Situational Analysis for Mainstreaming Nutrition in the Agriculture Sector of Sri Lanka

Nutrition Society of Sri Lanka

2020

Acknowledgements

Compilers of this report Anoma Chandrasekara and Roshan Delabandara of Nutrition Society of Sri Lanka would like to acknowledge contributors for this report and FAO guidance and financial support for the project.

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Executive summary

There are improvements in social indicators in Sri Lanka, but the nutritional status of people is stagnating for some age groups and non-communicable diseases are increasing while elderly age group is expanding. Agriculture sector plays a pivotal role to provide adequate food supply to people in a country.

There is a clear linkage between nutrition situation and good health and wellness of people and the agriculture sector. Though close relationship is obvious among three players namely, agriculture, nutrition and health, connection is missing among priorities of nutritious food production and their consumption by the population.

The current situational analysis was done to understand the current status of each component of agriculture sector and to identify gaps of factors related to nutrition affecting at basic and underlying levels. The specific objective of the analysis include to identify and shed light on crucial factors leading to nutritional gaps and to provide recommendations to resolve the situation and to improve overall nutrition situation of the nation.

Crop sector

In the Sri Lankan context analysis for production and consumer demand for specific commodities is not sufficient. Food imports to Sri Lanka need to be determined after careful analysis of monthly production of specific commodity and the consumer demand.

Nutrition is not identified adequately as an objective in agriculture related policies, acts/regulations/ strategic plans /actions plans related to agriculture and agriculture related programmes. Therefore it is necessary to carry out a comprehensive analysis on national level nutrition and nutrition-related policies to develop a harmonized national policy, strategy and action plan to ensure nutrition security in Sri Lanka.

At present bio-fortified staple food crops are not available in Sri Lanka. But two crops (maize and rice) are ready to be released with improved nutrient quality in the near future. Comprehensive studies on alleviation of micronutrient deficiencies with bio-fortification or food fortification including both epidemiological and interventional studies are limited in Sri Lanka. It is recommended to conduct well-articulated pilot scale studies to assess the benefits of biofortified food on improving nutritional status of people in Sri Lanka.

Home gardens increase annually in Sri Lanka by number but analysis of actual food and nutrient supply from home garden products and their temporal changes are not available. It is necessary to conduct scientifically designed studies on the contribution of home garden to the nutritional status of the household especially through crop-animal integration. Furthermore necessary analyze availability of nutrients of home garden products in determining appropriate composition of trees, crops and livestock in the system that will be useful in reducing poverty and malnutrition.

The per capita availability of fruits and vegetables in Sri Lanka is little above the minimum daily consumption recommended by the WHO. Although the fruits and vegetables are available, the actual daily intake of fruits and vegetables are well below the national recommendation. Post-harvest losses and unsafe handling of fresh fruits and vegetable increase the prices and consumer unacceptability. It is needed to design, develop, promote and implement urban and periurban

agriculture systems, appropriate technologies and incentives to increase fruit and vegetable consumption to ensure food and nutrition security among people. It is necessary to conduct scientific studies to assess the nutritional quality of traditional and new improved varieties/hybrids of commonly grown fruit and vegetables to facilitate nutrition security programmes in Sri Lanka. There is lack of a national policy to promote fruits and vegetables considering the availability, accessibility, affordability and acceptability. It is recommended to conduct a national food and nutrition security drive especially targeting promotion of fruits and vegetables consumption.

High postharvest losses occur at the consumer level as food wastes. It is recommended to design and introduce effective food distribution systems with supportive market mechanisms to reduce food miles, minimize post-harvest losses, and fresh, healthy and nutritious products reach the consumers.

A gap between the farmer and the agriculture extension exists. At present, it is a major challenge for imparting modern agriculture technology to farmers. It is recommend to develop and implement mechanisms to provide the required agricultural inputs to the farming community in a timely manner to ensure healthy and nutritious food crop production.

Some healthy food are costly in Sri Lanka and for some items it is due to the import taxes. Therefore it is vital to find ways to revise import taxes to ensure healthy food consumption.

Agricultural researchers do not aware enough of nutrition to support nutrition sensitive agriculture. Research output is mainly focused on issuing of new varieties to increase the production. Thus agriculture research investments is not streamlined on nutrition focused programmes. It is needed to develop and provide funding to implement a national research plan on nutrition sensitive agriculture. Further, there is need in design, develop and implement a continuing capacity building programmes targeting field level officers to educate and build awareness on human nutrition and healthy life.

Water management and irrigation is the major problem for agricultural activity in the rainfed dry zones of Sri Lanka. Several farmers have established agro wells but without proper guidance on hydrological properties of the aquifer creating environmental problems on reservoirs. Furthermore, specific interventions to safeguard the cash crop production targeting food security, such as agricultural commercial development, enterprise development and employment, rural financing and project and company management are lacking. Therefore it is vital to facilitate agricultural commercial development, enterprise development and, rural financing and project and company management to develop cash crop production in Sri Lanka leading to food and nutrition security by ensuring sustainable income to farmer families who are vulnerable to poor nutrition.

Drawbacks exist in organic farming due to lack of essential organically confirmed inputs such as compost, other manures, bio-fertilizers, bio-pesticides and high cost of production due to high price of the inputs. Only few farmers have adapted soil protection systems in the field level. Low organic matter content in soils has created several problems such as yield decline and yield stagnation in crops such as rice, fruits and vegetables grown in Sri Lanka. Under such conditions, retention of plant nutrients is low and subsequently decreasing the fertilizer use efficiency. Thus, seasonal application of organic fertilizers are promoted for crop production in Sri Lanka by

introducing novel technology packages to improve crop productivity/land productivity and climate resilience.

Livestock sector

In Sri Lanka the value chain of animal source food (ASF) struggle at the farmer and processing level. Therefore, the assistance is needed in production and processing methods to improve the productivity and sustainability of the ASF.

High cost in the livestock sector is associated with feeding animals, and use of some raw material imported into the country. It is recommended to plan research to improve the yield and efficiency of the feed raw materials, utilization and management of local resources which are commonly available in different climatic zones in the country

Though high yielding animals are provided through various government programs at the farmer level, proper feeding management practices are not implemented due to poor knowledge. Education of farmers about the importance of proper feeding management practices to obtain high production yield and profit margin is necessary.

Accommodation and placement of local ASF products, especially beef, mutton, and pork, are challenging with the existing infrastructure. It is needed to establish and strengthen infrastructure facilities for collecting networks, value addition, further processing, packaging, improve quality standards, and assurance of the quality of the final product reached by consumers.

Value addition of ASF especially milk is not satisfactory. It is crucially important to encourage small scale milk processing giving proper knowhow and facilities. Value addition to ASF can (e.g., conversion of milk to yogurt or cheese) increase the marketability to the product and provide additional income. The production of such producers is essential to reduce the importation and wastage of ASF such as milk. Farmers will receive an economically attractive price for their products and encourage more medium- and large-scale entrepreneurs to enter the animal husbandry sector and make further investments increase production and achieve self-sufficiency.

Lack of information on factors that impact the purchasing patterns of ASF products in order to cater to the purchasing behavior of consumers is highlighted in the review. Therefore need to develop and provide funding to implement a national research plan considering price, income, taste, and preference as key variables that affect the ASF purchasing and consumption patterns.

The operations at production level and post-production value-chain including processing and marketing are not horizontally integrated. It is especially need to revisit and amend the ASF value chains

Though various institutes provide statistical data, discrepancies of data and lack of the latest data is a problem to see the real situation of the livestock sector. It is recommended to strengthen and explore the mechanism for monitoring and updating national livestock statistics. According to Sri Lankan legislation, any animal husbandry establishment should be registered, and upgrading this database to an electronic or online system can enable the collection of real-time data.

Lack of maintaining the status quo on tax and trade policies for imported ASF products is a gap identified. Therefore regular reviewing and revising tax and trade policies on ASF to support domestic production with changes in the market and modify the supporting policies to improve the

production of the sector. The finances associated with the Sri Lankan ASF production should be assessed periodically

Some legislations relating to ASF are outdated, overlapping, and not streamlined, with appropriate consideration for current developments in the ASF and nutritional requirements. Undertaking a comprehensive review of all legislations relating to ASF that are outdated, overlapping, and not streamlined is necessary.

There is not of quantitative assessment to identify the adoption, robustness, resilience, and transformability of the changing food systems and resilience and adoption of farmers to the current trends and global phenomena such as climate changes, and pandemics. It is recommended to conduct quantitative assessment to identify the adoption, robustness, resilience, and transformability of changing food systems and farmers in achieving food and nutrition security in the country. With changes in the food systems of low- and middle-income countries, there will be an increasing demand for food and shift can observe towards high protein and/or processed diets.

The level of development, quality, and quantity across ASF and even within the commodity in Sri Lanka vary, at the farmer, processing, and retail level leading to suffer from marketing constrains in all sectors of livestock , Need to establish and strengthen all the segments to maintain quality standards, which are compatible with international standards and supported by capacity development and policies. Furthermore it is necessary capacity and legislations to be developed to monitor the implementation and inspection of food safety standards.

Though poultry sector performs well with an established network of farms, slaughterhouses, and processing plants other meat industries are not well organized with the social and cultural impacts, the and lack a consistent quality. It is recommended to make aware of consumers about the importance and necessity of consumption of ASF.

Often the indigenous animals used for farming are given the least priority in the existing policy, economic, and social regimes. In addition, there is minimal data available on indigenous animals. It is needed to formulate policies to support the conservation and sustainable utilization of indigenous animals. There are unique features of indigenous animals and they play an important role in the rural economy and household food security

Lack of using high end technology in the farms to increase the productivity is identified throughout all ASF production as a gap in livestock sector. Therefore it is needed to take steps to use high end technology in farms to monitor the activities of the farm and to generate valuable information to increase the productivity. Fourth Industrial Revolution (4IR) technologies, namely the Internet of Things (IoT), Artificial Intelligence (AI), drones, and robots, can be used in the animal husbandry sector to increase productivity. In IoT incorporate sensor to the network of devices so that these will have digital intelligence and will be able to communicate real-time data automatically.

Participatory research and extension efforts in support of the production and development of ASF is not adequate. It is necessary to promote linkage of researchers from universities and research institutes with veterinary officers, staff, farmer organizations, and NGOs.

Lack of efficient networking among related institutions, service delivery system and livestock farming community leading to poor performance in production capacity and export markets is an

identified gap. It is recommended to strengthen the institutions catering to livestock farmers, reinforcement of the government veterinary network, and enhancements in the service delivery system for the livestock farming community to enhance the production capacity and efficiency.
Since the poultry production has reached the sufficiency, to overcome the barriers for low exports need to formulate policies and procedures to the place the products in the international market.

Aquaculture and fisheries sector

Policies and act related to fishery industry is not aligned with food and nutrition security but they are interdependent to some extent. Aligning of the fisheries act and policy with the food and nutrition security is recommended.

There are large gender disparities in access to and control over resources relating to fisheries and aquaculture. Gender issues in fisheries have not received much attention and women participation in fisheries decision making bodies still remains quite low. Empowerment of women in training and capacity building to take up fish processing and other alternative livelihoods is necessary.

Change attitudes of fishing society towards more gender equitable way, providing more opportunities for women to engage in employment in fishing related activities and to hold positions in community organizations such as fisheries cooperatives

Identify technically and financially feasible activities and promote alternative livelihood practices for women and encourage them to use their time productively. Empower women themselves by improving hard and soft skills. Strengthening the existing women organizations and newly formed organizations by providing trainings under NAQDA's supervision. Skills development and capacity building programmes for small enterprises/businesses, management and marketing development and training on savings mobilization are important aspect to empower fisher's women societies.

Fishermen need to enter fish value chain to improve their income and social level without involvement of middlemen. Lack of opportunities for direct entrance to fish market is a gap. Therefore need to establish state fish purchasing centers at landing sites and allow for increased entry into fish marketing.

Lack of export market information to producers is a gap identified to increase the income and social level of farmer households and communities. It is necessary to facilitate provision of export market information to fishers and to help them access fish export firms.

Poor availability of appropriate infrastructural facilities, such as lack of landing centers, cold storage facility, clean ice, boxes and water have substantially contribute for the quality of fish while release of waste water and industrial effluents to the lagoons causing pollution of lagoons; land filing of mangrove areas for illegal coastal constructions and poor road network etc. have also been of serious concern which ultimately contribute for the serious hygienic issues of sold fish , low income and low acceptability of product among consumers. Therefore need to develop infrastructural facilities at landing sites to ensure the provision of facilities to ensure maximum yield (electricity, water, facilities for cold storage and waste disposal, wash rooms, drainage system, auction halls, etc.). It is essential to promote better post-harvest handling practices from the landing site to the end market. Promote the correct use of ice in preservation. Make available

the infrastructure facilities such as availability of cool storage facilities or connect the inland fish production to such existing storage facilities of Ceylon Fisheries Cooperation effectively.
Lack of information on economic losses, food insecurity of the fisher folk and less supply of fish during emergency situations is identified as a gap. It is needed to estimate the economic losses incurred by the fishers and aquaculture sector of Sri Lanka to date due to the pandemic outbreaks, natural disasters and associated containment measures. It is necessary to measure the impact of the food security of the fisher folk themselves and of consumers in different parts of the country, given the disruption in the supply chain including the disaster impact on fish imports that covers a significant part of the local fish/protein needs.

Natural resource management sector

Lack of nutrition objectives in sustainable agricultural & biodiversity projects, programs and policies is a gap. Steps are needed to incorporate nutrition objectives into sustainable agricultural & biodiversity projects, programs and policies. Traditional agriculture, agro-biodiversity and sustainable utilization of natural resources may have potential to yield nutrition improvements especially with community-level.
Lack of policy coherence supportive to enhance nutrition and sustainable natural resource use is identified as a main gap. One policy does not work coherently with another policy or program. Policies are not well synchronized. Land, water and biodiversity have direct linkages with nutrition, collaborative link among policies seems weak. Therefor it is needed to improve policy coherence supportive to enhance nutrition and sustainable natural resource use.
Multifaceted information gap exists related to nutrition and natural resources and biodiversity. Data is available, but much of this information is incomplete, imprecise, and often out of date. It is needed to develop collective information system for related policies, programs and projects; documentation of nutritional value of traditional food crops, indigenous & traditional knowledge. Information gap seem to have hindered the effective implementation of programmes.
There are less opportunities for multi-sector and multi-institution coordination program and projects aiming at sustainable utilization of natural resources. It is recommended to maximize opportunities for multi-sector and multi-institution coordination in planning and implementation of local level program and project formulated aiming at sustainable utilization of natural resources.
Sustainable natural resources management is less effective as in operation at present. It is recommended to formulate and implement overarching frameworks to improve overall effectiveness of sustainable natural resources management for enhancement of nutrition and food security.
Information and knowledge gaps need to be addressed to enhance the contribution of biodiversity for food and agriculture and to strengthen the conservation and management associated biodiversity and wild foods.
There is weak collaboration for linking fragmented instructional governance and implementation of nutrition and natural resources management plans. Institutional gap exists not due to lack of institutions, but there are many institutions and operate in fragmented nature. Overlapping mandates of different institutions are prominently exist specially in the agriculture sector. It is

recommended to strengthen collaborative mechanisms for linking fragmented local level instructional governance for effective local level implementation of nutrition and natural resources management plans.

Inadequacy of institutional legal arms of existing act related to nutrition, biodiversity conservation and natural resources management is an identified gap. It is needed to strengthen institutional legal arms of existing act related to nutrition, biodiversity conservation and natural resources management.

There are limited approaches for incorporating nutritious food traditions linked with agro-biodiversity. Modern approaches for incorporating nutritious food traditions linked with agro-biodiversity into modern life style need to be mainstreamed and promoted.

Section 1

Background

1.1 Introduction

Sri Lanka is currently facing a demographic, epidemiological and nutrition transition. This is coupled with economic transition shifting Sri Lanka to an upper-middle-income status with a GDP per capita of USD 4102 (World Bank, 2018). The population of the country is 21.7 Mn composing of 53% of women (Central Bank, 2019).

The economy of Sri Lanka is based mainly on agriculture, services and to a lesser extent on light industry. Recent reports show that agriculture earns about 7% GDP and employs 35% of the workforce in the country (Central Bank of Sri Lanka, 2019).

Furthermore, the majority of the population (77%) lives in the rural sector followed by urban (18.2%) and estate (4.4 %) sectors (Central Bank, 2019). It is noteworthy that the majority of rural people depend on the rice production. The workforce of the country has been 64.2% represented by the age group of 15-59 y. Women consists of 33% of the workforce. Next to the service sector, the majority of the workforce of Sri Lanka engages in the agriculture and related work (Central Bank of Sri Lanka, 2019).

1.2 Nutrition situation and trends of Sri Lanka

Though there are improvements in social indicators in Sri Lanka, the nutritional status of its people is stagnating for some age groups while non-communicable diseases are aggravating in the age group of adults and elderly.

The existence of maternal and child undernutrition with short-term consequences of mortality, morbidity, disability and overweight and obesity is notable in Sri Lanka. Current prevalence of low birth weight in Sri Lanka is 15.7 % (DHS, 2016). Compared to the prevalence in 2006/07 (16%) this indicator has remained relatively constant. Low birth weight (LBW) is defined as the weight less than 2.5 kilograms at the birth and infants with low birth weight have a higher risk for early childhood death and low intellectual development and poor academic performances. Accumulating evidences on long term consequences of low birth weight show the risk of having several non- communicable diseases at later adulthood.

Protein energy under nutrition of children are depicted by stunting, underweight and wasting. Current prevalence of stunting, wasting and underweight of children below 5 years are 17.3, 15.1 and 20.5 % respectively. Long-term consequences include short statue of adults, low cognitive ability, low economic productivity, poor reproductive performance, metabolic and cardiovascular diseases.

Nutritional status of women influence the nutrition of children. Short stature (height below 145 cm), thinness, overweight and obesity are identified nutrition problems of ever married women in Sri Lanka (DHS, 2016). Place of residence, and wealth status can be important factors affecting nutritional status of women. Women living in the estate sector and belonging to lowest wealth

quintile show higher prevalence of short stature and thinness indicating nutrient inadequacies, whereas those who live in urban sector and belonging to the highest wealth quintile show higher prevalence of overweight and obesity compared to their counterparts.

Sri Lanka is facing the triple burden of malnutrition; under nutrition, micronutrient deficiencies and non-communicable diseases (NCDs). Non-communicable diseases are increasing predominating overweight and obesity among all age groups. Cardiovascular disease risk and diabetes are leading diseases among others. Besides, coexisting of undernutrition coupled with micronutrient deficiencies of infants, children and women is also common in low-income communities.

According to the hunger map 2020 the prevalence of undernourishment which indicates the chronic hunger of the population of Sri Lanka is 5-14.9% (WFP, 2020).

A clear remarkable calorie gap exists between the poor and non-poor populations and there is a gap between the desirable average calorie intake and the actual calorie intake of vulnerable groups.

Population trends show an increase in the population of the elderly and the increased dependency ratio of 20% on the younger age. Among people inactive lifestyle is a commonplace while the prevalence of NCDs are the highest among the age groups beyond 30 years. Further raised blood pressure, blood glucose and cholesterol levels also show significantly increasing trends in the age groups 45 to 59 years.

On the other hand, low birth weight is persisting at a higher rate while short stature and thinness of women exist in a considerable rate. Nutritional problems of children (<5y), stunting, wasting, underweight are major health problems. Both children and adults face diet-related non-communicable diseases and overweight and obesity are leading among others. Micronutrient deficiencies exist considerably among Sri Lankans. One-third of vulnerable groups (pregnant, infants, young children etc) are iron deficient.

1.3 Purpose of the situational analysis

Over the past two decades, several steps have been taken in Sri Lanka applying several strategies to change the nutrition situation of its population. However, the triple burden of malnutrition, namely hunger, micronutrient deficiencies, overweight, and obesity coexists in Sri Lanka. Furthermore, the nature and causes of the malnutrition situation in the population are complex. Besides challenges such as changing demand for agricultural products with the globalization of economy, climate changes and poor management of natural resources complicate the food security situation of people even more leading to poor nutrition, health and wellbeing.

Among the strategies adopted priority has given to nutrition-specific interventions which addressed the immediate causes of malnutrition. However, growing evidences show the importance of applying nutrition-sensitive interventions to reduce the stagnating figures of malnutrition problems and to improve the nutrition situation of the vulnerable segments of the population addressing underlying and basic causes of the problem.

Adequate level of nutritious food production is the basic step to ensure the nutritious food consumption through the availability and affordability of the population in the country.

Agriculture sector which includes crop production, livestock, fisheries and aquaculture and natural resource base play the pivotal role. On the other hand, nutrition situation and good health and wellness of people show a clear linkage with agriculture sector. It is ironical to note that, though close relationship is obvious among three partners, namely agriculture, nutrition and health, whether the continuous dialogue exists to connect priorities of nutritious food production and their consumption by the population. Therefore the general objective of the current situational analysis was to understand the current status of each component of agriculture sector and to identify gaps of factors related to nutrition affecting at basic and underlying level. The specific objective of the analysis include to identify and shed light on main factors leading to nutritional gaps and to provide recommendations to resolve the situation.

1.4 Structure of the report

The situational analysis was conducted based on the desk review of available documents in the public domain, keyword search, and discussions among the expert group. To facilitate the collection of information focused questions were developed (Annexture1). This report is comprised of seven sections in total with this section (Section 1) presenting an introduction and background for the present situational analysis. Sections 2-5 are based on situational analysis and nutritional gap identification of the sectors namely crop sector (Section 2), livestock sector (Section 3), aquaculture and fisheries sector (Section 4) and natural resource management sector (section (5). Section 6 especially gathered information on present situation of food value chains of agricultural commodities (Section 6a) and status of women empowerment in agriculture sector (Section 6b) in Sri Lanka. Section 7 presented the recommendations for gaps identified in each agriculture sector in Sri Lanka.

Section 2

Crop Sector

1. Introduction & objectives

The strategies and action to ensure food security and nutrition in Sri Lanka have been handled through the National Agricultural Policy of the Ministry of Agriculture, the National Nutrition Policy of the Ministry of Health and Indigenous Medicine, and several other policy documents of various ministries that are directly and indirectly related to food security and nutrition (WFO 2017). Despite the multitude of different policies and programmes being implemented, the food security and nutrition objectives of the country are yet to be achieved due to the fragmented nature of the approach, insufficient coordination among the institutions and the absence of a central theme.

The Food and Agriculture Organization (FAO) of the United Nations defines a food system as 'the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption and disposal of food products that originate from agriculture, forestry or fisheries, and parts of the broader economic, societal and natural environments in which they are embedded'. Performance of a food system is generally measured using agricultural productivity, quality and safety of the produce, nutrition and health, farm income and employment, women empowerment, degree of agro-industrialization, food and nutrition security of the nation it serves, and the degree of depletion of natural resources particularly land and water (Weerahewa et al., 2020). Food security and nutrition were key topics of discussion in the SDG framework and sustainable agriculture is viewed as the central element of attaining food security and nutrition under the SDG Goal 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture. There is an increased concern over certain other aspects of the food system and measures are being developed to assess the nature of food items produced, provision of market access to small-scale producers and agri-enterprises, food loss and waste, incidences of food safety, and animal and human health issues, and energy-intensity and ecological footprint associated with the lengthening and industrialization of food supply chains.

Better nutritional status of the population is considered as an end as well as a critical input to an economic development (Narayan et al. 2010). Evidence from Sri Lanka indicates a strong causal relationship between the nutritional status and school achievement (Wisniewski 2010) and labour productivity (Sahn and Alderman 1988) reinforcing the importance of nutrition as an input to formation of human capital and in turn economic growth. Hartwig (2010) reported that the importance of nutrition to economic development is more important to middle income countries as their marginal productivity of health is higher than those in the high income countries.

The average dietary energy supply adequacy increased from 103 to 115 and prevalence of under-nutrition decreased from 3.5 million to 1.9 million from 1999/2001 to 2016/2018 (FAO 2019). Poverty is a rural phenomenon in Sri Lanka and the head count index of poverty decreased from 26.1% to 4.1% from 1990/91 to 2016 (Department of Census and Statistics 2017), which is highly attributable to increase in agricultural wages that grew

annually by an average of 5.7% during 2006 to 2013. However, child malnutrition as measured by under-weight, stunting and wasting has not significantly decreased during the period 2006 – 2016 (Department of Census and Statistics 2019). The WFP (2017) reported that the food and nutrition insecurity outcomes in Sri Lanka are reflected in major immediate concerns on high levels and disparity of malnutrition and micronutrient deficiencies. Such concerns include crop yield stagnation, rising food prices, income inequality, poor infrastructure, high informal sector labour force, gender inequality, land fragmentation and degradation, urbanization, population ageing and climate change.

The FAO in Sri Lanka has commenced the programme 'Mainstreaming Nutrition in Agriculture' for implementation in 2019-2020, under which initiatives will be taken to mainstream nutrition into agriculture in Sri Lanka. The ultimate objectives of achieving nutritional goals through building strategies and service provision in the agriculture sectors. This chapter provides a situation analysis of Sri Lanka aiming at providing stakeholders with the information to understand linkages between agriculture food systems, nutrition and health in achieving national nutrition goals, especially focusing on the crop sector. This understanding is expected to strengthen the knowledge base and skills fulfill the requirements of nutritious food to improve the nutrition situation of the population.

2. Methodology

The activities performed were based on the desk review of available documents in the public domain, keyword search, and discussions among the expert group. The relevant primary data were obtained from the Sri Lanka Customs, Socio Economic and Planning Center of the Department of Agriculture, and the National Fertilizer Secretariat of the Ministry of Mahaweli, Agriculture, Irrigation and Rural Development. Secondary data were obtained from published literature.

The policy analysis was performed to identify the nutrition related gaps in crop agricultural policies, acts, sector plans, strategies, budgets, institutional mechanisms and service provisions at national and decentralized levels. Ten national policies, seven acts, 15 programs, five projects, and five action/strategic/master plans effective/under implementation during 2014-2019 were considered. In addition, a few policy documents which indirectly support on crop agriculture were also considered, i.e., National Land Use Policy of Sri Lanka (2007) and National Biodiversity Strategic Action Plan (2016-2022).

The write up basically followed the format given in responding to a set of queries. However, the sequence of the questions were altered to ensure a smooth flow information in the document. The sub titles reflect the queries raised at the beginning and the authors focused on responding to them in preparation of this report. The analysis of the results presented were done under each question, without having a separate segment as suggested in the reporting format.

3. Inclusion & exclusion criteria of evidences

The section included the production and import/export statistics. The data on vegetables and export agricultural crops were pooled in presentation due to different categories of

products and easiness in understanding. The examples brought in under different sections focused mainly on the rice crop due to availability of data to provide scientific proof.

4. Findings and analysis

4.0 Crop production (Field crops, paddy, fruits & vegetables, green leaves, roots and tubers, coconut, condiments, underutilized agricultural commodities, home gardening)

The crop production statistics, availability for consumption, imports and exports during the past 5 years are reported from Tables 1 to 8. The highest recorded rice production (milled rice) since gaining independence in 1948 has been reported in 2015 (Marambe et al., 2020). However, climate vagaries have hampered the performance of the sector with a drastic decline in paddy yields in 2017 owing to the unprecedented drought affecting three consecutive seasons (Table 1), making Sri Lanka to import about 650,000 t of rice to feed the nation towards the latter part of 2017. The crop has since recovered minimizing imports. The wheat imports to Sri Lanka was significantly reduced in 2016 (Table 2) owing to the bumper rice harvest reaped in 2015, however, have reported a steady state thereafter. Maize production and import have increased over the years due to the heavy demand from the animal production industry (mainly poultry and cattle industry), where about 85-90% of maize produced in Sri Lanka being used as animal feed. Import of finger millet has shown more than 4-fold increase from 2015 to 2018 (Table 2) while the production and demand for the crop has gained momentum.

