sri Lankan government and focus on drafting the STI action plan themselves on the most critical sector during the global and national crisis while exploring the new ways of carrying out the bilateral cooperation.

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