The availability of green gram and other pulses in Sri Lanka over the period 2015-2018 (Table 3) have mainly been supported by imports with lower production extents and productivity (Marambe et al. 2020).

Table 1. Production and imports of rice (milled rice)

Rice	2015	2016	2017	2018
	tons (t)			
Production	3,277,188	3,005,657	1,906,522	2,672,285
Import	285,792	29,504	747,800	248,901
Export	9,563	4,320	4,968	5,338
Availability	3,562,980	3,030,942	2,649,354	2,915,848

Source: AgStat (various years)

Estimates done in 2015 indicated that the out of Sri Lanka's annual edible oil requirement of around 160,000 t, the country produce a total of 53,000 t of coconut oil and 18,000 t of palm oil. The balance 89,000 t of the edible oil requirement is imported from Indonesia and Malaysia. The palm oil imports to Sri Lanka has increased over the years from 121,000 t in 2015 to 235,000 t in 2018 (94% increase). The coconut oil to palm oil consumption in Sri Lanka is

known to be 1:9. Though the oil palm cultivation Sri Lanka has taken place since 1968, the crop has now become the center of focus where the Cabinet of Ministers of the government of Sri Lanka have decided to stop further expansion of oil palm cultivation in the country. This report will not further elaborate on this matter. Production and import of oil crops (Table 4) such as ground nut have remained steady over the years while that of gingelly the imports more than doubled in 2018 compared to 2017.

Table 2. Production and imports of other major cereal crops

Year	Wheat (grain + flour) (t)		Maize (t)		Finger millet (t)	
	Production	**Import**	**Production**	**Import**	**Production**	**Import**
2015	0	1,207,849	261,115	79,000	8,916	765
Availability	1,207,849		340,115		9.681	
2016	0	947,580	243,960	42,946	8,565	2,178
Availability	781,755*		286,906		10,743	
2017	0	1,250,461	195,744	179,589	5,574	2,918
Availability	1,189,805*		375,333		8,492	
2018	0	1,299,577	270,041	119.096	8,060	3,084
Availability	1,244,989*		389,137		11,141	

* (-) exports 66,570 t (2016), 60,657 t (2017) and 54,588 t (2018). Source: AgStat (various years)

Production of manioc, sweet potato and potato (Table 5) showed fluctuations over the years mainly due to climate vagaries while potato. A steady increase in potato imports have support the consumer demand owing to the declining in national production.

Big onion production has decreased dramatically over the years owing to lower production extents and lack of good quality planting material (Marambe et al., 2020) and the local demand is supported by increased imports. Green chilli production has shown a continuous increase to meet the local demand while dry chilli is still imported mainly from India where owing low cost of production and prices.

The vegetable production in Sri Lanka has shown fluctuations over the years mainly due to vagaries in the climate (Figure 1) with a significant reduction in 2017 and shown an upward trend thereafter.

The perennial fruit crops have shown a steady increase in production (Figure 2) in Sri Lanka despite changes in the climate showing there resilience to the environmental changes.

The cumulative production and availability of vegetables and fruits are presented separately in Table 7, including those of coconuts. Though cumulative vegetables production and coconut production have declined in 2017 owing to prolonged drought experienced in 2016 and 2017, fruits production has shown a continuous increase. Increase in imports. The vegetables and coconut production have shown signs of recovery in 2018. The total fruit production in Sri Lanka has increased by 45% in 2018 compared to the value recorded in 2016, with a marginal increase in imports.

The production of selected export agricultural crops has shown a steady increase despite set back in 2016 as explained for other crops earlier (Tables 8a and 8b). Cardamom and clove re-exports have increased over the recent years and hence accurate information on local availability is not available. Export quantities are higher due to re-exports.

Table 3. Production and imports of pulses

Year	Green gram (t)		Black gram (t)		Cowpea (t)		Soybean (t)	
	Production	**Import**	**Production**	**Import**	**Production**	**Import**	**Production**	**Import**
2015	15,058	19,613*	11,900	*	12,280	5,678	11,220	10,000
Availability	46,571*				17,958		21,220	
2016	14,546	13,862	11,197	11,991	13,740	6,055	7,946	7,126
Availability	28,408		22,664**		19,795		15,072	
2017	9,392	15,541	7,329	12,767	8,576	7,345	14,364	3,176
Availability	24,933		19,650**		15,921		17,540	
2018	9,856	16,425	11,852	12,414	11,180	8,136	2,500	6,419
Availability	26,281		23,650**		19,316		8,919	

* Cumulative value for green gram and black gram **(-) exports of black gram 564 t (2016), 446 t (2017) and 574 t (2018).
Sources: AgStat (various years) and Central Bank Sri Lanka (various years)

Table 4. Production and imports of oil crops

Year	Ground nut (t)			Gingelly (t)		
	Production	**Import**	**Export**	**Production**	**Import**	**Export**
2015	28,500	3,000	0	13,280	0	0
Availability	31,500			13,280		
2016	24,200	3,095	0.01	12,414	129	2,989
Availability	27,294			9,554		
2017	22,475	3,876	0	7,754	223	1,704
Availability	26,351			6,273		
2018	27,602	4,300	0.03	8,589	260	3,616
Availability	31,902			5,233		

Sources: AgStat (various years) and Central Bank Sri Lanka (various years)

Table 5. Production and imports of root and tuber crops

Year	Manioc (t)		Sweet Potato (t)		Potato (t)	
	Production	**Import**	**Production**	**Import**	**Production**	**Import**
2015	324,100	0	51,990	0	97,391	142,000
Availability	324,100		51,990		239,391	
2016	324,080	0	44,715	0	95,805	148,081
Availability	324,080		44,715		243,889	
2017	306,347	0	40,693	0	73,358	151,438
Availability	306,347		40,693		225,196	
2018	323,108	0	43,323	0	88,897	158,695
Availability	323,108		43.323		247,592	

Sources: AgStat (various years) and Central Bank Sri Lanka (various years)

Table 6. Production and imports of condiments

Year	Big Onion (t)		Green Chilli (t)		Dry Chilli (t)		Red Onion (t)	
	Production	**Import**	**Production**	**Import**	**Production**	**Import**	**Production**	**Import**
2015	89,323	210,253	62,866	0	N/A	49,928	61,200	15,168
Availability	299,576		62,866		49,928		76,368	
2016	65,223	215,593	72,311	0	N/A	51,018	63,675	19,842
Availability	280,816		72,311		51,018		83,517	
2017	53,603	232,318	51,827	0	N/A	51,692	57,747	10,911
Availability	285,921		51,827		51,692		68,658	
2018	28,047	246,337	79,003	0	N/A	52,849	61,073	15,276
Availability	274,384		79,033		52,849		76,349	

Sources: AgStat (various years) and Central Bank Sri Lanka (various years)

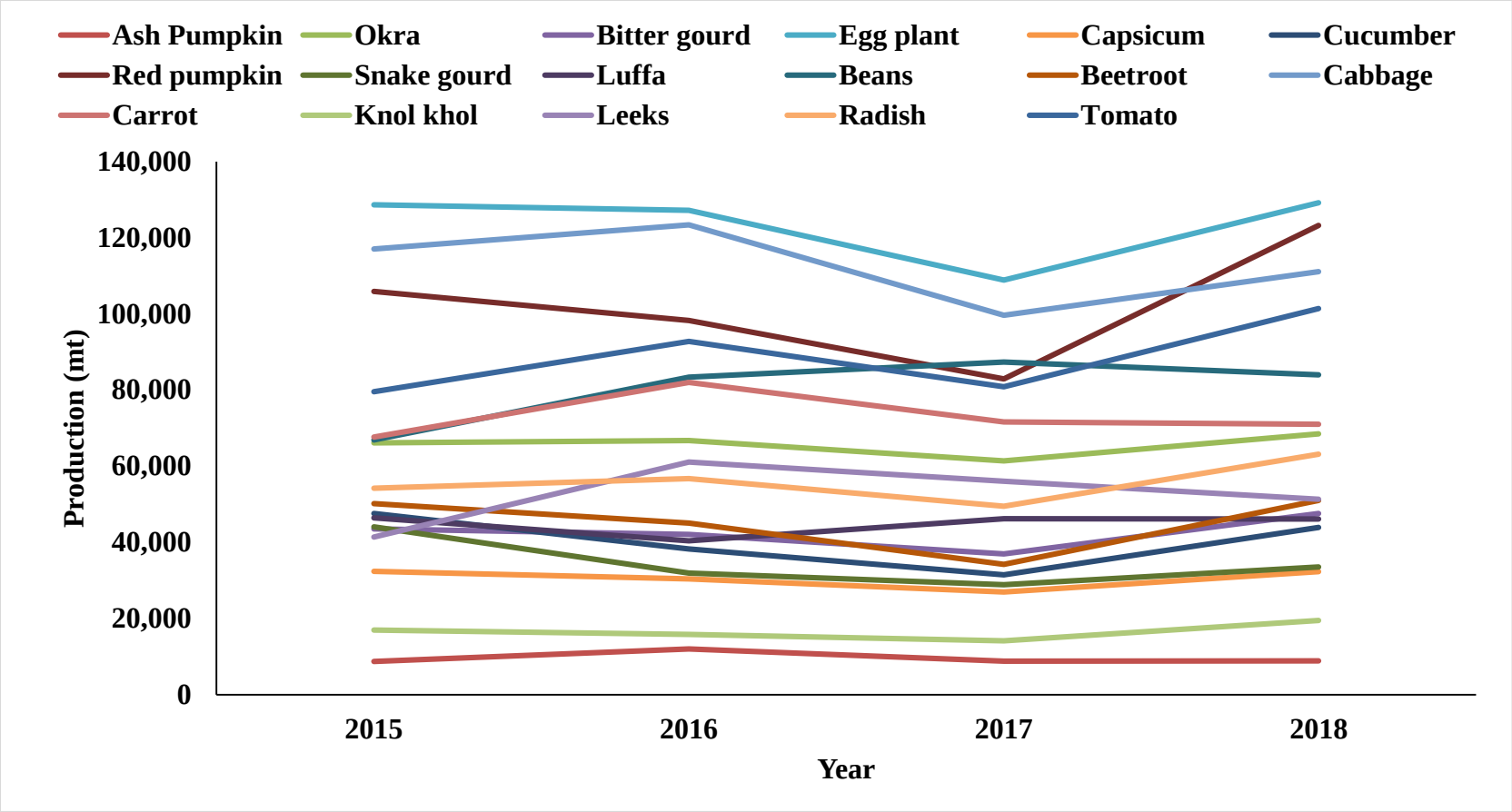

Figure 1. Production of selected vegetables

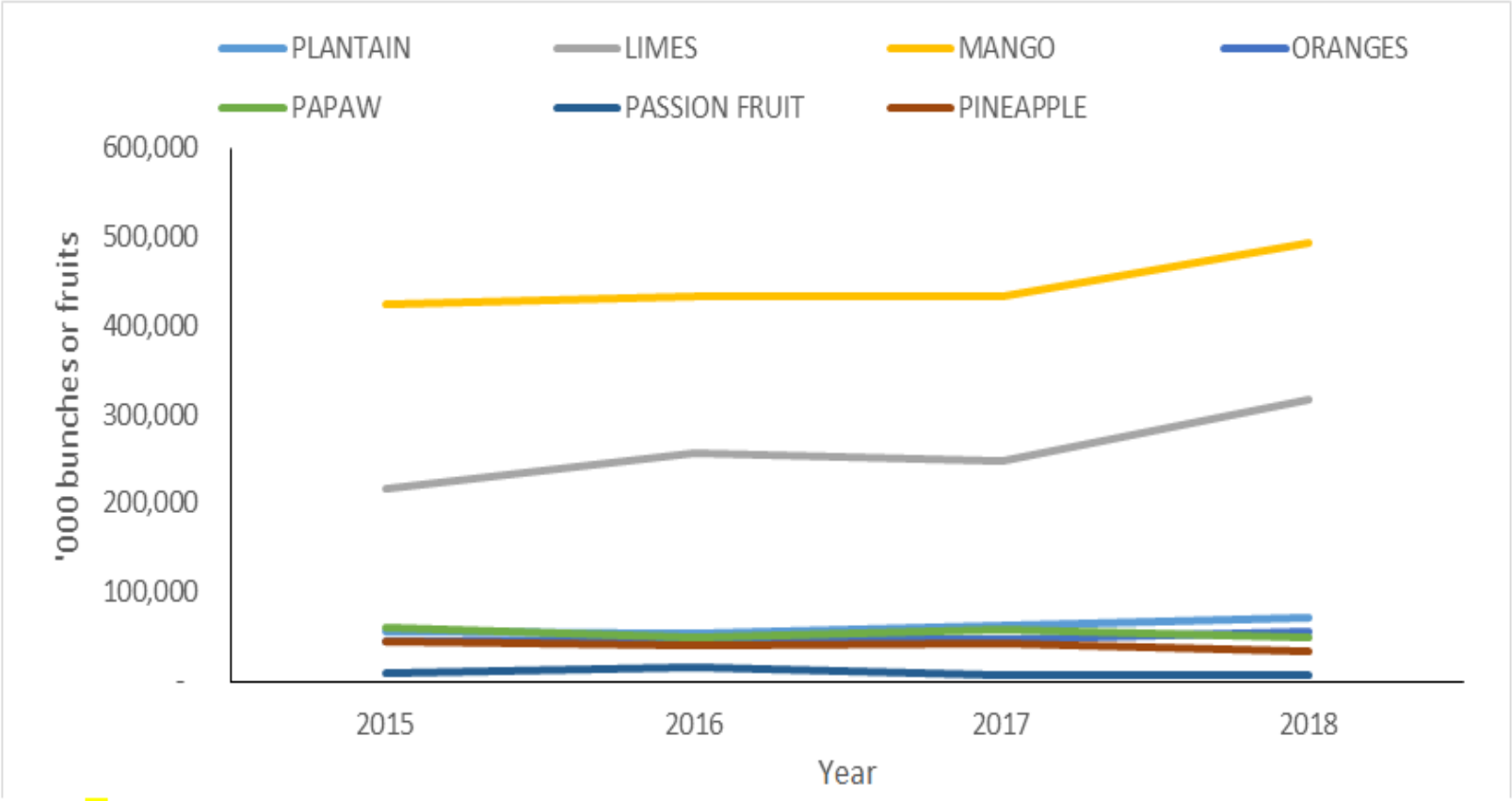

Figure 2. Production of selected fruits

Table 7. Production and availability of vegetables, fruits and coconuts in Sri Lanka

Year	Vegetables (t)			Fruits (t)			Coconut (million nuts)		
	Production	**Import**	**Export**	**Production**	**Import**	**Export**	**Production**	**Import**	**Export**
2016	1,128,985	102	21,140	1,199,946	63,406	25,709	3,011	0	892
Availability	1,129,067			1,237,643			2,119		
2017	998,482	96	21,697	1,338,030	62,417	22,394	2,449	0	750
Availability	998,454			1,378,053			3,199		
2018	1,167,141	229	25,765	1,744,807	68,739	24,718	2,623	0	776
Availability	1,166,551			1,788,828			1,847		

Sources: AgStat (various years) and Central Bank Sri Lanka (various years)

Table 8a. Production and import of Selected Export Agricultural Crops (tons)

Year	Cinnamon (t)		Pepper (t)		Cardamom (t)*		Clove (t)*	
	Production	**Export**	**Production**	**Export**	**Production**	**Export**	**Production**	**Export**
2015	17,707	13,828	28,177	17,027	91	120	5,253	5,529
Availability	3,879		11,150		N/A		N/A	
2016	18,945	14,946	18,476	8,383	120	779	1,823	1,849
Availability	3,999		10,093		N/A		N/A	
2017	22,341	16,967	29,546	13,778	113	839	6,413	7,815
Availability	5,374		15,768		N/A		N/A	
2018	23,019	17,860	20,135	13,601	71	108	1,284	3,290
Availability	5,159		6,534		N/A		N/A	

Source: Central Bank Sri Lanka (various years)

Table 8b. Production and import of Selected Export Agricultural Crops (tons)

Year	Cocoa (t)		Ginger (t)			Turmeric (t)		
	Production	**Export**	**Production**	**Import**	**Export**	**Production**	**Import**	**Export**
2015	457	93	17,273	336	62	14,297	4909	68
Availability	364		17,547			19,138		
2016	650	43	23,184	403	116	25,204	4660	70
Availability	486		23,471			29,794		
2017	471	164	16,326	1732	82	20,267	4958	115
Availability	307		17,976			25,110		
2018	654	296	14,208	1395	97	10,727	5387	76
Availability	358		15,506			16,038		

Source: Central Bank Sri Lanka (various years)

4.1. Agricultural policies /trade policies, strategies and investments those influence food production, food diversity and consumption to promote good nutrition

4.1.1. Programs and policies implemented by the Government of Sri Lanka to promote food and nutrition security of the nation

The government of Sri Lanka used diverse strategies to promote food and nutrition security. Figure 3 provides an account of policies and programmes implemented which directly aimed at improving access to food and nutrition supplements at household and/or individual levels. According to Weeahewa et al. (2017), who provided an overview of food and nutrition policies implemented in Sri Lanka during 1948-2017, food price and production policies made the food requirement of the nation available and affordable for large number of segments, the targeted nutritional programs reached the vulnerable in a cost effective manner.

4.1.2. The extent nutrition has been cited in the recent policies and programs to promote food production

The summary results of the analysis are presented in Table 9. National agricultural policy and National Food Production Programme (2016 - 2018) and sub programmes implemented under this such as fruit village, home gardening promotion, establishment of "*Sithamu*" women organization, can be identified as main programmes which have cited food security and ensure nutrition requirement of the nation. However, majority of crop agricultural policy documents have adequately covered segments to ensure food security of the country, which implicitly facilitate the nutrition requirement of the nation.

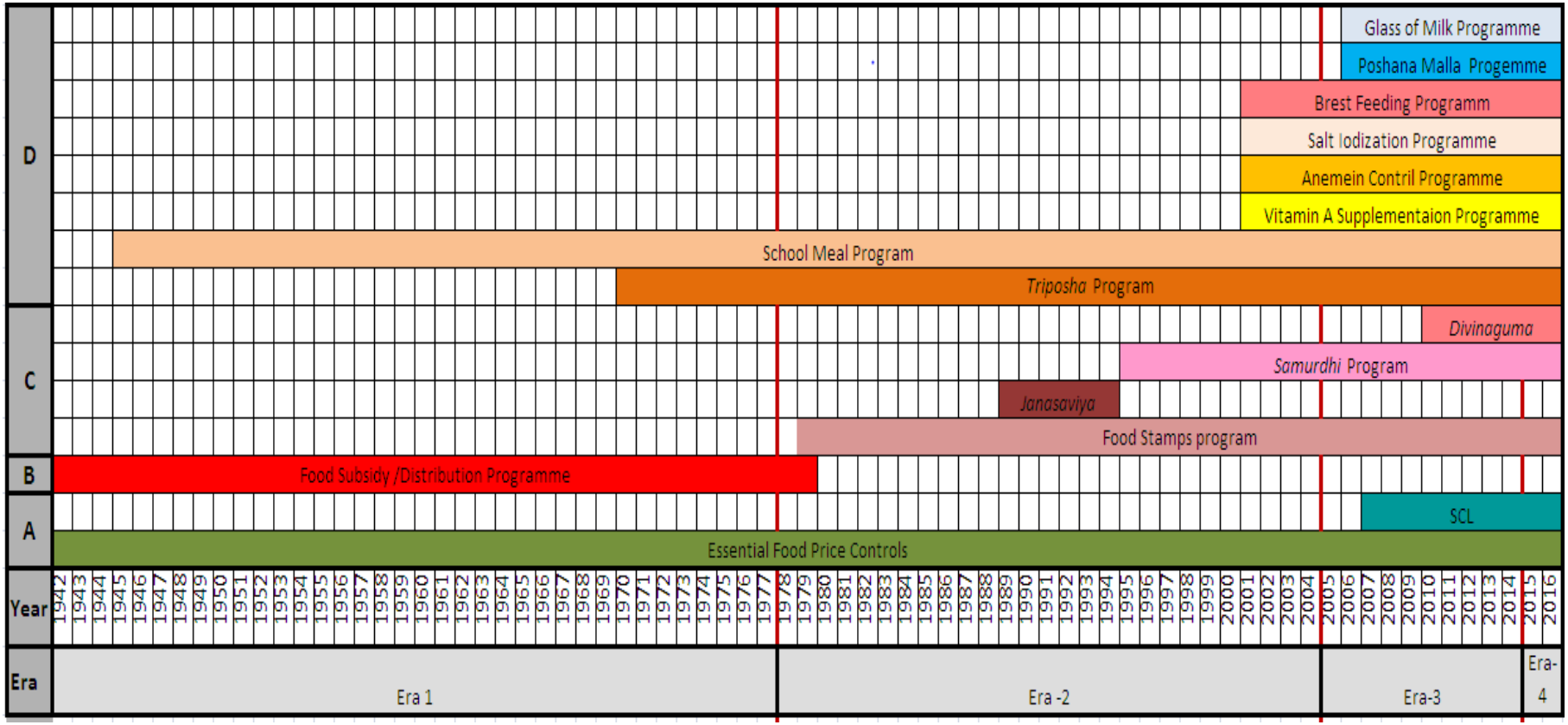

Figure 3: Food policies and nutrition programs implemented in Sri Lanka 1948-2017
Note: A= Price control policies, B=Direct Food Assistance Programs , C= Poverty Alleviation programs, D=Nutrition Intervention Programs Era 1= 1942-1977, Era 2= 1978-2004, Era 4= 2005-2014, Era 4= 2015-2017 , Source: Weerahewa et al. (2017)

Table 9: Incorporation of 'nutrition' in agriculture related programs

Document	Overall aims/objectives of the policy document	Relevant statement with respect to nutrition
Policies		
National Agricultural Policy (2007)	• To Increase domestic agricultural production to ensure food and nutrition security of the nation, and • To promote agricultural productivity and ensure sustainable growth.	**Section 16. Traditional Agricultural Crops and Methodologies** 16.1 Foster, preserve and disseminate traditional knowledge in agriculture relating to organic farming, pest control, and preservation and processing of food for nutritional and medicinal purposes and facilitate exchange such knowledge among the farming communities. **Section 17. Home Gardening** 17.1 Promote home gardening and urban agriculture to enhance household nutrition and income. 17.2 Promote women's participation in home gardening for enhancing family nutrition.
National Policy and Strategy on Cleaner production for Agriculture sector (2012)	• To ensure standard quality and required quantities of foods and other agricultural products, • To promote ecologically sound agricultural practices, • To enhance income and quality of life of the farming community, • To promote efficient utilization of inputs and natural resources for economically viable food production.	Promote value chain management from crop growing to consumers to improve the productivity, nutrition value and quality of the agricultural products. Ensure food and nutrition security to the nation

National Land Use Policy of Sri Lanka	• To prioritize agriculturally oriented uses relevant to the strengthening of national economy in order to ensure present and future food security, • To expand the role of the state in matters related to lands i.e. in addition to the allocation of land, provide guidance for the productive utilization of the land resources, • To conserve bio-diversity, and to preserve historical, cultural, religious, and aesthetic values associated with lands.	There is no any specific statement related to nutrition. However, it has focused on the protecting food security in the country.
National Policy on Sustainable Consumption & Production for Sri Lanka (2018)	• By 2030, sustainable management and efficient use of natural resources achieved • By 2030, per capita global food waste reduced to half at the retail and consumer levels and food losses along production and supply chains, including post-harvest losses reduced • By 2020, the environmentally sound management of chemicals and all wastes throughout their life cycle achieved, in accordance with agreed international frameworks, and their release to air, water and soil significantly reduced in order to minimize their adverse impacts on human health and the environment	Adequate nutritional status of all segments of society ensured through the affordability, accessibility and availability of nutritious food

Development of Provincial Agricultural Policy for Northern Province	• Improve the competitiveness of agriculture sector in province to get adequate market in other parts of the country and other countries	Providing food and nutrition security through domestic food production and flow of imports and safeguards for emergencies, whilst assisting with graduation of rural poor from poverty. Promote nutrition sensitive agriculture and food systems for northern province. Further, the policy aims at improving the access to availability, utilization and stability of safe and nutritious foods, suiting the tastes and preferences of the northern people and sufficient to meet the individual needs of all households and individuals at all times.
Overarching Agriculture Policy (Draft) August 2019	• To enhance competitiveness of agriculture and agri-businesses through innovative and sustainable technologies, and constructive partnerships, in a conducive institutional and regulatory environment, with a view to enhance contribution to economic growth and rising living standards of people engaged in agriculture, while ensuring sustainable use of natural resources and contributing to national food security.	Mainstream nutritional considerations in the food production strategies
Master Plans/Action plans/Strategies		
National Action Programme (NAP) For Combating Land Degradation in Sri Lanka 2015 – 2024	• To improve land productivity, to restore (or preserve) land, to establish more efficient water usage and to introduce sustainable development in the affected areas and finally to improve the living conditions of those populations affected by drought and desertification.	Promote alternative livelihoods solutions mainstreaming agro-biodiversity conservation and use in selected sites for better nutrition

Sri Lanka E-agriculture Strategy 2016	• Achieve self-sufficiency in food crops, which may grow locally and save foreign exchange on imports of those food items; • Increase availability of safe food by promoting eco-friendly practices and minimizing agro chemicals and pesticides in food crop production; • Ensure food security through appropriate management of buffer stocks; • Introducing and implementing agro-ecological region based food crop cultivation programs; • Increase the productivity of crop production through appropriate technologies; • Establish proper coordination among all agricultural stakeholders in the local food production process and connect all schools, civil organizations and general public to the program; • Provide quality inputs for production and establish proper marketing mechanism for their products; • Ensure building a healthy nation.	Information on linkage between food nutrition and health and promoting indigenous nutrition diets, Information System for Bio diversity of Food and Nutrition System
National Biodiversity Strategic Action Plan 2016-2022	• Strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way.	Promote and mainstream underutilized, lesser known or neglected food crops, livestock and food fishes which provide nutrition, Establish and maintain a searchable database linked with global databases on nutritional quality of food
National Climate Change Adaptation Strategy for Sri Lanka	• Systematically moving Sri Lanka and its people towards a climate change resilient future.	Ensure ability to meet food production and nutrition demand. Minimize Climate Change Impacts on Food Security. Includes agriculture, fisheries, irrigation,

2011 to 2016		nutrition, etc. Fluctuations in production will inevitably manifest in pricing variations that will make it even more difficult for vulnerable populations to meet their nutritional needs. Crop diversification may be required. Priority Adaptation Measures include increase awareness on alternative options to meet nutrition requirements
Programs/Projects		
Special Agriculture Development Programme for Ensuring Food Security	• Increasing locally produced crop production and saving foreign exchange by introducing import restrictions	This programme is implemented to improve food and nutrition security under the following sub programmes. 1. Youth Agri Entrepreneurship Programme. 2. Commercial Farm Programme. 3. Supplementary Food Crop Production Programme. 4. "*Awaraya Ahawarai*" Programme. 5. Establishment of Soil Conservation Villages.
National Food Production Programme (2016 - 2018)	• To convert the country to the sufficient level on foods via local foods which could be produced and save foreign exchange which were expended on importing foods. • To obtain high quality foods commonly via following environmental friendly methods and via reducing the use of chemical fertilizer and pesticides • To create food security by regularly manange the additional food resources.	Achieve nutrition requirements while enhance the food security

	• To introduce and implement crop production progrmme base on agro-ecological zones. • Fertilizer Subsidy Programme • National Food Production Programme. • Rehabilitation of small lakes and canals and development of minor irrigation system • Production of seeds under public and private partnership (PPP). • Organic fertilizer production and usage of stimulation programme • Water, sanitation and health regulatory pilot project	
Fruit Village Programme (2016)	• Increase the daily consumption of fruits per capita up to 200 g which is presently 100g and increase the nutrition level of public	Increase the daily consumption of fruits per capita up to 200 g which is presently 100g and increase the nutrition level of public and promote the fruit variants with high productivity which was identified by the Department of Agriculture among public.
Home Gardening Promotion Programme (2016)	• To implement 500,000 of home gardens in 25,000 villages with the aim of ensuring the food and nutrition security of the family and it is implementing 300,000 home gardens under the first stage of this programme	Improve the economic status of the family whereby able to achieve food and nutrition security of the family through the gardening and reduce the costs accordingly.
Supplementary food crop promotion programme (2016)	• Increasing the production and productivity of supplementary food crops with the contribution of state and private sector institutions.	Focused on protecting food security

	• Imposing restrictions on supplementary food crops. Increase the consumption of supplementary food crops. • Ensure the availability of seeds and inputs to meet the requirement. • To meet the demand of supplementary food crop consumers for ensuring the food security at national level. • Introduce value added productions. • Increase the income of farmers	
Home Gardening Promoting Programme – 2016	• To fulfill food and nutrition requirement of the family but also to augment the overall food production of the country	To fulfill food and nutrition requirement of the family but also to augment the overall food production of the country
Climate Smart Irrigated Agriculture Project (2018)	• To improve climate resilience of farming communities and productivity of irrigated agriculture in selected climatically vulnerable Hot-Spot Areas in Sri Lanka. This objective will be achieved through improved and modernized management of irrigation, drainage and flood protection systems, increased adaptation of climate-smart agricultural practices and technologies, improved agricultural diversification, better post-crop harvest management practices, and increased access to better prices and markets	Sustainable increases in food & nutrition security

Improve women entrepreneurship while improving nutrition status of people – (*Hela Bojun*)	• Improve economic and social status of farming families through empowering women, Change dietary patterns towards healthy food, Promote local food consumption, Increase availability of local prepared food, Entrepreneurship development of women, Create awareness on nutrition among farm women	To create awareness on nutrition among farm women, increasing nutritional status of people in the society while empowering female farmers
Empowerment of "*Sithamu*" Female Farmers' Organizations 2018	• Consider Agriculture as a livelihood method instead of considering as a business and strengthen farmers and thereby upgrading their living conditions and make them as a team with social acceptance and self-respect.	Increase family nourishing levels

All the policy documents listed directly or indirectly focus on productivity enhancement as the ultimate objective of increasing farm income and improvement of living standards Nutrition as an objective by only 2 policies. It is important to highlight theta Nutrition has not been identified adequately as an objective in many agriculture related policies, strategic plans and actions plans related to agriculture and agriculture related programmes in the country to-date. In all such considerations, there need to be an identification of what healthy foods are to support formulation of policy actions and their implementation.

4.2. Food price and associated policies and their effect on healthy dietary consumption

4.2.1. Food trade policy and consumption of healthy food

According to Bolaric and Satalic (2013), energy density is expressed in kJ/gram, which is a measure of available energy per mass unit of a particular food, was considered as a proxy to indicate healthiness of food items. The prices of healthy food items vis-à-vis prices of the substitutes of the same, among other things, largely determine food consumption pattern and the composition of healthy food items in the diet. Ratnayake et al. (2014) investigated the extent to which accessibility of healthy food items is influenced by food trade policies in Sri Lanka. They first compared energy densities of commonly consumed food items and cost of a unit of energy from each item. Then they examined the extent to which trade taxes escalated cost of energy from each item. Their results revealed that rice, sugar, wheat, edible oil, dhal, milk powder are the top most energy sources and the relationship between energy density and energy cost is negative. This implies that items having lower energy densities are costly (papaya and mango) and low energy cost items have higher energy densities (Kurakkan and cassava). Of the importable, the highly energy dense items (edible oil and sugar) have relatively smaller taxes (7% - 30%) and less energy dense healthy foods especially fruits (apples, oranges and grapes) are having larger taxes (50% - 100%). These results indicate that healthy food is costly in Sri Lanka and for some items it was due to the import taxes. A revision of import tax schedule was hence recommended to improve nutritional status.
This is an empirical evidence of the study that cannot be generalized the results of this study. The authors had correlated prices of 135 food items, as reported in Household Income and Expenditure Survey of the Department of Census and Statistics, and shown the food items with positive and negative correlations. Thereafter importable food items, which is a sub-set of food items considered above, were taken for further analysis. It was found that low energy items are highly taxed. Thereafter, reduction of import taxes was proposed as a potential strategy to enhance consumption of healthy food.

4.2.2. Investments on nutrition research

A pertinent question is whether agricultural researchers cognizant of nutrition to support nutrition sensitive agriculture. According to Stad et al. (2019), of the agricultural researchers attached to various research institutes in Sri Lanka, only 1.9% belong to the subject area of ‘food science and nutrition’. A large majority (62%) belong to crop research (of which cereals 9%; Roots and tubers 4%; Pulses 4%; Oil-bearing crops 7%; Horticultural crops 11%; and Other crops 27%) in 2016. Their research output is reflected in the varieties issued by different

institutions. The Fruit Crop Research and Development Institute (FRDI) released 18 new fruit varieties; Rice Research and Development Institute (RRDI) 13 new rice varieties; Field Crops research and Development Institute (FCRDI) 14 new maize, groundnut, pulse, and vegetable varieties; Horticulture Research and Development Institute (HORDI) 12 new vegetable and floriculture varieties; Department of Export Agriculture (DEA) 8 new spice varieties; and Sugarcane research Institute (SRI 5) new sugarcane varieties during 2013-2016.

4.3. Agricultural interventions/programs in Sri Lanka incorporating nutrition objectives and indicators

The underlying policy which govern the crop agriculture in Sri Lanka is National Agricultural Policy of 2007. It aims to increase domestic agricultural production to ensure food and nutrition security of the nation, promote agricultural productivity and ensure sustainable growth, maximize benefits and minimize adverse effects of globalization on domestic and export agriculture, adopt productive farming systems and improved agro-technologies with a view to reduce the unit cost of production and increase profits, apply environmental friendly techniques in agriculture, promote agro-based industries and increase employment opportunities thereof, and, enhance the income and the living standard of farming community.

Apart from this Draft Policy Framework of National Agricultural Policy for Sri Lanka (2018), National Policy and Strategy on Cleaner production for Agriculture sector (2012), National Policy on Sustainable Consumption & Production for Sri Lanka (2018), National Land Use policy (2007), and National Plantation Industry Policy (NPIP) framework in 2006 also govern crop agriculture sector. Among them, only National Agricultural Policy (2007) and Draft Policy Framework of National Agricultural Policy for Sri Lanka (2018) cite 'ensure food and nutrition security of the nation' as a main objective. Though the term nutrition is not explicitly cited, National Land Use Policy of Sri Lanka (2007), National Policy and Strategy on Cleaner production for Agriculture Sector (2012), and Overarching Agriculture Policy (Draft) cite the term food security of the nation in their list of objectives. National Food Production Programme (2016 - 2018), and other sub programmes implemented under this programmes such as fruit village, home gardening promotion programme, "Sithamu" (සිතමු(women organizations establishment programme, had given a higher priority for food security and ensuring nutrition requirement of the nation.

Crop diversification indirectly facilitates nutrition security through diversification of diets. Crop diversification was identified and highlighted as way to utilize space and other resources in optimum way and also way of enhance their earning from farm in a number of policies. They include National Plantation Industry Policy (NPIP) Framework (2006), National Agricultural Policy (2007), National Agricultural Policy (draft) (2018), National Policy and Strategy on Cleaner production for Agriculture sector (2012), Sri Lanka E-agriculture Strategy (2016), Fruit Village Programme (2016), Home Gardening Promotion Programme (2016), Supplementary food crop promotion programme (2016), Home Gardening Promoting Programme (2016), Agriculture Sector Modernization Project (2016), Empowerment of "*Sithamu*" [සිතමු (Female Farmers' Organizations (2018)], Urban Agriculture. All the policy documents either directly or indirectly focus on productivity enhancement as the ultimate objective of increasing farm income and improvement of living standards.

4.4. Biofortification programmes available for staple foods, their progress and impact on nutrition

Biofortification is the process by which the nutritional quality of food crops is improved through agronomic practices, conventional plant breeding, or modern biotechnology (Khush et al., 2012). Biofortification programs at the global level includes iron-biofortification of rice, beans, sweet potato, cassava and legumes; zinc-biofortification of wheat, rice, beans, sweet potato and maize; pro vitamin A carotenoid-biofortification of sweet potato, maize and cassava; and amino acid and protein-biofortification of sorghum and cassava. Discussions with officials of Department of Agriculture reveled that at present bio fortified staple food crops are not commonly available in Sri Lanka. However, quality protein with lysine and tryptophan amino acids fortified in maize is at almost the releasing stage and rice fortification with iron and zinc will be started in the next *Yala* season in Sri Lanka (Personal communication, Dr. WMW Weerakoon and Dr. Jayantha Senanayake, Department of Agriculture). Bio-fortified staple food crops are not commonly available in Sri Lanka as at present. But two crops (maize and rice) will be released with improved nutrient quality in the near future.

There is a scarcity of comprehensive studies done on alleviation of micronutrient deficiencies with bio-fortification or food fortification, including both epidemiological and interventional studies. These studies warrants more attention from the research where outcome of which could be effectively used to support implementation bio-fortification programmes in Sri Lanka.

It is suggested that supplementation and food fortification are the most commonly used strategies to alleviate micronutrient deficiencies in Sri Lanka. In particular, salt iodization and vitamin A supplementation have proven to be successful (Jayatissa et al., 2006; 2016). Food fortification programs with respect to micro nutrients and nutraceuticals have been progressing well at the staple food crop of rice grains which is at the commercialization level fortified with iron and other micronutrients (MR. Manju Gunawardena, Personal Communication). A rice fortification with iron has been tested at the pilot scale project according to the WHO guidelines in Sri Lanka (Prof. WMT Madhujith, Personal Communication). In addition, Serendib Flour Mills recently introduced iron and folic acid fortified wheat flour to the Sri Lankan market. Except for iodine which is not a crop product (Jayatissa et al., 2018), comprehensive studies on alleviation of micronutrient deficiencies with biofortification or food fortification including both epidemiological and interventional studies are limited but essential in Sri Lanka to predict their impacts on nutrition (Abeywickrama et al., 2018).

4.5. Availability of home gardening programmes and their impact on nutrition/ food security

Increasing annually, with little policy support. However, homegardens are now increasingly recognized as an example of traditionally developed agroforestry systems with excellent promise for facing present and future challenges. Having realized the importance of homegardens, the national development policy framework of the government of Sri Lanka now includes strategies to expand and improve food and timber productions in such landscapes of the country activities at village levels as a mean of ensuring village empowerment.

The *Haritha* Lanka program established under the National Council for Sustainable Development, which is chaired by H.E. the President of Sri Lanka, also promotes the process of sustainable development while recognizing the importance of homegardens in achieving sustainable development in Sri Lanka (NCSD, 2009). In addition, the National Agriculture Policy of 2007 (MADAS, 2007) also highlights the need for promoting homegardens, especially focusing on the urban sector, and the role play of women on homegardens. Improvement of homegardens in Sri Lanka has been the priority of many development programmes implemented in the country over the past five years where development of 375,000 homegardens were aimed under the "*Api Wawamu Rata Nagamu*" (Let us grow and uplift the nation) programme launched in 2007, and strengthening of 1.5 million homegardens is the target of "Divi Neguma" (Livelihood Development) programme in order to achieve self-sufficiency in vegetables and to reduce vegetable prices (Government of Sri Lanka, 2011). The outcome of these programmes unfortunately has not been evaluated systematically.

Although there is an ambiguity over the extent of homegardens in Sri Lanka, it is widely accepted that about 14% of total land area of the country is currently under homegardens which has been spread in almost all districts. Therefore, the inclusion and promotion of home gardens as an eco-friendly sustainable agricultural practice to improve food security and enhance social and economic growth and environmental security has been suggested by several studies (Pushpakumara et al., 2012; Galhena et al., 2013).

During the last decade, several homegardening programs have been established by respective governments. As a results, national development policy framework of the government, now includes strategies to expand and improve food and timber productions in such landscapes of the country. In the past, the Haritha Lanka program established under the National Council for Sustainable Development, which is chaired by H.E. the President of Sri Lanka, also promotes the process of sustainable development while recognizing the importance of homegardens in achieving sustainable development in Sri Lanka (NCSD, 2009).

The National Tree Planting Program by planting 1,100,000 trees island wide was launched in 2010, aligned with the *Mahinda Chinthana* - Vision for the Future in realization the commitment towards a "Greener Country" where tree planting was expanded to homegardens. However, no systematic evaluation of the success of the programme is available to comment on the outcome.

Deyata Kirula National Development Exhibition has launched promotion programs to enhance the bio diversity of the country. Aligned to that specific objective, in *Deyata Kirula* National Development Exhibition starting form 2011, there was a demonstrating stall to showcase the importance of Agro- Biodiversity in the field of Biodiversity conservation explaining the importance of keeping higher species mix in the home garden. The objective of this was to sensitize people on species diversity and promote conservation and sustainable use. This was further strengthen by the establishment of model food and nutrition rich homegardens in A-Parks of Department of Agriculture and also promotion of homegardens in schools and government institutes. Giving of best homegardens award in each district and in island wide also enhance the utilization of homegardens for food production drives. Several projects have also been conducted popularizing homegardens for climate change, biodiversity conservation,

food and nutrition and introduction and promotion of traditional and indigenous vegetables, fruits and yams etc. (Pushpakumara et al. 2012).

At present, the *Saubagya* homegardening program to improve food security through cultivation of one million homegardens are underway under the patronage of Ministry of Mahaweli, Agriculture, Irrigation and Rural Development by the Department of Agriculture. The distribution of seeds of vegetables have been conducted by the Department of Agriculture throughout Sri Lanka (DoA, 2020). Various additions to this program have also been launched, *Harita danawwa*, urban homegarden development program initiated by Sri Lanka Air force in collaboration with Department of Agriculture.

The combination of trees, crops and livestock in homegardens with different production cycles and rhythms provides a relatively uninterrupted supply of food products, which helps to increase the self-reliance and resiliency of households. The homegardens can enhance food security by (a) providing direct access to a variety of nutritionally rich foods, (b) increasing purchasing power from savings on food bills and income from sale of garden products, and (c) providing fallback food during periods of temporary food scarcity. One effective way of ensuring access to a healthy diet that contains adequate macro and micro-nutrients is to produce diverse kinds of foods in farming systems. High value products from home gardens such as timber can be sold to purchase staple foods during the periods of food scarcity. The production from most home gardens is used for home consumption or for sharing with neighbors, which is one of the important principles of achieving food security in rural villages.

Any marketable surplus can provide a security against future crop failures and also a source of additional income, which is particularly useful during the off seasons and droughts. Although it is considered that rearing small animals such as chicken will be useful in reducing malnutrition especially for the low income households, rearing of animals in home gardens of Sri Lanka is rather limited compared to other countries in the region such as India and Bangladesh (Marambe et al., 2012; Pushpakumara et al., 2010; 2012; Weerahewa et al., 2011; 2012; Wickramasinghe, 1993; Ulluwishewa, 1997). This indeed a limitation to enhance nutritional security in the household level.

Although there are several studies on home gardening and their contribution, analysis of actual food and nutrient supply from home garden products in Sri Lanka and their temporal changes are relatively sparse, and only a few analysis has been initiated (Weerahewa et al., 2011). Analysis of availability of nutrients of home garden products is particularly useful in determining appropriate composition of trees, crops and livestock in the system that will be useful in reducing poverty and malnutrition rather than maintaining a collection of different species in the home garden.

4.6 Extent of agriculture extension to support overall agriculture process

In the non-plantation crop production sector, the institutional arrangement is mainly focused on the Department of Agriculture managed by the Ministry of the Central Government of Sri Lanka that deals with agriculture. The Department of Agriculture (DOA) 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. The DOA

produces its own research agenda based on the national priorities and production plans, while Sri Lanka council of Agricultural Research Policy sets the research agenda for specific periods (SLCARP 2018). The extension activities are mainly carried out by the Provincial Department of Agriculture located in each of the nine provinces of the country (Marambe et al. 2017).

Extension programmes in the agriculture sector in Sri Lanka has commenced during the colonial regime of the Dutch in the 17th century with the expansion of cinnamon crop aiming at the export market. It has evolved over several decades with the Department of Agriculture (DOA) since its establishment 1912. Since 1977, the Department of Agriculture under the Ministry of Agriculture was regionalized on an agro-ecological region basis, especially with respect to research functions, in addition to its District level structure pertaining to extension and seed supply functions. Field workers in agriculture have significantly increased in numbers. Extension/Research priorities are decided at the district/regional level at a joint forum named the Regional Technical Working Group (RTWG) and later to the Provincial Technical Working Group (PTWG), which is the well-established extension-research link in the agriculture sector (i.e. crop agriculture). However, no research in the field of agriculture (crops, livestock and poultry, and fisheries) is carried out by the PCs of Sri Lanka (Weerakoon 2010). Further, the District Agriculture Committees (DAC), an administrative set up chaired by the District Secretaries in 25 districts of Sri Lanka, also have a research-extension dialogue prior to planning, plan and project implementation in the respective districts. The outcome of the discussions are transferred to the farming community for implementation through the agriculture instructors and the Agriculture Research and Production Assistant (ARPAs), especially when decision making take place at the pre-season cultivation meetings held with the participations of the farming community and in other farmer meetings and visits by the extension staff.

Owing to constitutional changes in 1987, the DOA is responsible for agriculture extension in those commanding areas referred to as Inter-Provincial Extension Areas. Crop production systems under the systems that are rainfed and supported by the minor irrigation schemes are with the PCs, who carry out extension activities in those areas. In the late 1980s, agriculture extension was fully affected with an urgent government decision to absorb all those officers to the public administration system to improve the welfare of the public. This removal urged the farmers to make contact with the Agriculture Instructor (AI) who does not work at the village level but at an upper level called Agrarian Service Centre (ASC) to find solutions for their problems related to agriculture (Marambe et al. 2017). One AI cannot reach many farmers for consultation as his/her commanding area is too large. This situation gradually widened the gap between the farmer and agriculture extension. At present, it is a major challenge for imparting modern agriculture technology to farmers.

4.7Level of incorporation of nutrition promotion in programs

Table 10 provides details of see how activities with respect to diversification are cited in the policy documents. However, most crop agricultural policy documents emphasized on food security of the country which implicitly facilitate the nutrition requirement of the nation. It should be noted that diversification at the farm level also does not directly guarantee nutrition security at the household or individual level. There is no firm empirical support to say that

households with diversified farms are more nutritionally secure. Diversification can promote nutrition security by making diverse food items available at the market place. It also serves as a strategy to manage risk.

Table 10. Actions to promote diversification under different policies, strategies and action plans

Document	Actions that promote crops/livestock diversification
Policies	
National Plantation Industry Policy (NPIP) Framework 2006	Encourage integrated and diversified plantation fields
National Agricultural Policy	Develop and maintain diverse farming systems,
National Agricultural Policy (draft) 2018	Encourage crop diversification and have identified the importance of crop rotation and diversification.
National Policy and Strategy on Cleaner production for Agriculture sector (2012)	Promote ecologically friendly integrated farming system management practices
National Land Use Policy of Sri Lanka	Diversification of agricultural land use will be encouraged only when land productivity can be increased
Development of Provincial Agricultural Policy for Northern Province	Encourage crop diversification
erarching Agriculture Policy (Draft) August 2019	Promote eco-friendly farming systems for sustainable and efficient agricultural production. Enhance sustainable management of ecosystems involving crops, livestock and poultry, aquatic resources and native biodiversity. Conserve native genetic diversity of cultivated plants, of farmed and domesticated animals, and wild relatives and soil biodiversity'
Master Plans/Action plans/Strategies	

National Action Programme (NAP) For Combating Land Degradation in Sri Lanka 2015 – 2024	Farmers will be supported for as necessary depending on the situation of the farm plot.
Sri Lanka E-agriculture Strategy 2016	Encourage crop diversification and conduct more research to identify suitable crop mix
National Climate Change Adaptation Strategy for Sri Lanka 2011 to 2016	Crop diversification is encouraged
Programs/Projects	
Commercial Farm Programme	Encourage to diversify the production structure
Other Field Crop Production Programme	Encourage to diversify the production structure
"*Awaraya Ahawarai*" Programme	Encourage to diversify the production structure
National Food Production Programme (2016 - 2018)	Encourage Diversification by Introducing crop diversification for paddy lands and other lands
Fruit Village Programme (2016)	Encourage crop diversification by planting fruits crops in coconut lands
Home Gardening Promotion Programme (2016)	Encourage crop diversification
Supplementary food crop promotion programme (2016)	Encourage crop diversification
Food Diversification Programme	Encourage crop diversification
Home Gardening Promoting Programme – 2016	Encourage crop diversification

Public investment programme	Crop diversification will be promoted to have optimum crop mix providing required incentives and new technical know-how to the farmers substituting the imports of other field crops.
Agriculture Sector Modernization Project (2016)	Encourage to diversify the production structure out of the relatively low value food crops and move towards high-value agriculture and promote agriculture exports, and also promote diversification, value addition and increased competitiveness in the agriculture sector
Climate Smart Irrigated Agriculture Project (2018)	Diversification into more climate-resilient and higher value crops
Empowerment of "Sithamu" (සිතමු) Female Farmers' Organizations 2018	Encourage crop diversification
Urban Agriculture	Encourage crop diversification

All in all, the programmes and sub-programmes implemented under the National Agricultural Policy and National Food Production Programme (2016 - 2018), such as Fruit Village, Home Gardening Promotion Programme, "Sithamu" (සිතමු(Women Organizations establishing programme can be identified as the key policies and programmes which emphasized nutrition requirement of the nation. However, most crop agricultural policy documents emphasized on food security of the country which implicitly facilitate the nutrition requirement of the nation.

4.8. Status of inputs for agriculture production - irrigation programs

4.8.1. Water availability, agro well, water pumps, distribution pipes, drip irrigation systems, micro irrigation systems, energy sources, water harvesting utensils

Water storage is the major problem for agricultural activity in the rainfed dry zones of Sri Lanka. Several farmers have established agro wells but without proper guidance on hydrological properties of the aquifer creating environmental problems on reservoirs, wells etc. Various capacity pumps and distribution pipes are available at the market at different rates. Although water harvesting has been suggested as a method of irrigation, adequately spaced tanks are less available for storage. In irrigation agriculture, availability of water depends on several factors which is a problem for irrigation and often ended up with conflicts among institutes and farmers. Items for drip and micro irrigations are available but expensive for

adaptation to majority of farmers due to higher prices. Energy sources for sprinkler and operation of pumps are again expensive and low cost solar systems should be promoted. In order to improve irrigation efficiency automated systems are available but expensive for adaptation.

4.9.1. Organic farming

Compost, cattle manure and poultry manure, organic fertilizers, biofertilizers, biopesticide Lack of essential organically confirmed inputs such as compost, other manures, biofertilizers, biopesticides and higher cost of production due to high price of compost, other manures, biofertilizers and biopesticides are identified are often cited as weakness of organic farming in Sri Lanka.

4.9.2. Soil protection

Land evaluation, Increase soil cover, increase soil organic matter content, increase water retention and moisture infiltration, reduce runoff and improving rooting conditions have been suggested as measures for soil protection. In order to achieve all these, application of land evaluation data based on suggestions, application of crop residue, coir mats, mulching, green manure, compost, construction of ridge and furrows and levelling, construction of stone bunds and channels for drainage, establishment of hedge crops, loosening of soil to facilitate root growth are necessary for such activities (IUCN, 2016). In reality, often without external support system very few farmers have been adapted such systems in the field level.

4.9.3. Seeds supply

The seed importation in Sri Lanka was liberalized in 1984 where private sector started importing seeds to fulfil the national requirement. In 1989, the Seedmen's Association was established and several private sector companies were appointed as leaders to distribute seeds produced by the state organizations. Further, the private sector initiated seed production locally in 1990 where basic seeds were provided to them by the government farms, and the Seed Producers' Association was established in 1996 to strengthen the institutional arrangement in seed production and distribution by the private sector. Seed industry in the country has now become a multi-institutional with both the public and private sector taking part actively (Marambe et al. 2020). The National Seed Policy (NSP) was approved in 1996 with a view to establish a viable seed industry in Sri Lanka and the Seed Act was enacted in 2003, which came into effect in 2008. More than 2000 seed handlers have registered under the act and a National Seed Council (NSC) has also been established. The state Departments are mandated for varietal improvement and development, while the government of Sri Lanka encourages the private seed companies to develop new varieties.

The DOA produces breeder and foundation seeds, which are multiplied by the contract growers and the private sector. The national seed paddy production program is currently focused on 28 recommended varieties providing approximately 17% of the national requirement. However, basic seeds of 53 varieties of 18 vegetables recommended by DOA are produced in seven

government seed farms and meets only 3.8% of total vegetable seed requirement of the country. Seed production and supply of OFCs, except chili and maize, is handled by the public sector.

In 2017, the government farms (the farms of the DOA) with its contract grower program produced 38% of certified seed paddy while the private growers supplied 62% of the requirement. In 2017, the government farms and the contract grower program together produced seed paddy at 18% more than that of 2016 and 373% more than that of 2013. The quantity of seed paddy produced by the private sector reached the maximum in 2013 and declined thereafter (Marambe et al. 2020). A marked variation in seed paddy production by the private sector was observed over the years due to their investment capacity, some organizations moving out of seed paddy production, and vagaries and uncertainty of the climate. However, the private sector still remained the dominant producer of seed paddy in the country.

Maize, green gram, ground nut, sesame, cowpea, finger millet, horse gram, mustard, black gram and soybean were included in the OFC seed production program. The registered extent of cultivation for OFC seed production increased by 174% in 2017 compared to that of 2016, as the regions with water scarcity showed a tendency to cultivate OFC‘s than paddy. The total OFC seed production in 2017 was 1573 mt, which is a 164% increment compared to that of 2016. The seed production program for OFCs was affected after 2003 mainly due to the importation and demand for hybrid seeds, especially maize, giving higher yields. Yet, more than 85% of the certified seeds of OFC produced in Sri Lanka are provided by the DOA farms and the contract grower system.

The registered extent for vegetable seed production in Sri Lanka in 2017 was 156 ha of which government and contract growers account for 66%. Total extent allocated for vegetable seed production showed a 77% increment in 2017 when compared to that of 2016. Tomato, okra, chilli, red onion, big onion, snake gourd, bean, brinjal (eggplant), bitter gourd, radish, luffa, capsicum, yard long bean, cucumber, pumpkin, amaranthus, vegetable cowpea, winged bean, water melon, and papaya (fruit seeds) were included in the seed production program of the country. During 2017, total vegetable seed production was 48 mt of which 37 mt were certified by DOA (Marambe et al. 2020), which is a 67% increase compared to 2016.

The seed production programmes of the vegetable crops has faced the same fate as that of OFCs, with the increased importation of hybrids by the private sector (Marambe et al. 2020). The recent statistics indicate that of the total certified vegetable seeds produced locally, where the DOA farms and the contract grower system provide around 88-90%.

During the past 15 years, imported maize hybrids developed by internationally-renowned companies have been popular among the maize farmers in Sri Lanka, where about 20 maize hybrids were imported for commercial cultivation in 2016 (Kumari 2017). All the exotic hybrids have been evaluated for adaptability and susceptibility for common pest and diseases before recommendation (Kumari, 2015), and the same is practiced for vegetable seeds. Currently, about 95% of the farmers cultivate imported maize hybrids. In 2016, the hybrid seed requirement was around 1000 tons to the value of about Sri Lanka Rupees 1000 million. Seed production of open-pollinated maize varieties (i.e. Ruwan and Bhadra-1) are carried out by government seed farms under the DOA and also with contract seed producing farmers.

A program is now under way to meet 10% of the hybrid seed requirement of “MI Maize H 01” released in 2013 in collaboration with contract farmers, private seed companies and government institutes (Kumari, 2017). The hybrid seed-producing farmers have been

encouraged by the provision of parental seeds free of charge and buy back of the F1 seeds at a fixed price. Furthermore, hybrid seed production technology was promoted by field demonstrations and visits, and follow up is done by extension staff. Carrot dominated among the exotic vegetable seeds imported to Sri Lanka, mainly to be cultivated in the up country region, with a stable demand over the years while pumpkin, okra and watermelon were the seeds of low country vegetables that were imported during the past decade (Marambe et al. 2020).

4.9.4. Fertilizer inputs

The National Fertilizer Secretariat (NFS) established in 1979 and functions under the Fertilizer Act No 68 of 1988, is responsible to issue and renew license to import, manufacture or formulate fertilizer. Currently, Sri Lanka imports chemical fertilizer to meet the requirement, except for Eppawala Rock Phosphate (ERP) and some amounts of Dolomite. A significant increase in the use of chemical fertilizers for crops in Sri Lanka was evident since early 1950s (Wijewardhane 2005), however, the widespread use of chemical fertilizer for food crops, especially for paddy, commenced in the year 1960.

The subsidy scheme focuses on to provide the much needed plant nutrients to the crop and to reap richer harvests from food crops (Marambe et al 2020). Prior to 1962, rock phosphate or bone meal and sulphate of ammonia or green manure were the main sources of phosphorus and nitrogen, respectively, used in rice cultivation. Urea became the main source of N from 1967 to 1978 while tripe super phosphate (TSP) replaced rock phosphate. Use of ammonium sulphate was recommenced during the period 1990-1994 due to transport restrictions imposed on urea to north and east owing to security reasons. The world price shock and removal of fertilizer subsidy had an impact on fertilizer use in rice in 1996 (Fig. 10.9). Fertilizer subsidy played a major role in promoting mineral fertilizer among farmers leading to intensification of the use plant nutrients in agriculture securing the food for the nation.

The paddy fertilizer market grew rapidly mainly due to the fertilizer subsidy, guaranteed price scheme for paddy, expansion of cultivation of high-fertilizer responsive and high-yielding rice varieties (Ekanayake, 2006) and enhanced area under irrigation, However, the decline in fertilizer application for paddy observed from 2012-2014 could be due to the shift in land use in paddy fields, especially in the wet zone, where majority of the land were either abandoned or made into other non-agricultural uses such as housing construction. Further, there was a reduction in the quantity of subsidized mineral fertilizer, especially urea, with the promotion of organic manures, composts, etc. Further, the new rice fertilizer recommendations for paddy introduced in 2013 did remove the “targeted-yield” approach under which high fertilizer rates were recommended for high yielding areas. All these would have contributed to the reduction in fertilizer use during 2012-2014 (Dr. Priyantha Weerasinghe – personal communication). The changes in world market price and subsidy policy in Sri Lanka has only made short-term impact on fertilizer use (Marambe et al. 2020).

The fertilizer subsidy scheme has been the heaviest subsidy in the agriculture sector and a heavy burden on government treasury. This has accounted for 2-2.5% of total government expenditure for the period 2005-2014 (Rodirigo and Abeysekera 2015), with increase in fertilizer prices in the global scale playing a major contributory role. Low organic matter

content in soils has created several problems such as yield decline and yield stagnation in crops such as rice, fruits and vegetables grown in Sri Lanka. Under such conditions, retention of plant nutrients is low and subsequently decreasing the fertilizer use efficiency. Thus, seasonal application of organic fertilizers are promoted for crop production in Sri Lanka. The Ministry of Agriculture of Sri Lanka has initiated a program to popularize organic fertilizer production. The program is expected to reduce the chemical fertilizer significantly. Further, the Ministry of Agriculture of Sri Lanka also promotes adopting Integrated Plant Nutrient Systems (IPNS), a concept that advocates a balanced use of both organic and chemical fertilizers for crop production and is considered the most suitable plant nutrient management system to increase the crop yield while maintaining good soil fertility (Wijewardena and Yapa 1993).

4.10. Level of agricultural commercialization/ diversification to cash crops and impact on food consumption at households, and communities

Since 1980s, the commercialization has been considered as a poverty alleviation measure targeting improved food security in poor farming communities, in low-income countries in particular (Von Braun, 1995). One of the simplest key indicators of commercialization is the cultivation of cash crops by the subsistence farmers as explained by many researchers (e.g. Linderhof et al, 2019). Cash crops differ from food crops in the aspect of its commercial value compared to the own consumption of the latter. As reported by Mahaliyanaarachchi and Bandara (2006), the farmers who produce a marketable surplus more than 50% of the total production can be considered as 'commercial' farmers. The market-orientation for selling the cash crops that the farmers grow is generally accompanied by use of modern technology under intensive cultivation systems with improved inputs, leading to higher investments (Niemeijer and Hoorweg, 1994). Although it has been reported that, the large-scale farmers are more cash crop oriented whereas small-scale farmers are food crop oriented in developing countries (Fafchamps, 1994), the observation in Sri Lanka does not follow the same association. While ensuring food security, agricultural commercialization has shown mixed impacts on nutrition security. In places where policies and programs directly benefit the most vulnerable groups, the commercialization has shown positive impacts on the nutrition security of farming communities (DeWalt, 1993).

In the present report, we confined the discussion only to the annual cash crops as those crops are under the spotlight from the farmers' perspective. Although a comprehensive account on the recent production statistics of cash crops is not presented here, a broader view can be visualized by observing the production statistics of four major cash crops that have been prioritized by the Department of Agriculture (Figure 4). It is apparent that, the total production of maize, chilli and potato shows a growing trend whereas B-onion shows a gradual decline in production since 2014. The total annual domestic requirement of maize and potato is *c.a.* 2-fold the domestic production whereas the requirement of chilli and B-onion is *c.a.* 5-fold the current production. This is something that the policy makers need to take a serious consideration on, otherwise the country will face a huge challenge in terms of food availability specifically during a pandemic situation like what we are experiencing right now in the country. Cultivating cash crops in Sri Lanka has been classified as low to medium climate-sensitive livelihoods (Cristina et al, 2017) due to its vulnerability to uncertain climatic events which

poses threats to the food security. Apart from the climate-related threats to the commercial agricultural productions, some other social factors such as, the level of farmer education, availability of finances and access to markets also play a role in success of these cash crop cultivations. Therefore, as described by Wickramasinghe (2009), some specific interventions are needed to safeguard the cash crop production targeting food security, namely, i) agricultural commercial development (agro-well, vegetable seed production, planting material, micro-irrigation etc), ii) enterprise Development and employment (enterprise orientation, training-vocational, entrepreneurial and skills etc.), iii) Rural Financing (credit, discretionary grants) and iv) project and company management (farmer organizations).

Table 11: Procurement by the fruit and vegetable industry. (*Note: the data are from ten processors, seven exporters and one super market chain)*

	Procurement sources in %			Volume of annual procurements	Number of contract farmers
	Spot market	Contract suppliers	Contract farmers	(MT)	
Processor	18.6	36.3	45.1	10596	3063
Exporter	65	27.6	7	8676	45
Super market chain	0	25	75	7200	750

Source: Esham and Usami, 2006

4.11. Level of quality of yield/storage facilities/agro processing and preservation opportunities/food safety and how influence them on nutrition across all agro-ecological zones in the country

As all the commercial vegetable-based cropping systems in Sri Lanka mainly follow the conventional crop production technologies which depend highly on agrochemicals (Weerakkody and Mawalagedara, 2020), there is a growing demand for safe vegetables. Apart from the organic food production, cultivation of crops under 'Good Agricultural Practices (GAP)' is an initiative introduced in 2015 by the Department of Agriculture (DOA) to feed the nation with safe food. Currently the GAP program is operating successfully under the Provincial Agriculture Departments, Agriculture Department in the Central Government and in the Mahaweli scheme. The sole authority for the certification lies on the hands of DOA. At present, ten different organic certification programs are available in Sri Lanka, namely, EU Regulation (regulation EEC-834/2007 & EEC-889/2008), National Organic Program (USDA-NOP), Japanese Agricultural standard (JAS), Environment Friendly Agriculture Promotional Act (EFAPA-Korean Organic), Food Industry Promotion Act (FIPA-Korean Organic), Bio Suisse (Switzerland), Demeter, Naturland, KRAV-Sweden and NASAA Organic Standards.

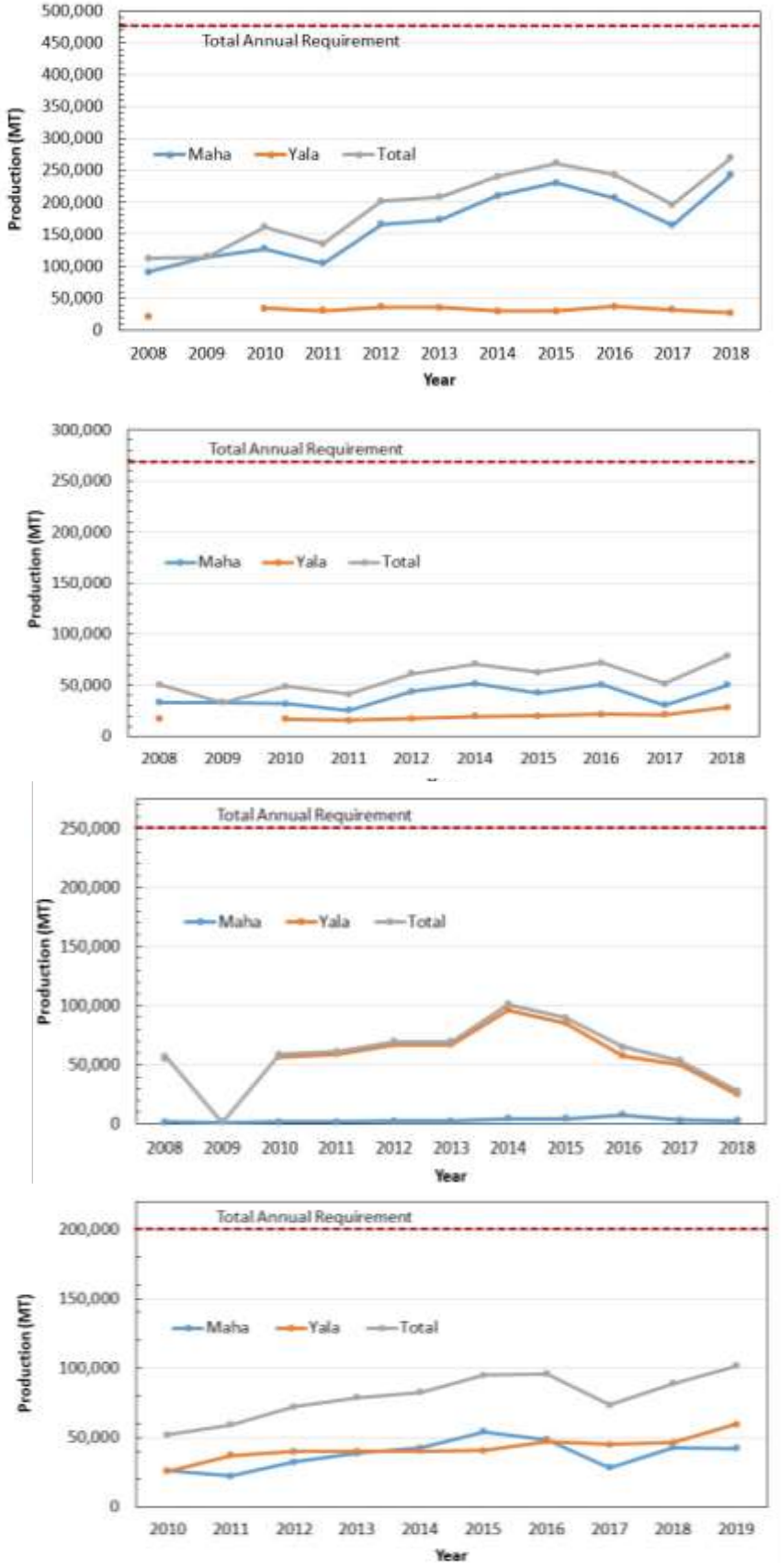

Figure 4: Annual production (*Yala, Maha* and Total) over the years and the total annual requirement of (a) Maize, (b) Chilli, (c) Potato and (d) Big onion. *Adapted from Samarasinghe et al (Unpublished data)*

Of the total fruit and vegetable production in Sri Lanka, more than 96% is available to be eaten fresh without any value addition (Bandaranayake et al, 2017). However, due to the high postharvest losses and because of the need of exports, the processing and value addition is inevitable. The food processing as an industry, including processing of fruits, vegetables, milling of grains, manufacturing of tea and spices, processing of meat, fish and dairy products, producing bakery products, confectionary and beverages, generates 19% of the total industrial sector employment (Department of Census and Statistics, 2013). Accounting for 29% of the total value addition in the industrial sector, food processing has become the largest manufacturing industry, having 34% of the total number of establishments in the sector (Esham et al, 2017).

The agro-processing industries offer many opportunities to the farmers. Esham and Usami (2006) have reported that, a sample frame of ten processors, seven exporters and one super market chain provided opportunities for 3,858 farmers across many agro-ecological regions in the country, procuring about 6.8 MT from each farmer, on average (Table 11), within a given season. These companies practice all three major types of contract farming such as market specification, resource providing and production management (Esham and Usami, 2006) where contract farmers are perceived to be a reliable source of fruits and vegetables supply to the industry.

4.12. Availability and practice of pre- and post-harvest losses and impact on food consumption adequacy and diversity

When the availability of food crops for domestic consumption is considered, it was apparent that about 90% of the total domestic supply of pulses is from the imports (Table 3). Both cereals and spices also depend on about 36% of imports. More than 90% of fruits and vegetables consumed locally are produced domestically. It is important to note that, the per capita availability of fruits and vegetables in Sri Lanka as of 2018 (465.7 g/capita/day) is little above the minimum daily consumption (400 g/capita/day) recommended by the WHO (WHO, 2004). This increase in availability has been observed since 2014. Although the fruits and vegetables are available, the actual daily intake of fruits (0.43 portion) and vegetables (1.73 portions) are well below the national recommendation (5 portions per day) as was evident in a survey conducted with 650 farming households covering 14 Districts in Sri Lanka recently (Chandrasekara et al, unpublished data).

As shown in the Table 12, the postharvest losses at the consumer level in terms of food waste was the highest in vegetables accounting for 12.5% followed by fruits with a 10.4% loss. However, the overall level of postharvest losses of perishables in the supply chain account for 20-40% as reported in many studies previously (e.g. Dissanayake et al, 2020; Wijewardhane et al, 2020; FAO, 2018; Weerasinghe and Priyadharsan, 2017). Several studies attempted to estimate the postharvest losses of selected commodities. As Dharmathilake et al. (2020) reported, the losses can take place during the supply chain (Figure 5) as well as during the storage after purchasing the commodities (Figure 6), before consumption.

Table 12: Domestic supply, utilization and per capita availability of major crop-based agricultural commodities

	Domestic Supply (1000 MT)				Domestic Utilization (1000 MT)			Per capita availability (g/day)
	Production	Imports	Exports	Total Domestic Supply	Food	Processed	Waste	
Cereals	2900	1658	80	4502	3651	400	195	460.3
Starchy roots	505	166	7	664	607	-	44	76.7
Pulses	33	228	10	251	250	-	1	32.9
Vegetables	2978	353	11	3319	2848	-	416	358.9
Fruits	1070	96	46	1121	854	79	117	106.8
Spices	111	56	14	153	146	-	-	19.2

Source: Food Balance Sheet, 2018

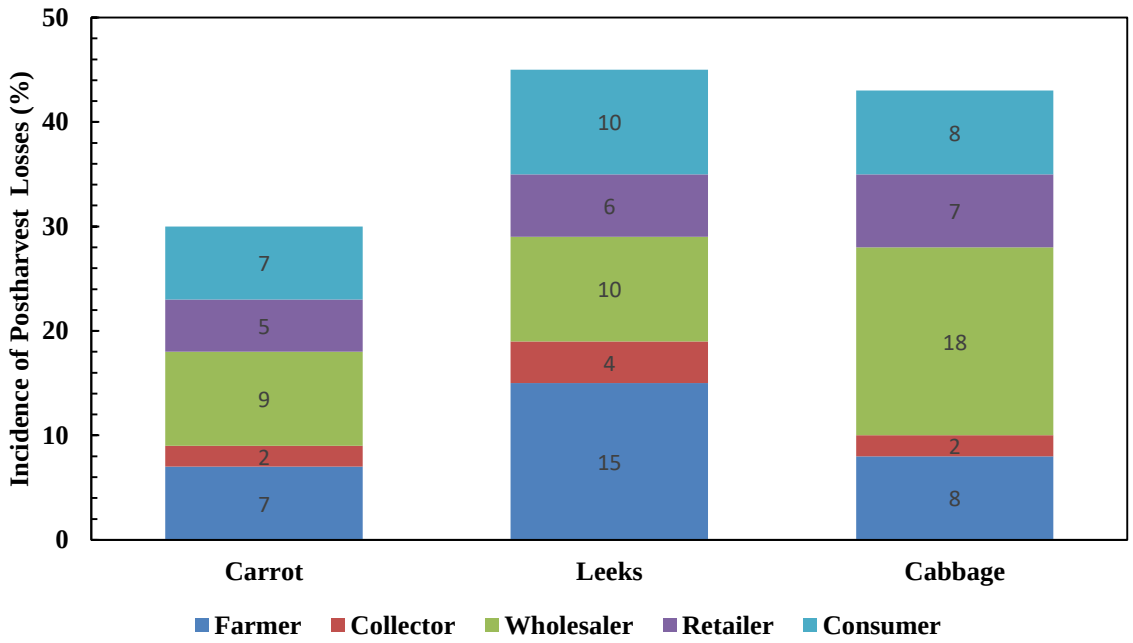

Figure 5: Postharvest losses of three selected vegetables during different levels of the common supply chain. (Adapted from Dharmathilake et al, 2020).

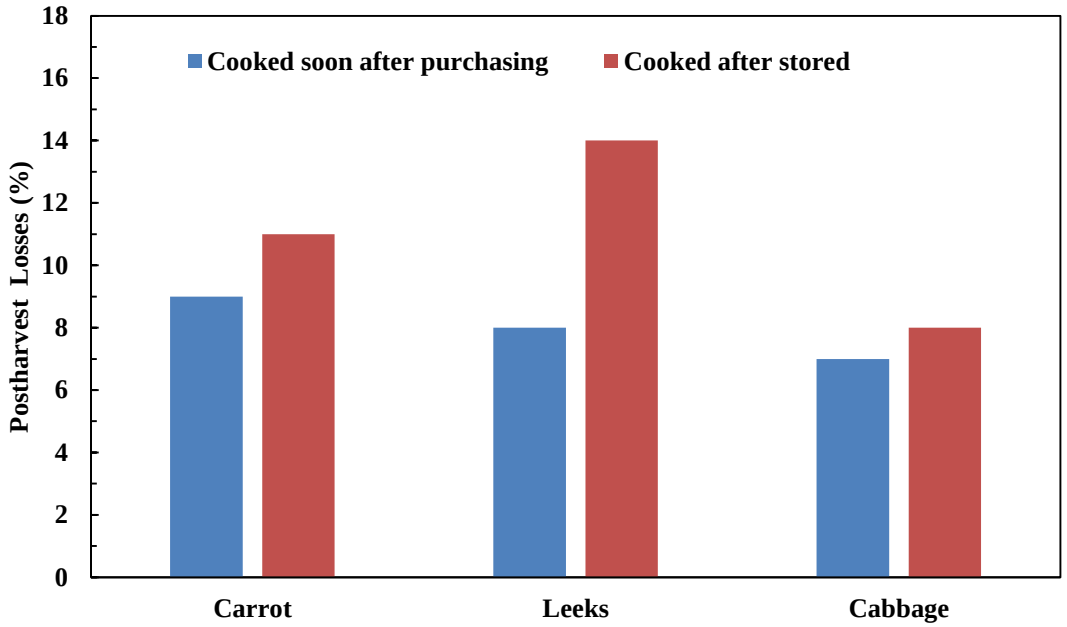

Figure 6: Postharvest losses of three selected vegetables at consumer level according to the pattern of utilization. (Adapted from Dharmathilake et al, 2020).

The modern supply chains established by the supermarket chains are much shorter, effective and follow good practices, thus resulting lower postharvest losses compared to that of conventional supply chains (Kodithuwakku and Weerahewa 2014; Perera et al, 2011). However, the volume of fruits and vegetables passing through these channels is as low as less than 4% (Esham et al., 2006). In the tradition supply chains, about 75% of the postharvest losses take place during transport (FAO, 2018). To minimize these losses, the government has made attempts to introduce plastic crates to transport perishable commodities. However, so far, the people do not seem to adapt this simple technology to minimize postharvest losses with the main reasons being that low packing capacity of plastic crates, low loading capacity in Lorries and additional transport cost incur in returning plastic crates (Dissanayake et al., 2020). Apart from these two value chains, direct value chains are also getting popular, particularly in Colombo and suburbs (FAO, 2018) and can become a competitive value chain in the future as the consumers will have the access to safe and fresh commodities.

There must be a national policy to promote consumption of fruits and vegetables considering the availability, accessibility, affordability and acceptability (quality, taste, safety, type of food, cultural sensitivity). The Figure 7 illustrates the fruit calendar developed by the private sector agency in Sri Lanka which can be utilized in development of value addition and marketing and promote consumption targeting on fulfilling the nutrition requirements of the Sri Lankan people. Cultivation of vegetables especially under protected agriculture has made vegetables available year around from the recent past thus making it difficult to provide a seasonal calendar.

4.13. Marketing /food prices/ distribution system/effect from non-food prices /risks and impact on food choices

Among the sources of price uncertainty, frequent changes in Government policy decisions is noteworthy. A perusal of notifications of changes in Special Commodity Levy (SCL) charged on food crops show that they highly fluctuated over the past 5 years (Central Bank of Sri Lanka, various years). Box 1 shows the changes in Maximum Retail Prices of food items during 2014-2017.

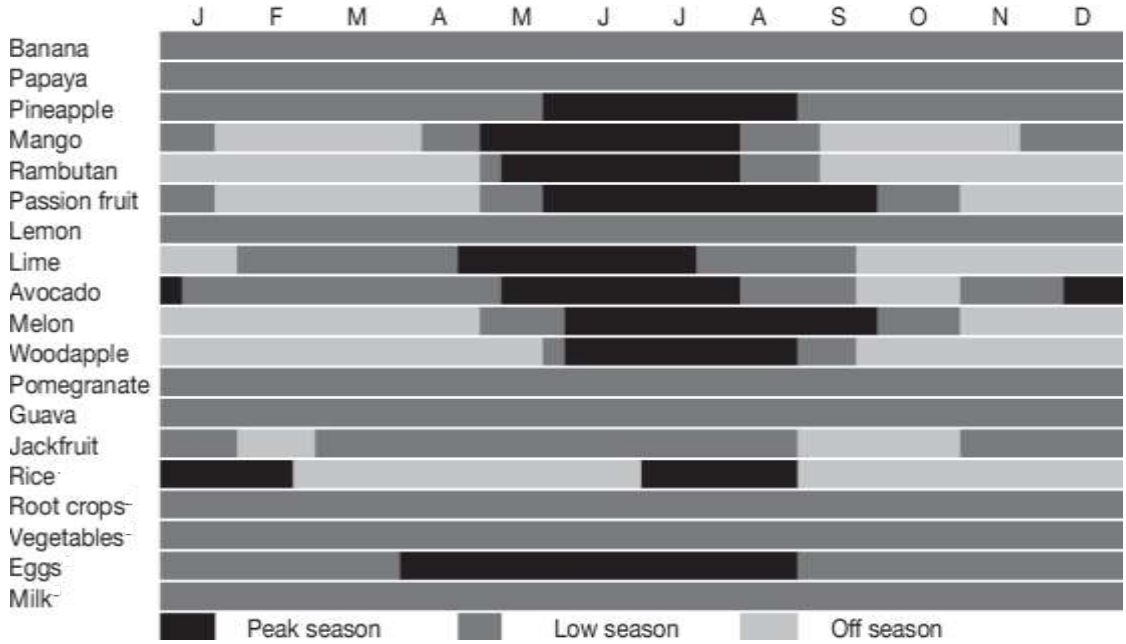

Figure 7. An example for a fruit calendar in Sri Lanka (Source: Pushpakumara et al. 2016)

Box 1: Changes in Maximum Retail Prices of Food Items over 2014-2017

20 February 2015

The maximum retail price of certain items was set as follows:

- White sugar (un-packetted) at Rs. 87 per kg
- Wheat flour (un-packetted) at Rs. 87 per kg
- Green gram (Moong) at Rs. 265 per kg
- Seeds of coriander, neither crushed nor ground, at Rs. 350 per kg
- Black gram at Rs. 300 per kg
- Turmeric crushed or ground at Rs. 800 per kg
- Chillies crushed or ground at Rs. 400 per kg

14 July 2016

- The Maximum Retail Prices (MRP) of certain food items were set as follows:
- Masoor Dhal (red lentils) at Rs. 169 per kg
- Gram at Rs. 260 per kg
- Green gram (Moong) at Rs. 220 per kg
- White sugar at Rs. 95 per kg
- Wheat flour at Rs. 87 per kg
- Potatoes (imported) at Rs. 120 per kg
- B' onions (imported) at Rs. 78 per kg
- Dried chillies (neither crushed nor ground) at Rs. 385 per kg

27 January 2017

The MRP of certain items was revised as follows:

- Masoor Dhal (red lentils) at Rs. 159 per kg
- Green gram (Moong) at Rs. 205 per kg
- White sugar at Rs. 93 per kg
- Potatoes (imported) at Rs. 115 per kg

08 February 2017

The MRP of rice was set as follows:

- Samba rice at Rs. 80 per kg
- Naadu rice at Rs. 72 per kg
- Raw rice (Kekulu) at Rs. 70 per kg

17 February 2017

The MRP of rice was revised to set at Rs. 90, 80 and 78 per kg for Samba, Naadu and Raw Rice respectively for locally produced varieties. They were set at Rs. 80, 72 and 70 for the imported varieties of Samba, Naadu and Raw Rice respectively.

14 March 2017

MRPs on following items were removed: - White sugar

16 August 2017

MRPs imposed on rice were removed.

06 December 2017

MRPs on certain items were reduced as follows: Masoor Dhal from Rs. 159 to Rs. 130 per kg
MRP of Rs. 75 per nut was imposed on coconut.

26 December 2017

MRPs on Naadu rice were revised as follows:

- Locally produced from Rs. 80 to Rs. 74 per kg
- Imported from Rs. 72 to Rs. 74 per kg

4.14. Profitability potential from farming and impact on household food security and nutrition

4.14.1. Major food items in a diet of an average Sri Lankan

Table 13 shows that 92.46%, 73.97% and 81.03% of calories, protein and fat derive from vegetable products highlighting the importance of vegetable products in nutrition. It is noteworthy to state that 46.58% of protein comes from cereals which provide 53.48% of calories. Pulses provide 9.59% of protein and vegetable oil provides 39.66% of fat.

Table 13: Intake of energy, calories, protein and fat by food item

Food Item	Per Day consumption				Percentage from each food item		
	Food	Calories	Protein	Fat	Calories	Protein	Fat
Grand Total		2917	73	58	100.00	100.00	100.00
Vegetable products		2697	54	47	92.46	73.97	81.03
Animal products		220	19	11	7.54	26.03	18.97
Cereals	168	1560	34	4	53.48	46.58	6.90
Starchy roots	28	95	1	0	3.26	1.37	-
Sugar crops	1	0	0	0	-	-	-
Sugar and sweeteners	28	277	0	0	9.50	-	-
Pulses	12	109	7	0	3.74	9.59	-
Tree nuts	2	14	0	1	0.48	-	1.72
Oil crop	26	151	3	14	5.18	4.11	24.14
Vegetable oils	9	204	0	23	6.99	-	39.66
Vegetables	131	111	5	1	3.81	6.85	1.72
Fruits	39	75	1	0	2.57	1.37	-

Source: Extracted from Food Balance Sheets of the Department of Census and Statistics, 2018

4.14.2. Expenditure on food and their importance on different categories of food

The allocations of household expenditure among the food items depend on the prices of food prevailed in the market. The changes in food expenditure pattern of a representative Sri Lanka is shown in Table 14.

Table 14: Household expenditure on selected food items as a percentage of total food expenditure on food and drink by survey period

Food item	1980/81	1985/86	1990/91	1995/96	2002	2005	2006/07	2009/10	2012/13	2016
Rice	31.5	25.3	25.7	21.2	18.0	13.8	13.9	17.3	13.6	12.8
Wheat flour	2.4	2.6	1.5	1.1	1.2	1.2	1.1	1.4	1.3	1.0
Bread	4.7	5.3	4.5	4.4	4.3	3.6	3.5	3.2	3.0	2.4
condiments	8.0	9.8	10.6	9.9	9.1	9.0	9.3	9.1	9.0	9.8
Pulses	NA	3.6	4.8	3.7	3.2	3.4	3.5	4.1	3.5	3.6
vegetables	7.5	9.9	9.9	8.3	7.9	8.1	8.4	7.6	8.2	8.0
Coconut	8.2	5.9	5.5	6.9	7.3	5.6	5.5	5.6	6.1	5.7
Meat	NA	2.6	3.4	4.4	3.2	4.4	4.2	3.9	4.3	4.8
Fish	4.9	5.9	5.8	6.6	6.3	8.5	8.6	8.8	9.1	9.5
Dried fish	3.2	4.0	4.2	4.6	3.7	3.8	4.0	3.7	4.2	4.0
Milk and milk products	3.3	4.3	5.1	7.1	8.4	9.9	8.7	7.8	8.9	8.2
Egg	NA	0.9	1.1	1.1	0.8	1.0	1.0	1.0	1.0	1.1
Fruit	NA	1.2	1.3	1.7	3.6	3.9	3.4	2.9	2.9	3.2
Sugar	7.8	6.3	6.5	5.2	3.3	3.3	3.6	3.4	2.9	2.2
Other food and drinks	18.5	12.4	10.1	13.8	19.6	20.5	21.3	20.2	21.8	23.7
Total	100.0	100.0	100.0	100.0	100.00	100.0	100.0	100.0	100.0	100.0

* Other food and drinks category shows all the items that are not listed in the rows above the respective line item. It is a composite commodity to accommodate the residual. Source: Household Income and Expenditure Survey (Department of Census and Statistics, various years).

4.14.3. Employment and income profile of households of Sri Lanka

It is important to assess the sources of income of Sri Lankan households to see the extent to which agricultural incomes influence the expenditure pattern of the household. An average household earned 7.6% of its total monthly income from agricultural activities as per the Household Income and Expenditure Survey (2016) of the Department of Census and Statistics. According to the Agriculture Household Survey (2016) conducted by the same agency, there were 2.1 million agricultural households, which represents 40% of total households, in 2016. Out of this household population 66% were aged 15 years and above (economically active). Of

them, 8% worked in government or semi government sector paid employments while 15% worked in private sector paid employments. Only 32% of population reported that their main economic activity was agriculture.

4.14.4. How much profits can be earned from different crop enterprises in Sri Lanka?

Tables 15 and 16 provides returns for an acre from a selected crop enterprises in Yala 2018 as reported in the Cost of Cultivation Reports of the Department of Agriculture. The earning from crop agriculture for a household depends on duration of the crops (vary from 2 to 4 months), extent of cultivation (on average an agricultural household used 2 acres as per the agriculture Household Survey of 2016) and the crop combination.

Table 15: Profitability of paddy in Sri Lanka

Water regime	Yield kg/ac	Farm-gate price Rs./kg	Gross return Rs/ac	Returns including family labour	Returns excluding family labour	Return to Labour Rs.	Return to Capital Rs.
Irrigated	2,130	42.00	89,460	38,154	51,949	3,706	2.38
Rainfed	1,396	40.00	55,840	8,608	27,492	1,721	1.97

Source: AgStat - Cost of Cultivation of Crops, 2018 Yala

Table 16: Profitability of selected crop enterprises of Sri Lanka

Crop	District	Total Cost Rs '000/ac	Average farm-gate price (Rs/kg)	Yield (kg)	Net Income* (Rs/acre)
Big Onion	Matale	228,641	65.00	6,370	185,409
Green Chillie	Anuradhapura	257,275	214.00	4,105	621,195
Red Onion	Puttalam	266,121	86.00	4,980	162,159
Tomato	Badulla	267,319	90.30	8,442	627,870
Maize	System H	73,678	44.10	2,040	16,082
Soy Bean	System H	64,926	106.30	912	31,746
Potato	Nuwara Eliya	363,071	90.80	6,207	200,524

Source: AgStat -Cost of Cultivation of Crops, 2018 Yala; * Computed

4.15. Availability of national agricultural market system and its impact on distribution across the country in all sectors

4.15.1. Organization of agricultural marketing systems

The Paddy Marketing Board (PMB) was established under Parliament Act No. 14 of 1971 to: (a) carry on the business of purchasing, selling, supplying and distribution of paddy and rice; (b) carry on the business and process of milling of paddy; (c) carry on any such other business as may be incidental or conducive to the attainment of the objects referred to in paragraphs (a) and (b) above; and (d) do all other things which in the opinion of the Board are necessary to facilitate the proper carrying on of its business. With the opening up of the economy in 1977, the PMB act was amended and allowed the private sector to involve in marketing rice. With this change in policy, the share of PMB in purchasing paddy declined and by 1990, the PMB became inactive.

The PMB was reestablished in 2007 and PMB re-commenced paddy purchasing in 2008 YALA season. In 2018, the guaranteed price for Samba and Nadu were Rs. 41 per kg and Rs. 38 per kg, respectively. Proposals to introduce guaranteed prices for other food crops, specifically for potato, maize, raw milk etc., have been made in a number of occasions. Such programmes however were not as last-longing compared to what was implemented for paddy.

4.16. Current status of value chain/ value addition of crops

4.16.1. Quantity of each food item used by the processing industry

Food balance sheets published by the Department of Census and Statistics provide the amount used for agricultural processing which gives an indication of value addition. Table 17 provides details for 2018.

The raw materials produced in Sri Lanka, 96% of sugar produced is processed. The percentage goes for the processing sector is fairly low for all other vegetables. They were 15.79 (sugar and sweetners), 15.7% (oil crop), 8.88% (cereal), 7% (fruits) and 5% (tree nuts).

4.17. Effect of climatic changes on yield, crop selection and food consumption and choices

In terms of food security, self-sufficiency in rice production has been the major strategy of agricultural policy since Sri Lanka gained independence in 1948. This has supported generation of employment and elimination of rural poverty. Sri Lanka reached the stated goal of self-sufficiency in rice in the year 2010 mainly due to the investments on research and development. The rice research outputs in Sri Lanka in the last half century further corroborate this contention in that on an average, for every 1 % increase in rice research investment, rice production increased by 0.37 % with an internal rate of return of 174 % in a tariff-protected regime and a benefit/cost ratio of over 2,300 (Niranjan 2004). Poverty, climate change, decreasing arable agricultural land, and increasing population pressure are the main issues that render achieving the national-level food and nutrition security more challenging in Sri Lanka (Marambe 2012; Weerakoon 2013).

Table 17: Domestic supply and demand by food item showing the amounts processed

Food Item	Domestic Supply, '000 MT					Domestic Demand, '000 MT				
	Production	**Imports**	**Stock change**	**Exports**	**Total Domestic supply**	**Feed**	**Seed**	**Processed**	**Waste**	**Other utilities**
Cereals	2900	1658	25	80	4502	169	88	400	195	0
Starchy roots	505	166	0	7	664	0	13	0	44	0
Sugar crops	645	0	0	0	645	0	10	622	0	0
Sugar and sweetners	111	628	3	21	722	0	0	114	0	7
Pulses	33	228	0	10	251	0	1	0	1	0
Treenuts	99	6	0	5	100	0	0	5	0	50
Oil crop	916	21	0	268	669	0	4	105	1	5
Vegetable oils	64	234	0	17	281	0	0	0	0	98
Vegetables	2978	353	0	11	3319	50	1	0	416	0
Fruits	1070	96	0	46	1121	76	0	79	117	1

Source: Extracted from Food Balance Sheets of the Department of Census and Statistics, 2018

The World Food Programme (2011) reported that out of the total population of Sri Lanka, 12 % are severely food insecure, of which 82 % are in the Northern and Eastern Provinces. Extreme climate events, such as the severe drought that prevailed over a period of 5–6 months in the year 2012, will provide its own challenges to food security in the near future.

The Global Food Security Index 2013 (www.eiu.com/public/topical_report.aspx?Campaigned=FoodSecurity2013) has ranked Sri Lanka 60th out of 107 countries. This index assists to identify and compare the core issues of food affordability, availability, access, and quality across countries.

The climate changes in recent decades in the forms of natural calamities like drought, flood, cyclone, accelerated land degradation, and sea-level rise pose serious threats to agricultural productivity and food security (Marambe et al. 2015). Additional pressure coming from ever-increasing population, poor terms of trade, weak infrastructure, and limited access to modern technology and market restrict the options available for people to cope with the negative consequences of climate change. The main food-related agricultural products in Sri Lanka are crops such as rice and other field crops, fruits and vegetables, and animal products such as

milk, meat, eggs, and fish. Sri Lanka has experienced frequent natural disasters in the wake of drought, flood landslide, and cyclone events threatening its agricultural production.

Coastal hazards such as coastal erosion and salinity intrusion to soils and aquifers are a common feature that affects agricultural production, especially in the drier parts along the Eastern coast of the country. Decreasing arable agricultural land, together with increasing population, renders these challenges more difficult to tackle. In Sri Lanka, most crops, e.g., coarse grains, legumes, vegetables, and potato, are likely to be adversely affected due to climate change (Titumil and Basak 2010).

The varied climatic conditions in the farming systems of Sri Lanka have given rise to a wide range of crop species and land races that are suited for different conditions of soils, rainfall, and altitude as well as to diseases and insect pests. Genetic diversity is particularly high among rice, other cereals, cucurbits, and vegetables such as tomato and eggplant, indicating the potential for crop improvement in the face of natural disasters such as climate change, as an adaptation measure. The genetic diversity of crop plants is the foundation for the sustainable development of new varieties for present and future challenges. Resource-poor farmers have been using genetic diversity intelligently over centuries to develop varieties adapted to their own environmental stress conditions. Systematic crop comparison programs under different agroecological regions of Sri Lanka through farmer participatory programs, strengthening the crop germplasm collection programs conducted by the Department of Agriculture with special focus on climate change, and creating access to and drawing in new genetic materials through intergovernmental programs to enhance food production would strengthen the strategic approaches for adaptation in Sri Lanka, thus minimizing the climate risk on food security.

In spite of the technological advances made on improved crop management, irrigation, plant protection, and fertilization, weather and climate are still key factors in agricultural value chain in Sri Lanka. Farming systems and agronomic practices in most agricultural regions of Sri Lanka have evolved in a close harmony with the prevailing climatic conditions of respective climatic regions of the island. However, it has been evident during recent decades that heritage of farming experiences and accumulated weather lore of centuries have become ineffective in agricultural planning process at all levels. The climate of the island has undergone a change to such an extent that correct amount of rainfall does not come at the correct time of the growing season.

4.18 Availability of climatic resilient agricultural practices for staple crops and their impact on food security

Being cognizant of the importance of adapting to climate change, the government of Sri Lanka has taken several initiatives at the policy level by developing the National Climate Change Policy (NCCP) of 2012 (Ministry of Environment 2012) and the National Climate Change Adaptation Strategy (NCCAS) 2010–2016 (Ministry of Environment and Natural Resources 2010). While the three main policies that deal with the agriculture sector related to food security, namely, the National Agriculture Policy of 2007 (Ministry of Agriculture and Agrarian Development 2007), National Livestock Development Policy of 2007 (Ministry of Livestock and Rural Community Development 2007), and the National Fisheries and Aquatic Resources Policy of 2006 (Ministry of Fisheries and Aquatic Resources 2006), are in operation,

the NCCP and NCCAS are expected to mainstream climate change adaptation into the national planning and development process.

As for availability of climate resilient agricultural practices in Sri Lanka, rice was taken as an example herewith to explain the development. Several successful attempts have been made in the rice production sector in the technological front to meet the challenges of climate change. The development of rice varieties, which are of short duration and suitable for short growing seasons (Harris and Shatheeswaran 2005) and high CO2 concentration (De Costa et al. 2007), is in the forefront of technological innovations. The recent release of ultrashort-duration rice varieties by the Sri Lanka Department of Agriculture such as Bg250 maturing in 75–80 days is a positive response by the government of Sri Lanka to cope up with climatic changes. Gunawardana et al. (2013) reported on the potential for adoption of aerobic growing conditions for rice varieties minimizing the water use under changing climatic conditions while assessing the competition for weeds.

As the sustainability of food production through traditional farming patterns is being challenged, farmers have been following water-conserving agronomic practices such as Kekulama or Manawari system and Nava Kekulama (dry-sowing systems; Upawansa 2013) and the System of Rice Intensification (SRI) (Somaratne 2010) and are also making informed choices in species selection by combining local knowledge on species and varieties under the guidance of several NGOs (Berger et al. 2009). Jayawardena et al. (2010) reported that paddy cultivation in the Dry and Intermediate Zones in Sri Lanka under zero-tillage condition has enabled a reduction in cost of production and enhanced water conservation without significantly affecting the yield. Breeding of salt-tolerant rice varieties is also a primary adaptation measure to maintain national rice production levels and ensure food security in the face of expanding salinity due to sea-level rise. In this regard, the salt-tolerant rice variety At354 (3½ month age class) has been developed by the Sri Lanka Department of Agriculture to meet food production challenges under saline conditions. Salinity in paddy fields could also be overcome by a combination of agronomic measures including improved field drainage, application of organic manure, rice straw and burnt paddy husk, and transplanting rice instead of direct seeding.

With more frequent extreme rainfall events, the area under major irrigation reservoir schemes (reservoirs with an irrigable area of more than 200 ha) in the Wet and Intermediate Zones that practice rice + rice annual cropping pattern would not be able to claim the usual share from the trans-basin diversion structures. This has forced the farming community to reduce the extent under cultivation or explore other adaptation options such as “shared cultivation” (Bethma system) but at the expense of the productivity of the system. Moreover, increased occurrence of extreme positive rainfall anomalies is likely to cause severe damages to existing irrigation infrastructure of major irrigation schemes, thus limiting the water availability for crop production systems under these reservoirs.

4.19 Production practices and crop diversity/biodiversity of crops effect on food security/ nutritious foods / traditional foods for consumption and sale

Components of biodiversity provide fresh water for domestic and industrial uses and underpin the socio-economically vital areas of agriculture and livestock production, fisheries, forestry, tourism, traditional medicine, and several important manufacturing industries. For example, Sri Lanka's biodiversity provides a wide range of ecosystem services, which include providing fresh water, ameliorating the climate, reducing soil erosion, regulating surface runoff, and providing biological resources for subsistence use as well as domestic and export-oriented markets. Biodiversity of the coastal and marine ecosystems of Sri Lanka provides over 65% of the animal protein requirement of the country (Marambe and Silva 2016). Thus, many components of biodiversity are vital to meet the consumptive and economic needs of the society.

Agrobiodiversity remains the main raw material for agro-ecosystems to cope with climate change because it contains the reservoir of traits for both plant and animal breeders and farmers to select resilient, climate-ready germplasm and produce new cultivars or breeds. The traditional farming systems in Sri Lanka are the results of centuries-long evolution of production systems to suit local conditions. Agrobiodiversity in any form can only be effectively maintained and adapted with the human management systems that created it, including indigenous knowledge systems and technologies, specific forms of social organization, customary or formal law, and other cultural practices (Marambe et al., 2012).

Sri Lanka has a high diversity of traditional varieties of rice, vegetables, and cash crops that are clearly resistant to diseases and insect pests and are well suited for the various soil and climatic conditions on the island. The nation also has many wild relatives of rice and other crops in farmers' holdings, forests, and wetlands, amounting to 410 species (Fonseka and Fonseka, 2010). Of these, 289 species are indigenous and 77 are endemic to the island and are mostly underutilized.

This diverse gene pool can be used in crop breeding programs to enhance crop production and food security for the nation. The development of the livestock sector in Sri Lanka is based on cross-breeding or grading up of local stocks of cattle, goat, swine, and poultry with imported high-yielding breeds. The main target of this effort is to preserve the characteristics of local poultry and livestock as much as possible while improving the productivity. Local livestock breeds are more resistant to disease and parasites than imported breeds, are well adapted to local conditions, and have low nutritional requirements (Marambe and Silva 2016).

Traditional agriculture practices coupled with endogenous paddy varieties have proven to be more successful in facing climate change events such as droughts and floods (Sharma and Rai 2010). There are many traditional paddy varieties in existence today in Sri Lanka, which have strong characteristics that help them survive climate change impacts such as droughts, heavy rains, and floods compared to newer varieties used in chemical-intensive paddy cultivation (Rathnabharathi 2009). This vigor is based on certain characteristics unique to traditional paddy varieties.

The traditional varieties are capable of surviving in the nursery until the field conditions are favorable for planting. Traditional varieties are tall with a strong stem compared to the new improved varieties, thus helping them to withstand heavy rains, winds, and droughts. The husk of the paddy seed of traditional varieties can withstand waterlogged as well as drought conditions (Rathnabharathi 2009). Traditional rice varieties such as *Hata da vee* that survives

long dry spells are being cultivated in selected areas in the Dry and Intermediate Zones of the country.

4.20Profitability potential from farming and impact on household food security and nutrition

4.20.1 Mmajor items in a diet of an average Sri Lankan

Table 17 provides the pattern of food consumption of a representative Sri Lankan and sources of calories, protein and fat by food item.

4.20.2 Expenditure on food and importance of different categories of food

Refer to Table 14 on the allocations of household expenditure among the food items.

4.20.3 Extent of profits earned from different crop enterprises in Sri Lanka

Tables 18 and 19 provides returns for an acre from a selected crop enterprises in Yala 2018 as reported in the Cost of Cultivation Reports of the Department of Agriculture. The earning from crop agriculture for a household depends on duration of the crops (vary from 2 to 4 months), extent of cultivation (on average an agricultural household used 2 acres as per the agriculture Household Survey of 2016) and the crop combination.

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Water regime	Yield kg/ac	Farm-gate price Rs./kg	Gross return Rs/ac	Returns including family labour	Returns excluding family labour	Return to Labour Rs.	Return to Capital Rs.
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Rainfed	1,396	40.00	55,840	8,608	27,492	1,721	1.97

Source: AgStat - Cost of Cultivation of Crops, 2018 Yala

Table 19: Profitability of selected crop enterprises of Sri Lanka

Crop	District	Total Cost Rs '000/ac	Average farm-gate price (Rs/kg)	Yield (kg)	Net Income* (Rs/acre)
Big Onion	Matale	228,641	65.00	6,370	185,409
Green Chillie	Anuradhapura	257,275	214.00	4,105	621,195
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Tomato	Badulla	267,319	90.30	8,442	627,870
Maize	System H	73,678	44.10	2,040	16,082
Soy Bean	System H	64,926	106.30	912	31,746
Potato	Nuwara Eliya	363,071	90.80	6,207	200,524

*Source: AgStat - Cost of Cultivation of Crops, 2018 Yala; * Computed*

4.21 Extent of urban and peri urban agriculture and their impact on food security and nutrition promotion

The population and household census in 2012 showed that, 18.2% of country's population is 'urban', as defined as those who live in the areas under the jurisdictions of Municipal Councils and Urban Councils (DCS, 2012). However, Weeraratne (2016) defines a Grama Sevaka division as urban if it has a minimum population of 750 persons, a population density greater than 500 persons per km^2, firewood dependence of less than 95% of households, and well-water dependence of less than 95% of households and estimates that 43.8% of Sri Lankan population live in urban areas. Western Province is the most metropolitanized province carrying 5.8 million dwellers with a 38.8% in urban environments (DCS, 2012).

Urban agriculture is considered as one of the best strategies to ensure the food and nutrition security while uplifting the family income of urban dwellers (Baker, 2012; Zezza and Tasciotti, 2010). It has been estimated that, through the harvest from urban agriculture, a 51% and 26% reduction of expenditure can be achieved on vegetables and fruits, respectively (Gamhewage et al, 2015).

Of the total land in the Colombo District, 26% is used as home gardens while 11% and 1% are utilized for paddy and other field crops respectively (Table 20). This shows the potential to promote and facilitate the urban agriculture in the said District. However, to cater to the demand for rice and other crop-related commodities within the urban areas such as Colombo, it is essential to guarantee a continuous supply from elsewhere. It is important to focus on the vegetables and fruits to cultivate in the urban agricultural lands targeting food and nutrition security. As the lands are limited, green roofs, plant-factories, vertical farming and green walls can be recommended as several alternative strategies other than the conventional cultivation systems.

Table 20: Land use pattern in Colombo District, 2010.

Land use	Extent (Ha)	Percentage (%)
Non-agricultural lands		
Built-up areas	18792.96	27
Agricultural lands		
Home gardens	18276.39	26
Planation crops (rubber, coconut)	17925.86	26
Paddy	7658.38	11
Other field crops	378.12	1
Forest lands	2340.79	3
Water bodies	2162.86	3
Other field crops	2276.55	3

Source: Adapted from FAO, 2018

On a recent survey conducted in urban environments in Sri Lanka by Chandrasekara et al (unpublished data), the lowest per capita fruit consumption was recorded among the urban shanty dwellers. In the sample area, the vegetable consumption was also found to be significantly low. In the same study, the food consumption routine was totally different in urban shanties compared to other areas where rice and bread, rice and gram, rice and string hoppers, rice and roti, rice and green gram or cowpea were popular among them. This needs to be addressed immediately taking sustainable measures to make this population a healthy group.

4.22 Research on improving productivity, and quality of food and value chain

As Thibbotuwawa and Hirimuthugodage (2015) stated the yield levels of domestically grown food crops, except for rice have been stagnated for more than a decade in Sri Lanka. However, due to the limited scope for further area expansion, a possible solution to the problem of meeting the growing food requirement from the domestic production front should come through yield improvement or productivity improvement.

Research on improving productivity of food crops includes (i) varietal improvement for high yielding ability or shorter time requirement or improved quality (i.e. MICH chili variety with a high yield), (ii) soil fertility and its sustainability including development of precision agriculture technologies through site specific fertilize management systems, nano fertilizer and biofertilizer etc. apply through drones, (iii) development of integrated pest, disease and weed management systems including use of bio pesticides (iv) developments of tools and techniques for efficient irrigation and fertilizer management through ICT, (v) postharvest and quality improvement and production technologies (DOA, 2019). However, except for a few crops such as chilli, maize and rice use of research outputs on improving productivity are limited. Hence, prompt and accelerated research program and application of such research data in the field are essential to enhance productivity of all food crops with less land, labour and water and limited use of chemicals. Quality research on quality of food value chain are extremely limited in Sri Lanka.

Recently started the World Bank funded Agriculture Sector Modernization Project also has a component on improving agricultural productivity and competitiveness to strengthen the links between rural and urban areas and facilitate Sri Lanka's structural transformation; providing and strengthening rural livelihood sources, employment opportunities in agriculture and along agriculture value chains, as well as market access for the poor, and vulnerable people, thereby improving income sources and livelihood security in lagging rural areas; and contributing to improved flood and drought management, through project's linkages to the water and irrigation sectors and a climate-smart agriculture approach. This is largely through promotion of application of proven technology to increase the yield at farmer's level.

4.22.1 Availability and potential adoptability with cross-sectoral (crop, livestock, forestry, fisheries and aquaculture) approaches

Food and Nutrient Security in household level need cross sectoral approaches by integrating crop system with planned livestock systems, with available fisheries and forest resources. In Sri Lanka, planning and implementation is usually in isolation without consideration of the other sectors. So, integrated approach through multidisciplinary mode is the option but yet to materialize to impact on food and nutrition security of the society.

5 Summary

This desk review was carried out to identify the gaps in fulfilling the nutritional requirements in relation to food crop sector in Sri Lanka. The report initially focused on the production of food crops in the country, which has been not been able to meet more than 50% of their domestic requirements, in majority of the cases. The total requirement is wheat is met through imports and more than 95% of the domestic requirement of dry chilly is imported. Further, majority of pulse crops requirements and that of potato are imported. Vagaries in climate had negative impacts on the production of food crops over the years. Only few farmers have adopted soil protection systems in the field level to improve soil productivity.

Poor water management and irrigation are major constraints to increased agricultural productivity especially in the rain-fed dry zones of Sri Lanka. Technologies such as using agro wells and micro-irrigation systems being adopted by some farmers but without proper guidance on hydrological properties of the aquifer creating environmental problems on reservoirs. There are gaps in specific interventions to safeguard the cash crop production targeting food security, namely (i) commercial agricultural development through agro-wells, seed and planting material production, micro-irrigation etc), (ii) enterprise Development and employment (enterprise orientation, training- vocational, entrepreneurial and skills etc.), iii) Rural Financing (credit, discretionary grants) and (iv) project and company management (farmer organizations).

Drawbacks in organic farming are resulting in from limited availability of essential organically-certified inputs such as composts, other manures, bio-fertilizers, and bio-pesticides and the higher cost of production due to high prices of these inputs. Low organic matter content in soils has created several problems such as yield decline and yield stagnation in crops such as rice, fruits and vegetables grown in Sri Lanka. Under such conditions, retention of plant nutrients is low and subsequently decreasing the fertilizer use efficiency. Thus, seasonal application of organic fertilizers are promoted for crop production in Sri Lanka.

Moreover, nutrition is also not identified adequately as an objective in agriculture related policies plans related to agriculture, strategic and action planning and agriculture-related development programmes. These scenarios could also have emanated owing to that agricultural researchers paying less attention to nutrition or support nutrition sensitive agriculture. Research outputs in agriculture over the past few decades have mainly focused on improving productivity with special emphasis on development of new varieties. Thus, agriculture research investments on nutrition is not streamlined. Absence of comprehensive studies on alleviation of micronutrient deficiencies with bio-fortification or food fortification including both epidemiological and interventional studies is an important gap that warrants due attention of the researchers. As per government policy framework, home gardening has increased annually however, analysis on the actual food and nutrient supply from home garden products in Sri Lanka and their temporal changes are limited.

The per capita availability of fruits and vegetables in Sri Lanka as of 2018 (465.7 g/capita/day) is little above the minimum daily consumption (400 g/capita/day) recommended by the World Health Organization in 2004. This increase in availability has been observed since 2014. Although the fruits and vegetables are available, the actual daily intake of fruits (0.43 portion) and vegetables (1.73 portions) are well below the national recommendation (5 portions per day). High postharvest losses at the consumer level has led to huge food wastes threatening the food and nutrition security of the Sri Lankans. Lack of a national policy to promote production of fruits and vegetables considering the availability, accessibility, affordability and acceptability (quality, taste, safety, type of food, cultural sensitivity). A serious gap between the farmer and agriculture extension exists. At present, it is a major challenge for imparting modern agriculture technology to farmers. The desk review makes 15 key recommendations to overcome the challenges identified through the analysis to ensure food and nutrition security of Sri Lankan people are safeguarded in the short, middle and long run.

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Section 3

Livestock Sector

1.Introduction & objectives

Human civilization is in parallel with the domestication of animals. These domesticated animals supplied food and clothing for humans. According to some historians, human civilization may not have occurred in the absence of animal domestication (Gillespie and Flanders, 2010). Livestock farming in Sri Lankan has a long history (Chandrasiri, 2002).

The generic term 'Animal-Source Food' (ASF) refers to all foods of animal origin, including livestock and poultry and wild animals (game/bushmeat). However, this report focuses only on farm animals and products derived from farm mammals (cattle, buffalo, sheep, goats, pigs, and poultry). Among the food groups that are commonly considered three or four are ASF: dairy products, eggs, meat, and organ meat. The ASFs are a group of high nutritional value food products, which provide highly bioavailable nutrients that are essential for growth and health, and that may be difficult to obtain from plant-source foods alone (Murphy and Allen, 2003). Food of animal origin is a universally accepted high-quality protein source. According to Dietary Reference Intakes (DRIs), an adult male requires 0.66 g of protein per day (Intakes, 2011). However, there is a wide variation in the amount of protein consumption among countries and communities, which correlates to the economic status and availability of animal origin food sources (FAO, 2010).

The objective of this report is to provide stakeholders with the information to understand linkages between agriculture food systems, nutrition, and health in achieving national nutrition goals. This understanding would develop the knowledge and skills to fulfill the requirements of nutritious food to improve the nutrition situation of the population. This support is provided through this situational assessment to identify nutrition-related gaps in livestock and poultry.

2. Methodology

The PRISMA principles (Preferred Reporting Items for Systematic Review and Meta-Analysis) were used to conceptualize the review and gap analysis process using PICO Table 1.

3. Inclusion & exclusion criteria of evidence

For an article to be included in this report, it must meet all the following inclusion criteria:

1. The study includes an explicit reference to animal production, and it focuses on animal production for human consumption.
2. The study includes an explicit reference to animal product consumption in Sri Lanka.
3. An explicit reference on animal production related policies, sector plans, strategies and regulations in Sri Lanka.
4. An explicit reference on services provided to the animal husbandry sector in Sri Lanka.
5. The study was published after 2000.
6. The study includes an explicit reference to livelihood, food security, or income in Sri Lanka.

7. Documents focus on activities on animal husbandry in Sri Lanka.
8. The study uses primary and secondary data to demonstrate the contribution to outcomes.
9. Studies in English.

For an article to be excluded from this study, it must meet one of the following exclusion criteria:

1. The study does not include an explicit reference to animal husbandry in Sri Lanka.
2. The study does not include an explicit reference to Sri Lanka.
3. The study was published before 2000.
4. The study does not include an explicit reference to livelihood, food security or income in Sri Lanka.
5. The study focuses on animal production for non-human and animal consumption.
6. The study focuses on activities in crops, agroforestry, fisheries, and aquaculture.
7. The study uses modeling approaches to demonstrate the contribution to the outcomes.
8. The study is not written in English.

Table 1: Inclusion criteria for the systematic review (PICO table)

Participants (individuals or population of interest to us)	**Geographic location: conducted in Sri Lanka, South Asia Group: Livestock, poultry**
Intervention	Provide stakeholders with the information to understand linkages between animal food production systems, nutrition, and health in achieving national nutrition goals. This understanding would develop the knowledge and skills to fulfill the requirements of nutritious food to improve the nutrition situation of the population.
Comparator	Review documentary evidence for nutrition considerations in livestock Compare the nutrition-related gaps in policies, sector plans, strategies, budgets, institutional mechanism and service provision at national and decentralized levels in livestock
Outcomes	Primary: Nutrition-related gaps (lack of consideration of nutrition requirements) in the livestock sector would be identified. Secondary: Provide strategies and knowledge that can be used to improve nutritional status in Sri Lanka

Online information sources were information sources and conducted a comprehensive search of the electronic databases and grey literature sources. Various project documents, databases, and previous studies both in print and electronic versions in the area of impact studies were utilized for designing and planning of this study. Database-specific search syntax was

developed to capture all relevant papers while avoiding the retrieval of an unmanageable number of irrelevant documents.

4. Findings & analysis

4.1 Current status

Sri Lanka is a low-income economy country with a GDP per capita of US$ 4,102. The population is 21,670, 000 while 77.4% live in rural areas. In 2019 GDP growth averaged 2.3% per annum, with agriculture being the slowest growing sector in the economy (Central Bank, 2019). The agriculture sector contributes around 7% to GDP (Central Bank, 2019) and employs 25.5% of the labor force (Department of Census and Statistics, 2018a). The contribution of the livestock sub-sector to agricultural GDP has remained at 0.7% in the years 2018 and 2019. However, it has shown a slower growth rate (3.2%) in 2019 compared to the 8.0% growth rate in 2018 (Central Bank, 2019). The generic term 'livestock' refers to this report for all foods of animal origin, including livestock and poultry.

Contribution of the livestock sector to the agriculture production index, which measures the output of the agriculture and fisheries sectors, broadly remained unchanged during the period from 2014 to 2019 period (Table 2). The livestock sector reported a slight reduction in growth (3.1%) compared to the 5.9% growth in 2018 (Central Bank, 2019; 2018).

Table 2: Livestock contribution to the Agriculture Production Index (2007-2010 =100)

Item	Year					
	2014	2015	2016	2017	2018	2019
Agriculture	119.9	127.3	127.2	113.6	126.1	126.2
Livestock	136.2	147.2	158.2	166.6	176.4	181.9
	Growth Rate (%)					
	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Agriculture	-1.6	4.4	-0.3	-10.7	11	0.3
Livestock	3.1	11.4	7.5	5.3	5.9	3.1

Sri Lankan animal husbandry sector mainly comprised of cattle, buffalo, goat & sheep, swine, and poultry. The livestock population during the period from 2009-2018 is indicated in Figure 1. The highest population growth was noted in poultry, followed by swine 19.84% and 10.61%, respectively. During the period from 2009-2018, the cattle population has increased by 2.87%, while sluggish growth was noted both in buffalo, goat, and sheep population (Livestock Statistical Bulletin, 2017; 2016; 2015; 2014;2013; Annual Report, 2011;2010;2009).

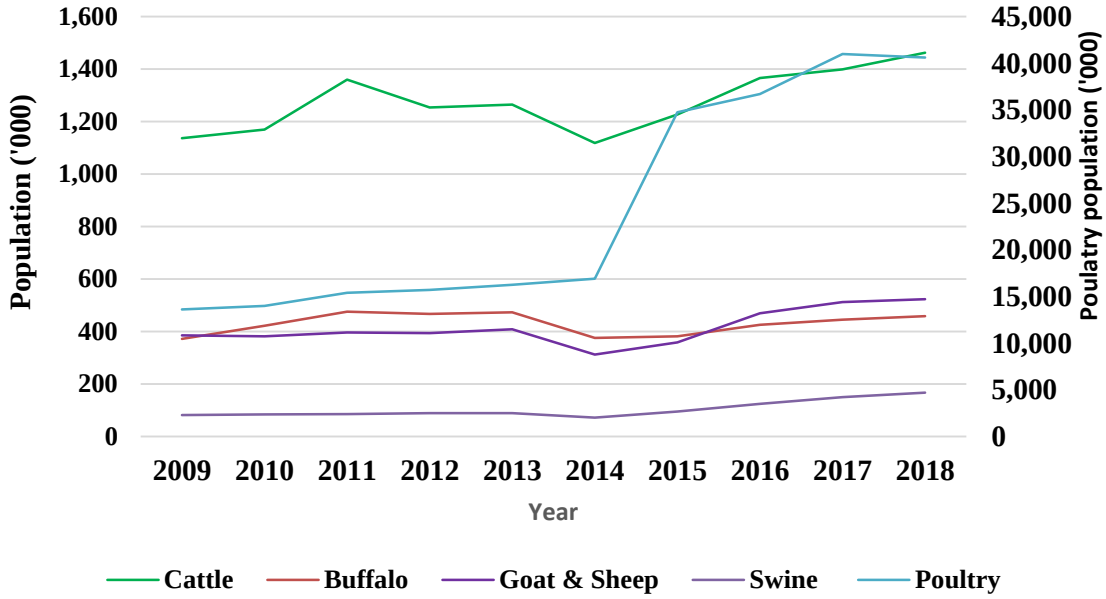

Figure 1: Livestock population ('000)

According to the estimations by the Department of Census and Statistics, per capita per day availability of calories, proteins, and fats from ASF has been stagnant during the period from 2015-2018 (Figure 2) (Department of Census and Statistics, 2018b). In the world, the highest amounts (57%) of protein in the diet were derived by plant sources, while 37% were contributed by the meat (18%), dairy (10%), and other animal products (9%) (FAO, 2010). The ASF availability as a protein source in Sri Lanka is lower than the global levels, and barely fulfill around 23-26%. In contrast, more than 60% of the protein requirement of the British were provided by ASF (Lonnie *et al*., 2018).

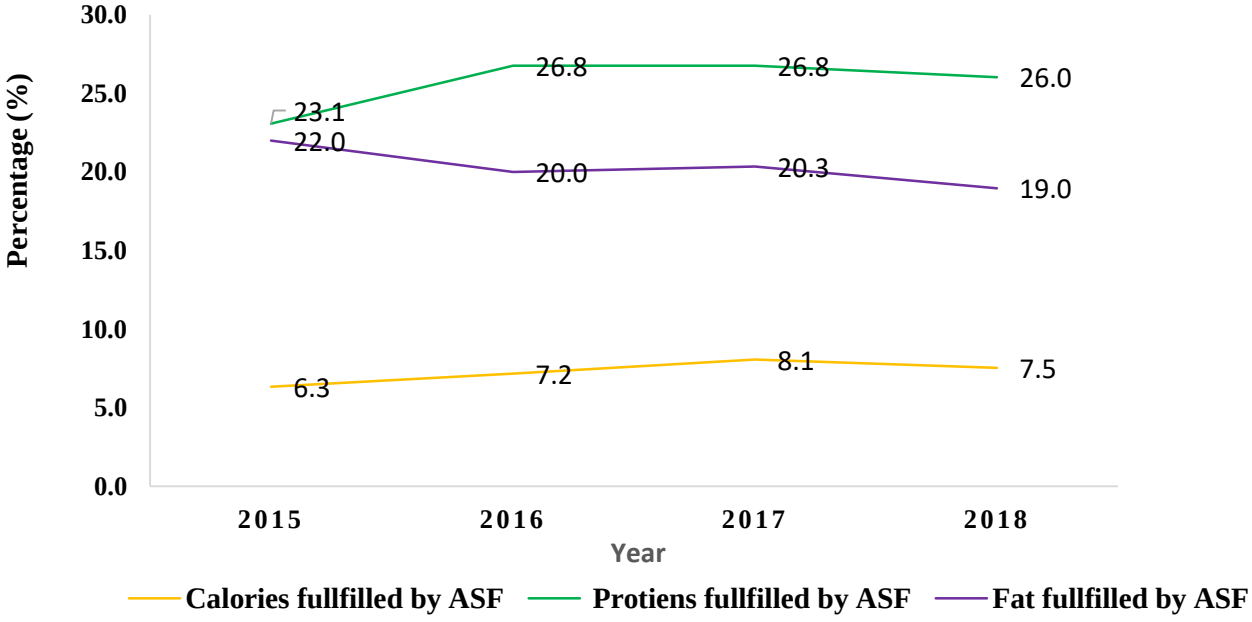

Figure 2: Per capita per day availability of Calories, protein and fat derived by ASF

Consumption of ASF is higher among households in the 10th decile which is the highest income group based on monthly income comparative to the households in the 1st decile group (Figure 3). Expenditure on ASF from the 1st decile to 10th decile was also increased (Department of Census and Statistics, 2016).

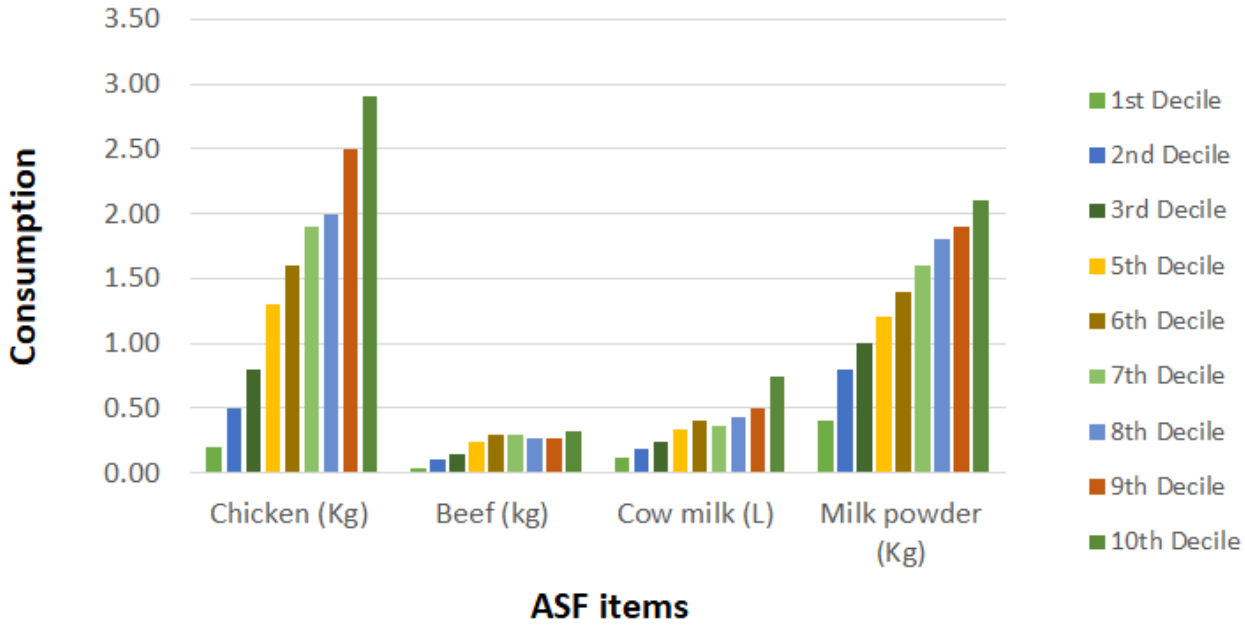

Figure 3: Distribution of Per Capita Consumption of ASF based on monthly income of households in 2016

4.1.1. Dairy Industry

Dairy animals are reared for both milk and meat production. Cattle are considered as a capital reserve and employ to help farmers over lean periods, and give greater income stability (Special Report, 2017). Cattle farming is an important source of income in the rural areas of the country. Average milk yield of the local breeds in the dry zone is around 2 liters per day, while the production of hybrid animals in the wet zone is around 6 liters per day (Siddiky, 2018; Bandara, 2000a).

Table 3: Cow and Buffalo Milk Production 2015 - 2019***

Year	Number of milk collecting Centers	Places of Production of value-added Milk Products	Average Monthly Milk Production (Liters)		Total Monthly Milk Production (Liters)	Annual Milk Production (Liters)		Total Annual Milk Production (Liters)
			Cow Milk	**Buffalo Milk**		**Cow Milk**	**Buffalo Milk**	
2015	**3,430**	**2,341**	25,945,110	5,926,890	31,872,000	311,341,320	71,122,680	382,464,000
2016	**3,503**	**2,385**	25,511,871	5,087,512	30,599,382	306,142,447	31,050,139	367,192,586
2017	**3,637**	**2,442**	27,417,600	5,741,964	33,159,627	329,011,951	68,903,569	397,915,520
2018	**3,793**	**2,350**	32,627,550	6,346,722	38,974,272	391,530,600	76,160,664	467,691,264
2019***	**3,469**	**2,199**	31,167,995	6,130,530	37,298,525	374,015,943	73,566,360	447,582,303

***-Provisional**

The annual average milk production during the period from 2015-2019 is given in Table 4. In 2019, approximately 83.56% of total milk production was supplied by dairy cows, while only 16.44% contributed by buffalo milk. Total milk production in 2018 was estimated at 467.69 million liters, which is a 17.5% increment comparative to the previous year. The growth can be resultant due to the introduction of improved cattle during 2018 (Department of Census and Statistics, 2018b). However, around a 6.3% reduction in milk production was observed due to the Foot and Mouth Disease outbreak in the second half of the year 2019 (Central Bank, 2019).

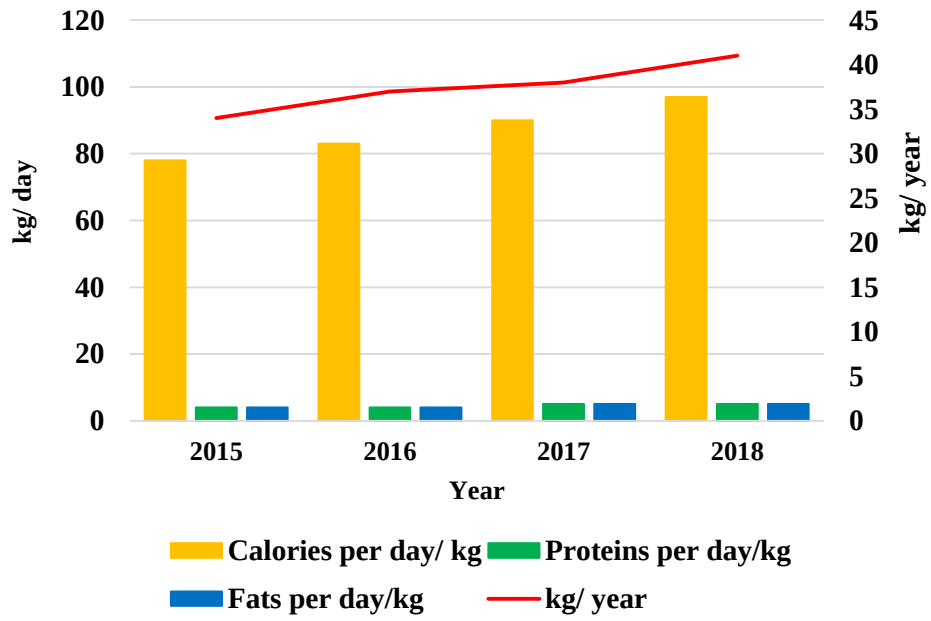

Figure 4: Per capita supply of milk and milk products

Table 4: Average monthly per capita consumption and expenditure on milk and milk products

Item	Unit	Quantity	Value (Rs.)
Cow milk	L	1.13568	113.28
Goat milk	L	0.0276	5.16
Sterilized milk	L	0.06216	9
Curd		-	202.8
Yoghurt/ Moru		-	442.2
Condensed milk	grams	0.02952	23.64
Milk powder	grams	4.18116	3440.76
Infant milk powder	grams	0.22848	318.6
Butter	grams	0.06432	84.72
Margarine	grams	0.09708	83.52
Cheese	grams	0.05064	87.36
Milk packets (liquid)	number	2	63.72
Other milk and milk products		-	57.72

The annual average per capita supply of milk and milk products (excluding butter) in 2018 was 41 kg/year; this was a 7.89% increase in comparison to the previous year (38 kg/year). Further, the supply of calories, proteins, and fat has shown a marginal increase over the past four years' time period (Figure 4) (Department of Census and Statistics, 2018b). According to the Household income and expenditure surveys, the average annual per capita consumption of milk powder and liquid milk was as 4.1 kg and 1.1 L per person, respectively. The highest consumption of milk powder was recorded from the urban sector and Western province. The lowest milk powder consumption was reported in North Western Province (Department of Census and Statistics, 2016).

There is no organized beef industry in the country, mainly due to the strong protest by cultural and ethnic groups in the country. During the last five years from 2014-2019, beef production in the country has reduced by -3.20%. Further, the consumption of buffalo meat is not widespread, and slaughtering buffalos were prohibited in the country. The per capita availability of beef has reduced from 1.55 kg/ per year in 2014 to 1.31 kg/per year in 2018 (Livestock Statistical Bulletin, 2017; 2016; 2015; 2014). In 2016, the average monthly consumption of beef was at 0.67 kg per year (Table 6).

Table 5: Annual meat production and per capita availability

Item	2014	2015	2016	2017	2018	Annual Growth rate %
Beef Production (000 MT)	33.84	32.18	31.54	29.79	28.42	-3.20
Mutton Production (000 MT)	13.40	13.50	13.50	17.40	16.30	4.33
Pork Production (000 MT)	7.08	7.18	7.28	7.89	10.47	9.58
Beef *	1.55	1.53	1.49	1.41	1.31	-0.22
Mutton *	0.08	0.09	0.09	0.12	0.075	0.71
Pork *	0.34	0.34	0.34	0.37	0.49	5.81

*Per capita availability kg/year

4.1.2 Goat Industry

In Sri Lanka, the goat production is still conducted as a traditional form mainly by the farmers in the dry zone (Livestock Statistical Bulletin, 2017). Goats reared mainly in the dry zone to produce meat (Perera and Jayasuriya, 2008). Consumption of goat milk and milk products is becoming more popular, especially in peri-urban areas with changes in food habits. Therefore, rearing goats has become popular, and the goat population has increased by 3.57% during the period from 2009-2018 (Livestock Statistical Bulletin, 2017; 2016; 2015; 2014;2013). The goat population is concentrated in the dry and intermediate zones (Livestock Statistical Bulletin, 2017). The highest population of goats (145,379) was reported in Eastern Province, and out of the total population, 50% was in Eastern and Northern provinces (Annual Report, 2018).
The annual mutton production has shown a marked increase during the period from 2014-2018. Total mutton production in 2018 was 16.30 (‘000) MT with 0.07 kg per capita availability (Table 6). Nevertheless, a comparatively slight reduction has noted in the number of animals slaughtered in 2006 (68,171) to 43,864 slaughtered in 2018. However, these data are collected only from licensed slaughterhouses. The per capita availability of mutton has fluctuated between 0.1-0.07 kg during the period from 2006-2018 (Department of Census and Statistics, 2018b Censers, 2020). However, the per capita consumption of mutton in 2016 was 0.04 kg/ per year (Department of Census and Statistics, 2016).

4.1.3 Swine Industry

The Sri Lankan swine industry is mainly located along the coastal belt known as pig belt that spans from Western to Northwestern provinces, including Colombo, Gampaha, Kalutara, and Puttalam districts (Livestock Statistical Bulletin, 2017). During the past decade, marked annual growth (10.61%) in the swine population was observed. From the total population, around 43% of pig farms are located in the Western province (Livestock Statistical Bulletin, 2017; 2016; 2015; 2014; 2013). Extensive, semi-intensive, and intensive management systems are being practiced in the swine industry (Alahakoon and Jayasena, 2016). The swine industry considered

the most profitable livestock sector due to simple management and feeding practices (Alahakoon and Jayasena, 2016). The rural farmers manage pigs in free-range systems with low input basis by feeding kitchen waste and conduct natural, controlled breeding (Dematawewa *et al*., 2009; Subalini *et al*. 2010).

In parallel, pork production has increased by 9.58% during 2014-2018 with resulting 10.47 (‘000) MT production and per capita availability of 0.49 kg/year in 2018 (Livestock Statistical Bulletin, 2017; 2016; 2015; 2014;2013). The national pork consumption data collected by Household income and expenditure surveys indicate that per capita consumption of pork was 0.09 kg/year in 2016 (Department of Census and Statistics, 2016).

4.1.4 Poultry Industry

Poultry accounts for 70% of the livestock GDP. Initially, Sri Lankan poultry sector has started as a backyard production system. Within the country, poultry is the only well-stabilized industry that achieved a self-sufficient level. The poultry industry of the South Asian region, the poultry production of the country comprises of large-scale commercial farms, buyback operations, small scale farms, and back yard system. The small-scale poultry industry and backyard system in the country mainly focused on egg production and has higher potentials in meat production (Annual Report, 2018).

In Sri Lanka, the poultry industry is the fastest growing and the most developed livestock sub-sector (Central Bank, 2019). There are three grandparent farms and nearly 33 registered breeder farms operating in Sri Lanka. Most of these large-scale companies maintain environmentally controlled broiler houses for efficient broiler meat production and thereby to meet high chicken meat demand. Management practices in these controlled houses are highly advanced, and high importance has been given on effective health management through a strong biosecurity program (Wijesinghe *et al*., 2017). The poultry population has increased from 13, 620 ('000) in 2009 to 40,640 ('000) by 2018 with an annual growth rate of 19.84% (Table 2). The broiler industry is accountable for this marked growth as there is no detectable improvement in the layer sector. Kurunagala, Kaluthara, Gampaha, Kandy, Puttalam, Anuradhapura, Ampara, and Jaffna are the key poultry farming districts. In 1980 per capita availability of chicken and egg was 0.1 kg and 38 eggs respectively, and this has increased to 9.3 kg and 132.9 eggs in 2017 (Table 7) (Livestock Statistical Bulletin, 2017). While the average monthly household quantity of meat was 22 kg and eggs 144 (Department of Census and Statistics, 2016).

Table 6: Poultry per capita availability

Items	2013	2014	2015	2016	2017
Per Capita Availability of Chicken	7.09	7.19	7.82	8.56	9.29
Per Capita Availability of Eggs	102.60	107.69	109.05	108.43	132.90

4.2 Exports of animal source food

With regard to exportation of meat from Sri Lanka, poultry accounts for the highest quantity (1,995.82 MT) in 2017, followed by beef (67.10 MT), pork (3.29 MT), and mutton (58 Kg), respectively (Livestock Statistical Bulletin, 2017; 2016; 2015; 2014;2013). Besides, there is a contribution from edible offal, preserved meat, pig fat, and poultry fat to export quantity. The bulk of the chicken meat and meat products are exported to Maldives, Seashells, UAE, Azerbaijan, Armenia, Iraq, Angola, Oman, Kuwait, Doha Qatar, Ghana, and India (Annual Report, 2018; 2017, 2016, 2015, 2014, 2013). The exports of chicken meat and meat products show an upward trend during the last five years. In addition, Sri Lanka exports poultry eggs, milk, and milk products that show a slight increase during the period from 2013-2017 (Table 8). In the year 2017, 1,089,335 kg of milk and milk products were exported (Livestock Statistical Bulletin, 2017; 2016; 2015; 2014; 2013).

Table 7: ASF exports

ASF	2013	2014	2015	2016	2017
Eggs (Mn)	3.44	4.93	4.22	4.09	4.60
Poultry Meat (MT)	1,524.46	1,964.66	1,080.32	1,473.03	1,995.82
Pork (MT)	5.1	8.44	8.42	7.31	3.29
Goat (kg)	7,076	9,210	N.A	8	58
Beef and Beef Products (MT)	70.50	79.96	72.63	67.10	61.35
Milk and Milk Products (kg)	626,570	595,063	718,765	839,611	1,048,411

4.3 Imports of animal source food

There is a notable gap between the production and demand for ASF in Sri Lanka. Therefore, to fulfill the requirement, ASF is imported from high producing countries. The domestic milk production is sufficient only to meet nearly 38% of the country's requirement (Central Bank, 2019). Therefore, in 2019 US dollars 293.5 million was spent on importation of 93,749 MT milk powder, which is a 5.3% decline compared to the 99,028 MT importation during 2018 (Central Bank, 2019; 2018). From the total imports, around 85% comprised of milk cream with fat more than 1.5% while buttermilk and curdled was the lowest (0.06%) (Livestock Statistical Bulletin, 2017). Milk is mainly imported from Australia and New Zealand (Special Report, 2017). Each year a large sum of expenditure is allocated for the importation of milk; hence, milk production capacity at the domestic level needs to be improved while finding solutions for the existing issues (Central Bank, 2019).

When considering about meat items, the highest imported product was poultry meat, followed by mutton, beef, and pork during the last ten years (Figure 5) (Livestock Statistical Bulletin, 2017; 2016; 2015; 2014;2013; Annual Report, 2012; 2011;2010).

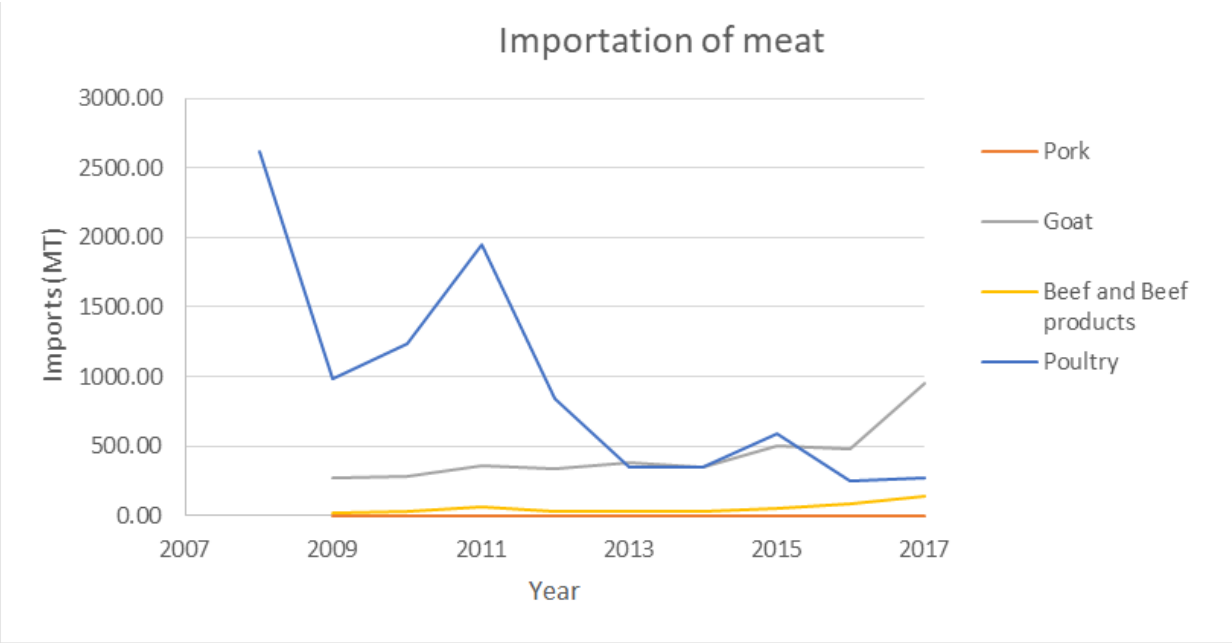

Figure 5: Importation of meat

Imported chicken consisted of chicken meat products such as mechanically deboned meat (MDM) that used for the preparation of value-added products. A drastic reducing trend was observed with poultry importation, while a slight increase in mutton importation was noted. A total of 853,948 MT of mutton and 116.8 MT of pork has been imported into the country (Annual Report, 2018). Though tables eggs were not imported to the country during the same period, liquid eggs (17.92 MT) and egg powder (13.24 MT) were imported to the country during 2018 (Annual Report, 2018).

4.4 Processing and value addition of animal source food

Around the country, there are around 2000 places that involve in the production of milk value addition. The highest number of milk value addition places (205) is located at Galle and Matara Districts (Department of Census and Statistics, 2018b) and can be due to the location of curd and yogurt processing facilities in Southern Province of the country. Large and medium-scale processors produce value-added milk products, including liquid milk, ice cream, and chocolates using modern technologies (Jayasena *et al*., 2019; Ranaweera, 2009).

In Sri Lanka, there are mainly three main classes of processed meat products, namely comminuted meat products (sausage, luncheon meats, and hot dogs), formed meat products (nuggets, meat fingers, drumsticks) and cured meat products (bacon and ham). Recently introduced marinated meat products are also becoming popular among the consumers (Alahakoon and Jayasena, 2016). In the year 2018, fifteen (15) processing establishments and elven (11) poultry further processing establishments were registered under DAPH. Estimated chicken meat production in 2018 at 214.20 (‘000) MT recorded an increase of 7% over the 2017 volume of 200.98. A total of 16, 349.05 MT meat-based value-added products were manufactured in the country (Table 9). Chicken meat-based products comprised nearly 90% of the total meat-based value-added products. Chicken sausages were the most predominantly processed meat product (Livestock Statistical Bulletin, 2017).

Table 8: Meat-based value addition

ASF	Quantity (MT)
Chicken Sausages	9,941.70
Chicken meat balls	1,720.82
Other further processed chicken	3,307.55
Total chicken-based products	14,970.07
Pork products	974.67
Beef products	308.41
Mutton products	95.90
Total	16,349.05

4.5 Marketing of animal source food

In Sri Lanka, the marketing of milk is a complex process that involves various methods. There is formal and informal marketing of milk (Perera and Jayasuriya, 2008). Some individual farmers sell directly to processors, consumers, hotels, cafeterias, and canteens. There are organized co-operatives primarily to collect and sell milk to either hotels or processors. The formal or processed dairy market consists of small primary dairy co-ops, larger local co-ops, district-level dairy co-ops, dairy co-operative unions, and networks of collection points and milk chilling centers operated by co-ops or the leading dairy processors. Most farmers are not members of co-operatives or farmer societies. There are more than 3000 milk collecting centers in the country, and the highest number is located in Kurunegala District (856) (Department of Census and Statistics, 2018b). From the total milk production of 467.69 million liters in the year 2018, 269.26 million liters were collected through the formal market while rest sold through the informal market. Around 27% of milk was collected from Central Province, while 19.8% and 17.0% were from the North-Western and the North-Central Province, respectively. There are around 14 large scale companies that perform milk collection and distribution in the formal market (Annual Report, 2018).

The private sector dominated the poultry sector with the provision of input supplies and markets. The small-scale rural farmers are provided with inputs and market their products at a pre-agreed price (Annual Report, 2018). The organized chicken processing sector supplies more than 80% of the local demand for poultry meat while rest is by the informal sector, such as live bird markets in Western, Northwestern, and eastern provinces. Branding of chicken meat products with the implementation of quality standards has progressed over the years to cater to customer requirements.

The layer industry of the country does not have a well-organized out-grower system for the marketing of eggs. In Northwest province, the key egg-producing area, small and medium scale feed mixers provide feed and supply inputs later collect eggs from farms and distribute eggs to

wholesale markets. Small scale egg producers sell 59% of the eggs to the neighbors, while more than 30% are placed at nearby markets (Hitihamu, 2017).

4.6 Pre and postharvest losses of animal source foods

From production to consumption, there can be various degrees of wastage and comparatively higher in perishable food commodities. The ASF is mainly affected by various losses at the level of the farm until reaching the consumers. The ASF can be easily contaminated with biological, chemical, and physical hazards during the production process. Only the nutritional composition and some biological contaminants are included in the available national standards. At the milk, collecting centers monitor the nutritional composition and adulterants in the milk. If any adulterants were detected, the milk is rejected. The absence of marketing infrastructure required for the dairy industry, such as chilling tanks and transport vehicles, can lead to losses in milk production (Chandrasri, 2009). The hygienic quality of raw milk produced by small-scale dairy farmers (Vairamuthu *et al*., 2010) and curd are poor (Bandara, 2000b). The established milk and poultry processors maintain quality standards and monitor the biological and chemical contaminants in the final products.

Infectious diseases in livestock animals can lead to losses in the production yield and animal population. The notifiable diseases are monitored through the Department of Animal Production and Health and take proper measures to reduce the incidence of these diseases by implementing management and health programs. Routine monitoring and vaccinations are conducted to prevent the occurrence of disease outbreaks (Annual Report, 2018).

4.7 Breeding and breeds

Sri Lankan farmers rare a variety of exotic, cross, and indigenous breeds. In the dairy industry, the commonest are crossbreds, including crosses between indigenous Bos indicus (Zebu) cattle and improved Zebu breeds from the Indian sub-continent, or between Zebu and *Bos taurus* (European/American) dairy breeds. Sindhi and Sahiwal are the famous Zebu breeds used in dairy production, while Holstein/Friesian and Jersey are the main European breeds (Perera and Jayasuriya, 2008). The Sri Lankan indigenous cattle "Batu Haraka" (*Bos Indicus* var Ceylonicus) mainly found in the low country dry zone. Murrah, Nili Ravi, Surti, and indigenous buffaloes are available in the country. Indigenous buffaloes are distributed in low country dry zone areas (Siddiky, 2018; 2015).

Most of the goats in the country are exotic breeds, mainly crosses between indigenous and Jamnapari from India and the Saanen from Europe (Siddiky, 2018; Perera and Jayasuriya, 2008). Locally improved Kottukachchiya breed is available in the country (Subasinghe, 2016). Three-way crosses (Landrace, Large white, and Duroc) are used in the large-scale commercial pig farms while crosses of indigenous pigs are used in the middle scale intensive farms and semi-intensive back yard farms (Livestock Statistical Bulletin, 2017). In rural smallholder farming, mainly exotic breed crosses with village pigs are the most popular (Silva *et al*., 2016). The registered broiler breeder farms purchase majority (more than 70%) of the chicks from the locally available Grand Parent (GP) farms. Imported commercial breeds mainly Cobb (52%), Hubbard (25%), Indian River (13%), and Ross (10%) were used in the broiler industry. Since

there are no layer GP farms, layer breeder imports Bovans-White (28%), Lohmann LSL (19%), Hyline Brown (14%) Hyline White (10%), and Lohmann Brown (10%) in the year 2017. More than 70% of the breeds lay white eggs (Livestock Statistical Bulletin, 2017). Among small scale poultry, the most prevalent breed types were white leghorns, brown leghorns (24%), and broiler species (Hitihamu, 2017).

4.8 Farmers income and pricing

At the end of the year 2019, a total of 149,390 farmers were raising livestock in the country (Table 10). Except for the poultry industry, other industries have been stagnant during the past two decades. The main reason for the slow growth in the sector is that most of the farmers function in a subsistence-based activity that provides secondary income for them (Perera and Jayasuriya, 2008).

In the year 2018 and 2019, a new segment of farmers raising improved cattle and buffalo were introduced (Table 9) (Department of Census and Statistics, 2018b) and can be attributable to the 'The Heifer Calf Rearing Project' initiated to support farmers to feed and manage heifer calves. At the end of the year 2018, a total of 25,602 calves have been registered under this project (Central Bank, 2018). At present, the dairy industry is one of the primary employments of rural poor communities. Dairy cattle provide a constant supply of revenue while functioning as a shock absorber during failures in crop production. Small scale dairy is predominant, while newly established large and medium scale dairy operations are also available (Livestock Statistical Bulletin, 2017). During the year 2019, the national average cost of production of milk increased by 7.2 % to Rs. 51.11 per liter in 2019 from Rs. 47.67 per liter recorded in the preceding year. However, the average farm-gate price increased only by 4.6% to Rs. 69.96 per liter (Central Bank, 2019). In Sri Lankan milk production, the highest cost was the opportunity cost for labor (Jayaweera *et al*., 2007), indicate the effect of the increased cost of living on the price of milk production.

A remarkable difference in the number of farmers rearing goats was noted during the period from 2015-2019 (Table 9). Among the meat items, the mutton was marketed at the highest price in Sri Lanka. During the period 2013-2018, the price of the mutton was more than Rs. 1000 per kg, and in the year 2018, the average price was at Rs. 1833.22 (Annual Report, 2018; 2017;2019;2015;2014;2013). The average cost of production of mutton was Rs. 310.24 in the year 2018 (Annual Report, 2018).

Around five thousand farmers are engaged in swine farming as their primary income-generating activity (Livestock Statistical Bulletin, 2017). The average retail price of curry pork and pork parts in the country reported as Rs. 650/Kg in the year 2018 and 2017. However, the price of loin, leg, and shoulder pork was recorded as Rs. 700/ kg during 2017-2018 (Annual Report, 2018; 2017).

Table 9: Number of Livestock farmers

No. of Farmers Raising										
	Cattle and/or Buffalo (Improved)	Cattle and/or Buffalo (Local)	Goat	Swine	Poultry					
					Local Poultry	Broiler Farmers		Egg Producing Farmers		Total
						No. of Chicken Below 1000	No. of Chicken Over 1000	No. of Chicken Below 1000	No. of Chicken Over 1000	
2015	NA	191,756	58,399	8,269	139,344	8,861	1,847	44,276	11,134	195,462
2016	NA	180,635	48,925	6,539	107,432	6,750	1,972	32,459	1,522	150,135
2017	NA	182,150	49,684	7,529	114,993	6,504	1,877	38,793	1,237	163,404
2018	59,013	126,491	56,143	5,801	114,849	9,261	2,336	29,242	1,219	156,907
2019	56,274	119,892	53,804	5,577	108,892	11,453	23,428	25,428	1,488	149,390

The number of farmers owns broilers below 1000 were increased by 23.67% in 2019 compared to 2018 while the number of farmers owns layers more than 1000 were increased by 22.07% (Department of Census and Statistics, 2018b). During the middle of the twentieth century, significant changes took place in the poultry industry, and with these changes, the average market weight of broilers has increased by about 50%. Before the 1950s, chicken meat was a delicacy in the country. With the development of the poultry sector, the product price of chicken meat and eggs has reduced in comparison to other ASF. The cost of production of chicken (dressed) has increased to Rs. 314.30 per kg in 2019, competitive to Rs. 265.85 per kg in 2018. For a large-scale egg producer, the cost of production increased to Rs. 13.70 per egg in 2019 from Rs. 12.80 per egg in the preceding year (Central Bank, 2019). When considering the small-scale poultry farmers, based on the scale of operation, the income of the farmers varied, while around 20% of the farmers received more than Rs. 50, 000 per month (Hitihamu, 2017).

4.9 Social factors for ASF

Lanka is a multi-ethnic, multi-cultural and multi-religious country with a long history and various traditions. Various social, cultural, and religious beliefs, myths, and misconceptions affect the consumption of ASF (Chandrasiri, 2002).

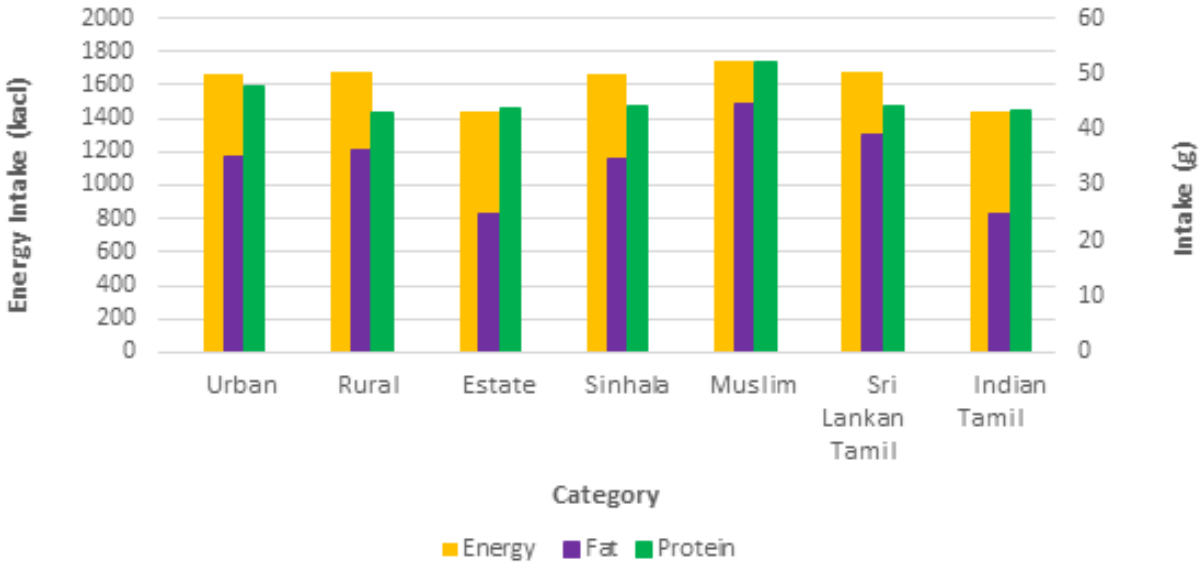

Figure 6: Food consumption among Sri Lankans

The residents in urban (47.8 g) areas had the highest intake of proteins, while the lowest was in rural counterparts (42.9 g) (Figure 6). Though the mean protein intake of Sri Lankan adults was reported as 52.8 g, comparative to males (52.8 g) female protein intake was significantly lower (40.0 g). The protein consumption among Muslims was highest and lowest among Indian Tamil (Jayawardena *et al*., 2014). Sri Lankan dietary guidelines recommend 10-15% per protein consumption from daily calorie intake (MOH, 2011). Average protein consumption among Sri Lanka adults was far below the recommended level of 57 g of daily protein intake (MRI, 2007).

Liquid milk consumption was not a strong tradition among Sri Lankans (Moll *et al*., 2007). Unlike milk powder, the consumption of fresh milk appears to have increased with income, suggesting that as incomes increase over time, demand could shift towards liquid milk (De Alwis et al., 2011; Ranaweera, 2009).

According to a study conducted in Southern Province, religion has a significant effect on the consumption of meat. None of the Muslims consumed pork, while only 12% of Buddhists males consumed beef. The most favored meat-type was chicken (84 %) followed by mutton (44 %), beef (33 %), and pork (24 %) (De Silva *et al*., 2010). The swine industry suffers from the effects of religious and social taboos. Disease outbreaks such as Japanese Encephalitis and environmental issues, including smell, noise, and solid wastes has led to the closure of piggeries. Further, government authorities hesitant to issue permits to establish pig farms in urban or high population density areas (Chandrasiri, 2002).

High consumer preference towards chicken was due to consideration as white meat and not influenced by any religious or ethnic beliefs (Alahakoon and Jayasena, 2016). From late 2009 a marked increase in the demand for chicken meat and eggs could be noted in the country (Kothalawala *et al.*, 2011). The locals tend to have a higher preference towards the consumption of indigenous chicken meat comparative to exotic varieties due to its high nutritive value and flavor (Weerahewa, 2004). Purchasing and consumption of processed meat are relatively lower in the rural market than in urban areas of the country. The consumption and purchasing pattern could be explained by the availability and price of meat or regional/cultural differences. Consumption of processed meat is higher in urban areas of the country compared to the rural areas. In addition, many of the meat processing factories prepare marinated meat products, which have become popular among consumers during the past decade. There is a higher consumer demand towards processed poultry products, particularly by the younger generation (Alahakoon and Jayasena, 2016).

4.10 Climatic change and natural resources

Rearing systems of cattle, buffalo, goat, and sheep farming is mainly depending on the climatic factors and distribution of resources (Chandrasiri, 2002). The livestock sector is categorized as a high climate-sensitive livelihood (Special Report, 2017). Rain is one of the main climatic factors that affect the livestock sector; furthermore, floods, and landslides have affected the livestock sector. Monsoon and inter-monsoon rainfall influence the cultivation of rain-fed crop products, growth of vegetation crops (animal feeding), maintain water levels in tanks and reservoirs. Some farmers grow crops used for animal feed in the paddy fields during the Yala season (Overarching Agricultural Policy, 2019).

At present, animal feed is a rapidly growing market opportunity for Sri Lankan farmers (Overarching Agricultural Policy, 2019), and maize is becoming a vital feed raw material with an estimated national requirement is around 550 000 tons (Special Report, 2017). More than 80% of the maize is produced during the Maha season. Though the maize cultivation land area has increased, the production is enough to meet only 75% of the national requirement due to low yield. Even though the paddy has reached self-sufficiency, fodder and feed crops have not been unable to meet the local requirement, and outstanding amounts are imported to the country (Overarching Agricultural Policy, 2019).

Low rainfalls affect both production and quality of crops and pasture, leading to declining in ASF production, especially milk yield. With climatic effects on paddy production, the farmers tend to sell the cattle for slaughter, and this tends to affect milk production in the country indirectly. Sometimes if the vegetable market prices are low, in highland areas, farmers tend to feed those to animals (Special Report, 2017).

4.11 Trade policies and taxes

Since independence, Sri Lanka has adopted various development strategies and policy regimes for the trading of ASF, subjected to standards established by the Sri Lanka Standards Institution. The Government of Sri Lanka (GoSL) has actively intervened with a range of trade and pricing policies on various ASF. The objectives of these trade policies were to control retail prices, protect farmers, and encourage value addition industry. In Sri Lanka, the primary trade policy mechanism has been import tariffs (Karunagoda *et al*., 2011).

Currently, there are three import tariff bands: 0, 15, and 30 percent. The raw materials, including live animals, are at zero percent, intermediate goods are at 15 percent, and finished goods are at 30 percent. Additionally, there are several supplementary taxes and levies. Other taxes are Ports and Airports Development Levy (PAL), Value-Added Tax (VAT), Nations Building Tax (NBT), and Special Commodity Levy (SCL). Locally manufactured products are subjected to VAT while exempted from SCL and PAL (Sri Lanka Customs, 2020).

Milk powder is defined as an essential food item, and the GoSL can regulate (fix, contain) its maximum retail price. With changes in the world prices of milk, to maintain the maximum retail price, the GoSL adjust the import tariff on milk powder (Sri Lanka Customs, 2020).

Trade policy on poultry sub-sector is complicated as two prices are administered along the value chain, which is a maximum retail price for chicken meat (as poultry is designated an essential food item), and a secured farm price for maize, the main feed. Influencing this value chain is import duty and cess for the maize development fund. For all these reasons, poultry policy has become controversial and complex (Karunagoda *et al*., 2011).

4.12 Gender influence

The economically active female population is higher in agriculture predominant districts, such as Nuwara Eliya (39.9%), Anuradhapura (39.7%), and Badulla (39.5%). The lowest percentage (21.9%) of the economically active female population is reported from the Trincomalee district. Female Labor Force Participation Rate is also higher in agriculture predominant districts (Department of Census and Statistics, 2018a). Rural Sri Lankan women are engaged in the livestock sector, especially dairy animals. Around 40% of members registered in dairy co-operatives are women (IFD, 2009). Women often engaged in regular activities of livestock sector such as feeding, cleaning, watering, milking, and sometimes shepherding. In contrast, men perform breeding activities and fodder production (Miller, 2011).According to a study conducted on small scale poultry farmers in the Gampaha, Puttalam, and Kurunegala districts, indicated that 61% of the poultry farmers are women who were educated up to GCE O/L and that is their primary income source (Hitihamu, 2017).

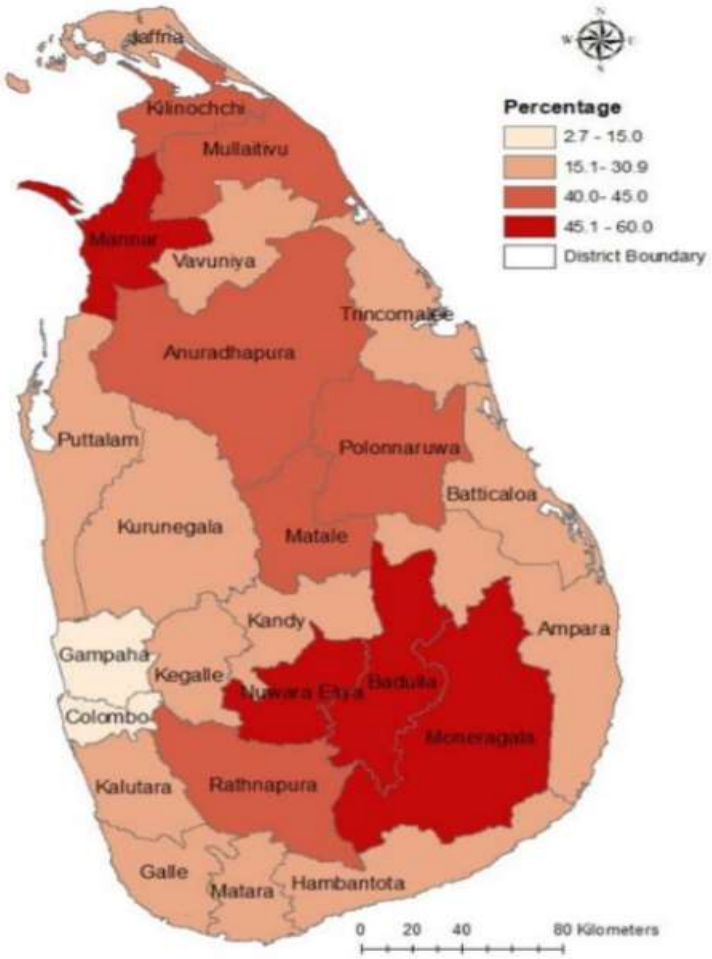

Figure 7: Percentage distribution of the employed population in the agriculture sector by districts – 2018

4.13 Nutrition-related gaps in policies, strategies, sector plans, regulations, and services

From time to time, various national policies have been introduced to uplift the livestock sector of the country. These policies mainly focused on the dairy sector for strategies such as promoting and expanding the liquid milk market; upgrading the native cattle herd, facilitating the transformation dairy producers/farmers into commercially viable and sustainable enterprises, allow market forces to govern the pricing mechanism of domestic milk and encourage the private sector dairy processors to contribute to dairy development. However, to implement these strategies need clear-long term policies backed by activities and investments. The fluctuation of ASF prices and the high cost of feed is the main limitations of the livestock sector in the country. Low farm gate price and marketing issues are major drawbacks to dairy development in the country. Further, a beef industry is not available in the country, and beef is just a by-product of the dairy industry. In 1983 completely ban the slaughter of buffaloes and female cattle. The available policies and practices are not in favor of making an income by raising any surplus stocks for beef. Famers encounter further difficulties in disposing of non-productive females and excess males. Therefore, encounter difficulties in slaughtering and marketing of animals resulted in an economic burden to the farmers. However, with the changes

in crop yield, farmers tend to sell animals for slaughter in informal markets. Few wholesale collectors control the egg market, and sometimes the price of the eggs is lower than the cost of production. As a result, farmers tend to sell premature birds and move away from the layer industry. Therefore, a mechanism should be available to assess the constraints and provide a standard price for ASF. Sri Lanka imports a substantial quantity of milk and raw materials required for the livestock industry. Changes in the food prices at the international market can have detrimental effects on national food security and the economy. Therefore, as a nation necessary to stabilize the prices of the essential ASF items to facilitates economic growth, it improves the livelihood of the farmers and enhances the welfare of the consumers.

Up to now, various, inconstant, and ad-hoc trade policies were adopted that fluctuate between delivering benefits to consumers or producers. Abrupt changes in the trade policies have led to considerable uncertainty and a lack of sustainability in the livestock sector in the country. However, the standard price and hefty import tariffs are imposed on liquid milk to ensure local food security. Especially the small-scale farmers struggle to invest in productive and sustainable practices due to lack of insurance schemes and credit programs. In Sri Lanka, the cost of production of ASF is comparatively higher. Therefore, farmers have a shallow profit margin for their products. As a result, farmers tend the move away from the animal husbandry sector, fluctuate the ASF production in the country, and the government tends to import ASF to fulfill the shortage.

In Sri Lanka, the consumption of ASF is governed by many cultural, religious, and social taboos. The communication of valid and updated scientific information on ASF to general consumers is minimal. Numerous misconceptions and false information are circulated through social media and web positing. This bogus information can lead to intolerable repercussions on different segments of the ASF supply chain. There is no proper mechanism to disseminate the correct information on ASF to the consumers.

The high population density (i.e., nearly 23 million population lives in about 65,000 square km of land) in the country has led to inadequate land distribution for agriculture and livestock. Therefore, finding lands for livestock farming has become challenging. Besides, the livestock farmers do not have adequate lands for cultivation of quality fodder, forage, and pasture. Therefore, achieving productivity targets is not realistic; the cost of production of ASF increases, leading to a low-profit margin. Ultimately, land availability affects food security and employment opportunity in the livestock sector.

The main legal instruments available in Sri Lanka to tackle the animal husbandry sector is; Animal Act No 26 of 1958 amended in 1964, Animal Disease Act No 59 of 1992, Animal Feed Act No 15 of 1986, and Veterinary Surgeons and Practitioners Act No 46 of 1956 amended in 1964. The first national cattle breeding policy was issued in 1989. Later it was revised in 1994, and 2010 was published as the 'National Breeding Policy Guidelines for Livestock in Sri Lanka' focusing on cattle, buffaloes, goats, sheep, and pigs both in state farms and in the field. These legal documents do not adequately accommodate the current nutritional requirements of the country.

The Department of Animal Production and Health is the leading institute that assists the animal husbandry sector in Sri Lanka. Farmers are provided with technical training on converting existing traditional dairy management practices using new concepts and technologies to enhance their dairy production and improve their income. State veterinaries of the Department

of Animal Production and Health are linked with the farmers to provide these services (DAPH, 2020). Since this livestock sector deals with live animals, there are a lot of risks and instability. However, there are no mechanisms for protection from these risks to the people engage in the livestock sector and resulting in instability of the ASF production.

Unlike the poultry meat, other ASF uniquely eggs are neither branded nor graded. Even in the dairy sector, hardly practice grading of milk-based on the microbial quality. The standards developed by SLSI applicable to the eggs do not include a standardized grading method in par with the international standards. There are many discrepancies in the quality standards compared with the international standards and hinders consumers with access to quality ASF. Though gender inequality is limited in Sri Lanka, still women face inequality in per capita consumption of ASF, labor participation, and participation in taking management and policy decisions.

5. Summary

In summary, the livestock sector contributes to the nutrition of Sri Lanka has few strengths but many constraints and weaknesses. The major weaknesses are low productivity, low non-remunerative producer prices for ASF, and insufficient supporting infrastructure. Especially the medium and small-scale ASF producers in Sri Lanka sometimes are not able to cover the production cost and struggle on razor-thin profit margins. Further, the producers must compete with the heavily subsidized cheap ASF imports. Therefore, local consumers encounter difficulties with accessibility to high-quality ASF products due to unavailability and cost. Social, cultural and religious barriers hinder the consumption of ASF in the country; aggravated by myths and misconceptions. These concerns should be translated into actions in the form of long-term national policies to fulfill the nutritional gaps associated with the livestock sector. Also, there are many grey areas associated with ASF in the country, which should be addressed by long-term research programs with universities and research organizations.

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Section 4

Aquaculture and Fisheries sector

1. Introduction & objectives

The objective of this section is to provide stakeholders with the information to understand linkages between aquaculture and fisheries sector in the food systems, in achieving national nutrition goals. This understanding would develop the knowledge and skills to fulfill the requirements of nutritious food to improve the nutrition situation of the population. This support is provided through this situational assessment to identify nutrition related gaps in aquaculture and fisheries sector.

2. Methodology

In order to examine how the nutritional related aspects are addressed by the fisheries and aquaculture sector in Sri Lanka, the following documents was mapped using nine criteria listed below to find information on relevant priorities:

1) Aquaculture and Fisheries production statistics/ availability for consumption/ imports/exports (2015 onwards)
2) What are the policies, strategies /trade policies and investments those influence the aquaculture and fisheries production and whether nutrition objectives and indicators are incorporated
3) Availability and promotion of sustainable fishing opportunities
4) Level of postharvest losses/management of losses and processing techniques and facilities
5) Promotion of small fish (nutrient dense) consumption
6) Opportunities and barriers of inland fish farming and aquaculture
7) Income and socio economic factors of producers
8) Gender issues and influence on nutrition at households
9) Level of input and extension services availability to increase production and consumption

A summary of the results is presented in Annexed table, and the findings are presented below. Importantly, the summaries and analysis in this section are based on documents that were available online. For some of the criteria a number of documents were not available.

3. Inclusion & exclusion criteria of evidences

A comprehensive literature survey was conducted giving special emphasis in finding the online literature published after 2015 by using following keywords: food security; nutritional security; Sri Lankan fisheries sectors; fisheries contribution; gender issues; nutrition at households; inland fisheries; culture based fisheries; market chain analysis and nutritional values of fish species.

The entire article was selected if it 1) published by an authorized body or reputed journal 2) original study (when duplicate materials were found the best-documented material were only included while excluding the other) 3) reliable. Newspaper articals, magazine articles and non-reliable web blogs were excluded in the review. When information was scanty materials which were published before 2015 and published conference papers were also included for this review.

4. Evidences & analysis

4.1 Aquaculture and Fisheries production statistics/ availability for consumption/ imports/exports (2015 onwards)

According to the FAO (Food and Agriculture Organization of the United Nations), fish are the most widely traded foods in the world, with about 50% coming from developing countries. Today capture fisheries and aquaculture provide 3.0 billion people with almost 20 percent of their average per capita intake of animal protein, and a further 1.3 billion people with about 15 percent of their per capita intake. This share can exceed 50 percent in some countries (HLPE, 2014).

Sri Lanka's population consumes relatively large amounts of fish, which is an average of 11.8 kg/yr, in 2017 while 582,000 people (3.7 % of the workforce of the country) find direct or indirect employment in the fishing industry in 2017. The marine fishing population consists of 190,000 households and 221,000 thousand active fishers spread out along the coastline. In addition 48,900 fishing households and 54,450 active fishers are engaged in lagoons and inland water bodies. The total fisheries dependent population has been estimated as 2.7 million, including fishing; processing and marketing engaged with both commercial and small-scale fisheries sectors (Fisheries statistics, 2018).

The percentage contribution of Sri Lankan marine fishery production remains highest than the recently blooming inland fisheries (Figure 1). According to total value of Sri Lankan marine fish production in 2017 was US$ 512638 which comprises 1.2% of total Gross Domestic Product (GDP) of the country but 13.54% of the production value as the percentage of agricultural GDP (Fisheries statistics, 2018). Total exports quantity of Sri Lankan marine fishery products was 25,000 Mt which value 37,000 million LKR in 2017 (Fisheries statistics, 2018). The FAO estimates that the net value of fish exports from developing countries in 2011 was over $20 billion which is greater than the net exports of rice, coffee, tea, tobacco, and meat combined (World fish center, 2011).

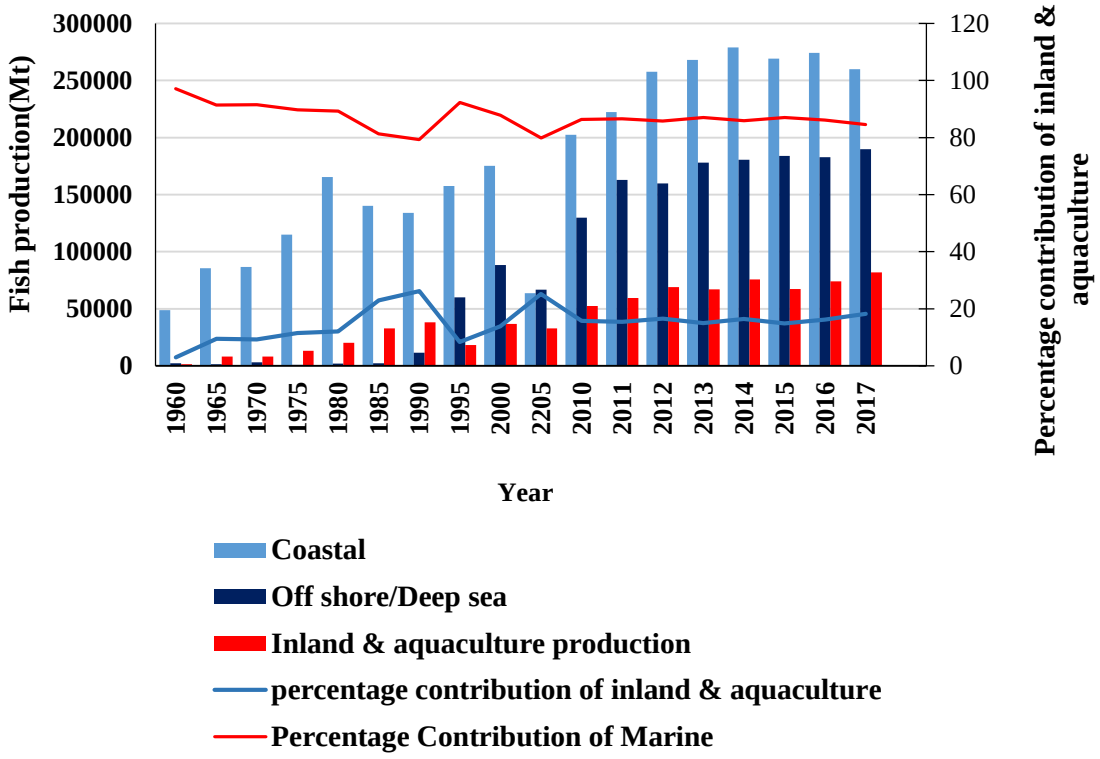

Figure 1. Contribution of fishery production from coastal; inland aquaculture and offshore/deep sea fisheries: total quantities and percentage contribution (Graph constructed using data from Fisheries Statistics 2018)

Sri Lanka's 'large scale' fisheries is confined to the 'off-shore and deep sea' sub-sector (Figure 2), consisting of a fleet of 4,218 multiday crafts, length varying from 32 ft to 45 ft, rather small-scale crafts in comparison to fisheries of developed nations. Yet, a clear distinction exists between this fleet from the rest; owned generally by non-fishing investors, use hired labour, targeting expensive fish like tuna and producing for the export market. In 2017, contribution of tuna to fish exports in volume was 53.5% (Fisheries statistics, 2018). In contrast, Sri Lankan 'small-scale' fisheries make an important contribution to nutrition, food security, sustainable livelihoods and poverty alleviation. Despite this significant contribution, the issues constraining the sustainable development of small-scale fisheries (SSF) remain poorly understood" around the world (FAO, 2019). Sri Lanka is no exception to this rule.

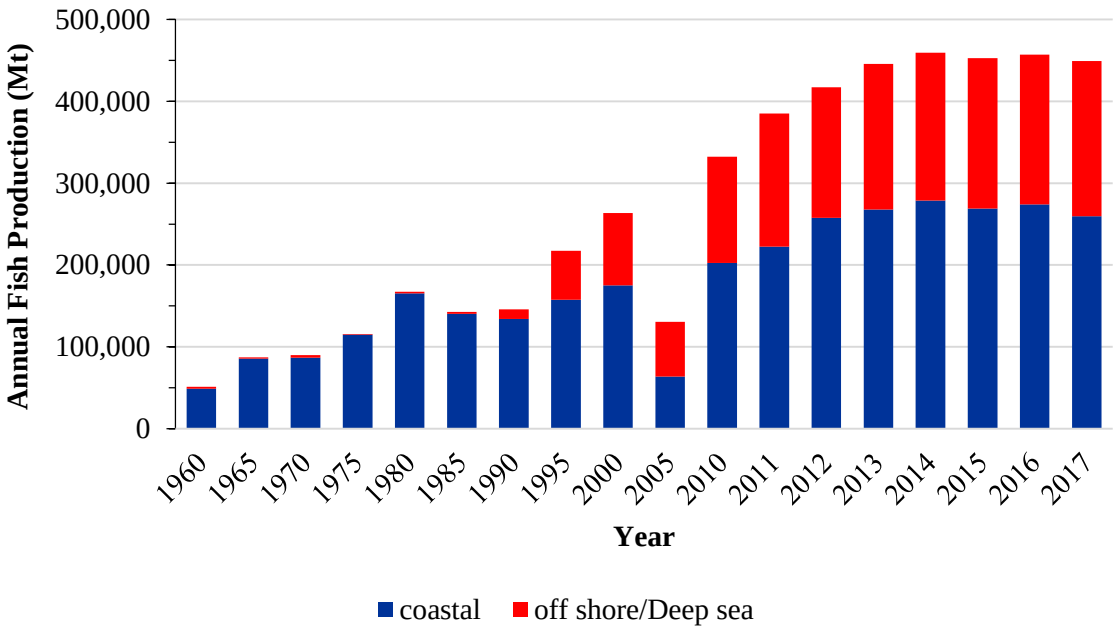

Figure 2. Contribution of fishery production from coastal; and offshore/deep sea fisheries (Graph constructed using data from Fisheries Statistics 2018)

Sri Lanka's aquaculture is of fairly recent origin. Despite large fresh water and brackish-water resources, only marine shrimp aquaculture has been developed to a certain extent. About 17,000 are actively involved in the aquaculture sector. Nevertheless, shrimp and finfish production is growing. Today, the country's main focus is to start small-scale aquaculture, aiming at supporting rural communities with income and food security.

Inland fisheries contributes significantly to the food and nutritional security in the rural areas of the country. Total inland fish production in 2019 was reports as 90,580 Mt (https://www.naqda.gov.lk). Inland and fresh water aquaculture fish production together contributed 18% of the total fish production in the country (Figure 3).

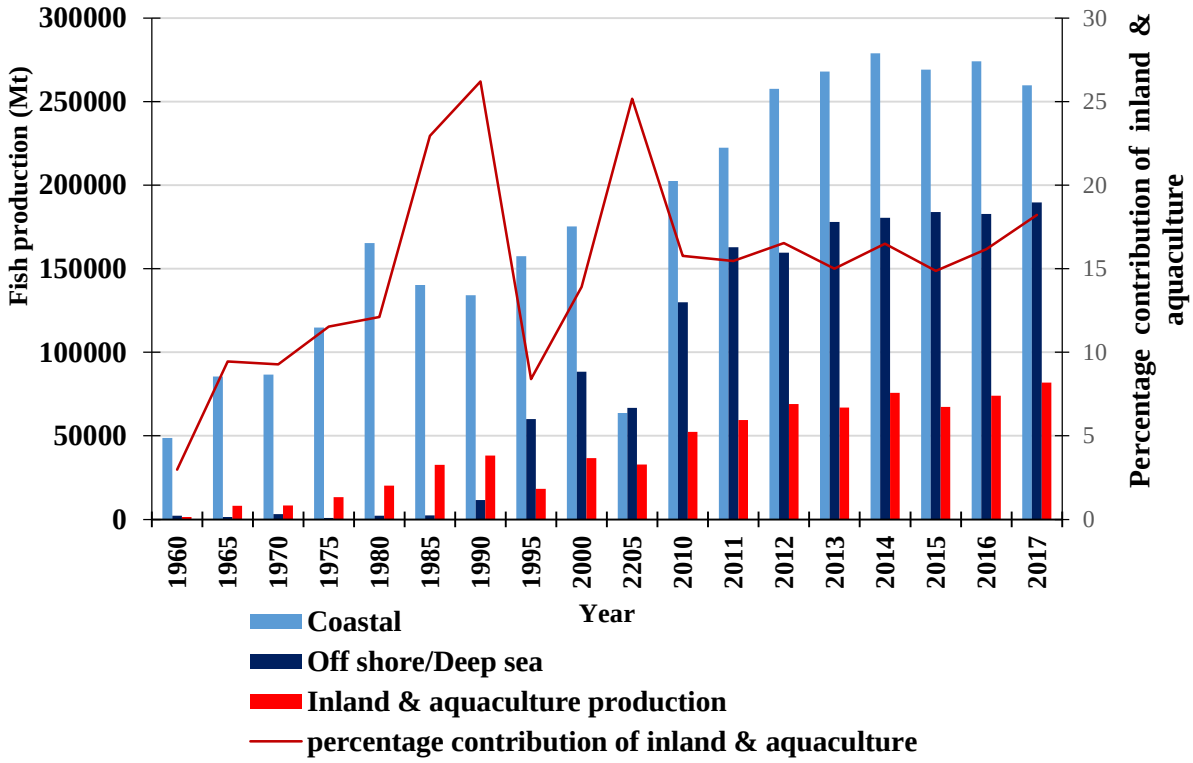

Figure 3. Contribution of different fishing sub sectors for the total fish production of Sri Lanka and the percentage contribution of inland fish and freshwater aquaculture to the total fish production of the country. (Data sources: Ministry of Fisheries 2018 and NAQDA)

Inland fish production has a steady growth from late 1990s due to government support, development and improvement of aquaculture techniques, management strategies in reservoirs and effective aquaculture extension in the country (Figure 4). Although, fish production is in increasing phase due to climatic influences; mainly changes in rainfall (distribution and intensity) creates changes in the total inland and aquaculture fish production (Figure 5). Fluctuations in fish production may impact on availability of the fish and the price of inland fish, which can negatively influence the fish consumption and flowed nutritional security of the rural communities.

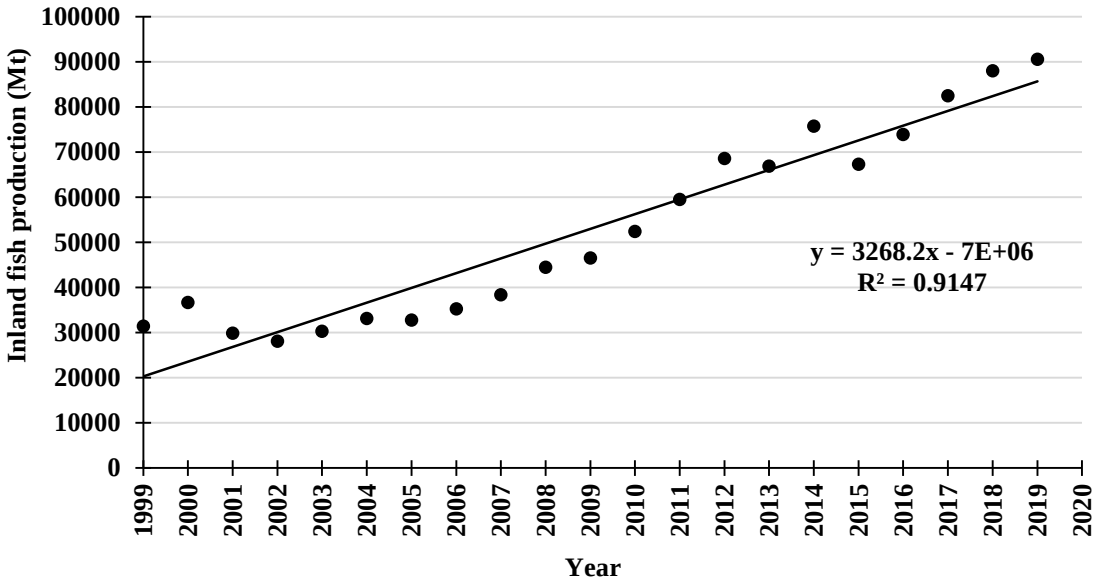

Figure 4. Inland fish production of Sri Lanka. (Data sources: Ministry of Fisheries 2018 and NAQDA, https://www.naqda.gov.lk)

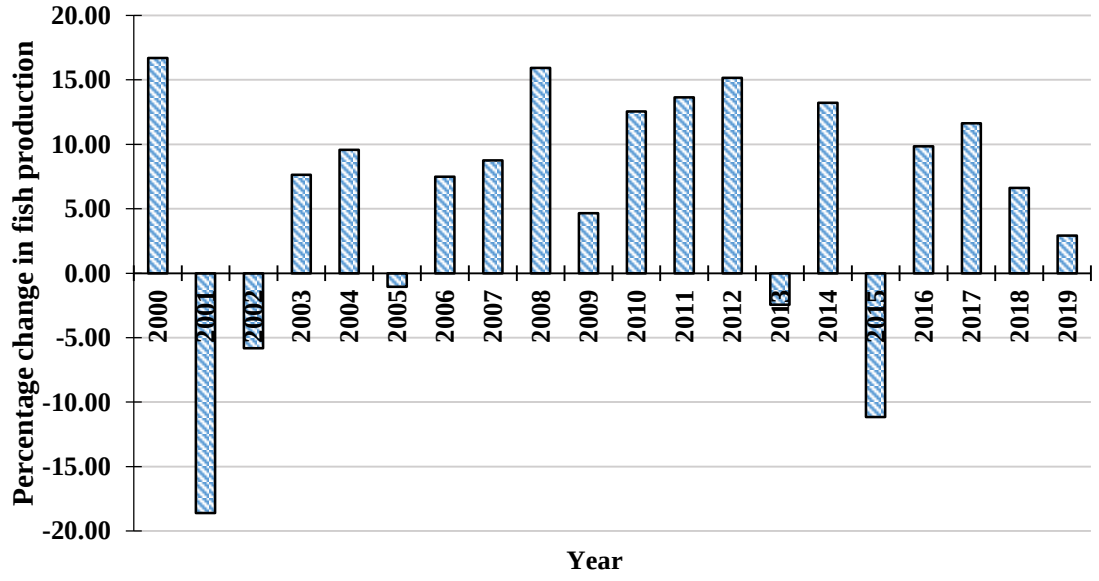

Figure 5. Percentage change of inland fish production compared to the previous from year 1999 to 2019 (Data sources: Ministry of Fisheries 2018)

Monthly fluctuations of the inland fish production clearly indicates a significant increase of fish in the period of July to October (Figure 6). This fluctuation changes the inland fish prices and the availability of fish in the market. During this period, increased availability of fish may increase the daily fish consumption. This annual fluctuation occurred due to the high catch ability of fish

at reducing water in reservoirs. Harvesting of seasonal reservoirs during the same period also have an impact on increasing fish supply to the markets.

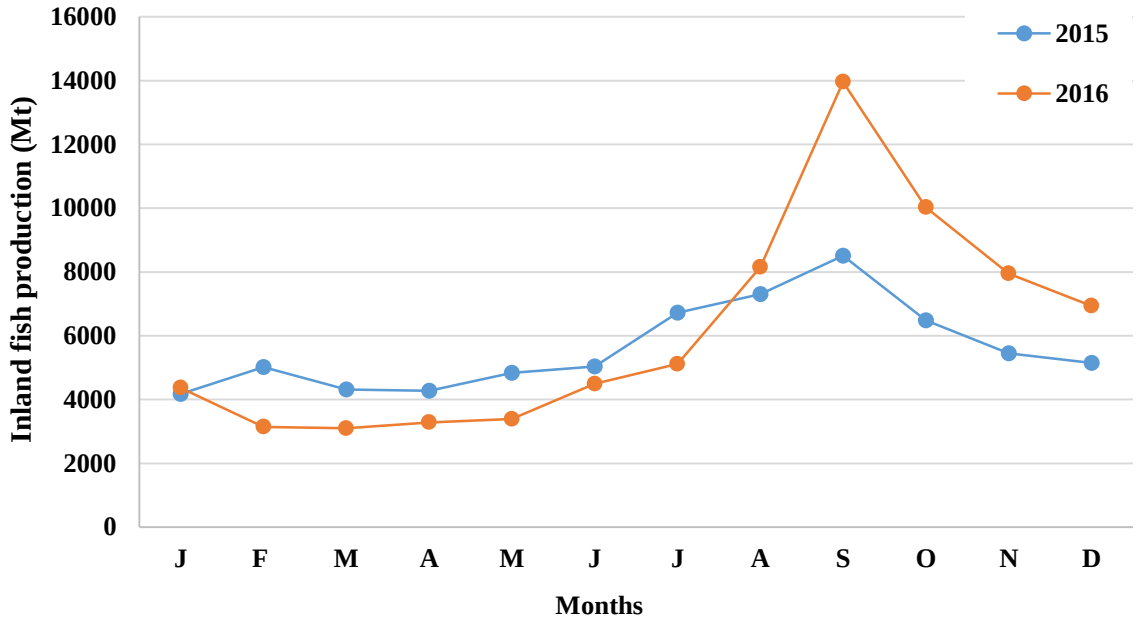

Figure 6. Distribution of inland fish harvest in year 2015 and 2017 (Data source: NAQDA, https://www.naqda.gov.lk)

It is important to noticed that the regional distribution of inland fish production. More than 80% of the inland fish production is coming from the districts, which are suffering from poverty and malnutrition (Figure 7). When considering the inland fish consumption in the country majority of fish are consumed by the rural communities where fish is produced (Amarasinge and Nguyen. 2010). According to (Sachini Perera and Wijenayake 2017) at the landing site markets, priority has given to the community members coming to the landing sites and the second priority has given to local fish venders, who were selling fish in the local areas around the reservoirs. In some reservoirs the reduced prices were defined for local communities. This may facilitate the increase consumption of fish in the rural areas.

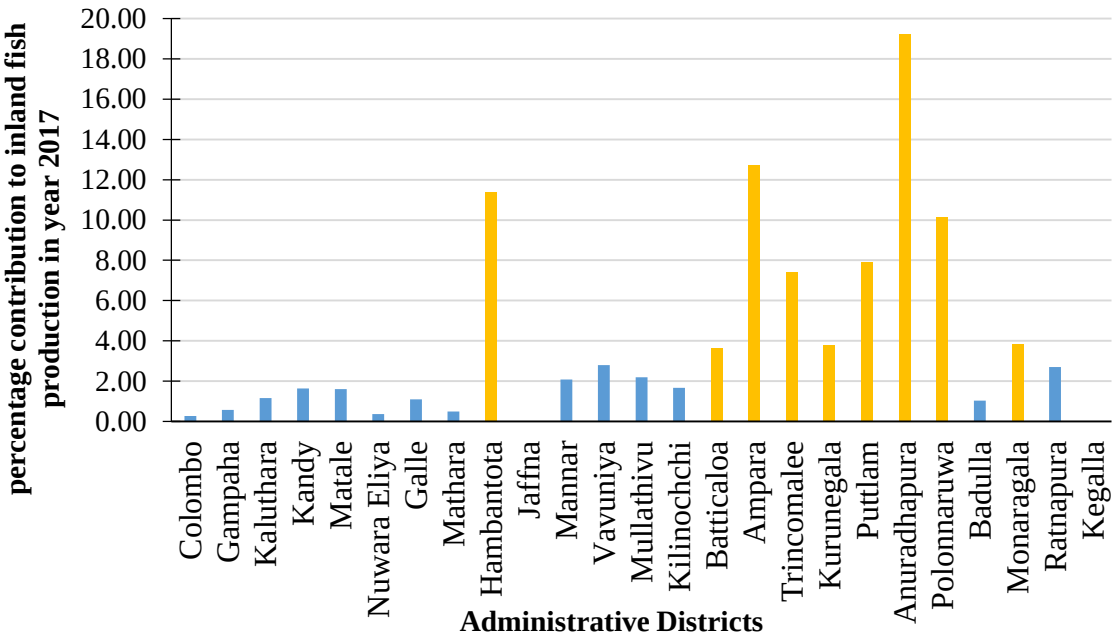

Figure 7. Percentage contribution of different administrative districts for inland fish production in year 2017. Note: the yellow color bars represents the districts produce more than 3000 Mt per annum. (Data source: Ministry of Fisheries 2018).

Administrative districts produced more than 3000 Mt are colored in yellow color and these nine administrative Districts were contributed the 80% of the total inland production.

Inland fish production of the country is dominated by the exotic species and the figure 8 illustrated the estimated fish species composition in inland fish landings of the country in year 2017 (Ministry of Fisheries 2018). Tilapia is the dominating species in fish landings and major Indian and Chinese carps and common carp together produces the second highest contribution. Tilapia, introduced carp species and local fish species contributed 50065 Mt, 12685 Mt and 19120 Mt to the total inland fish production respectively.

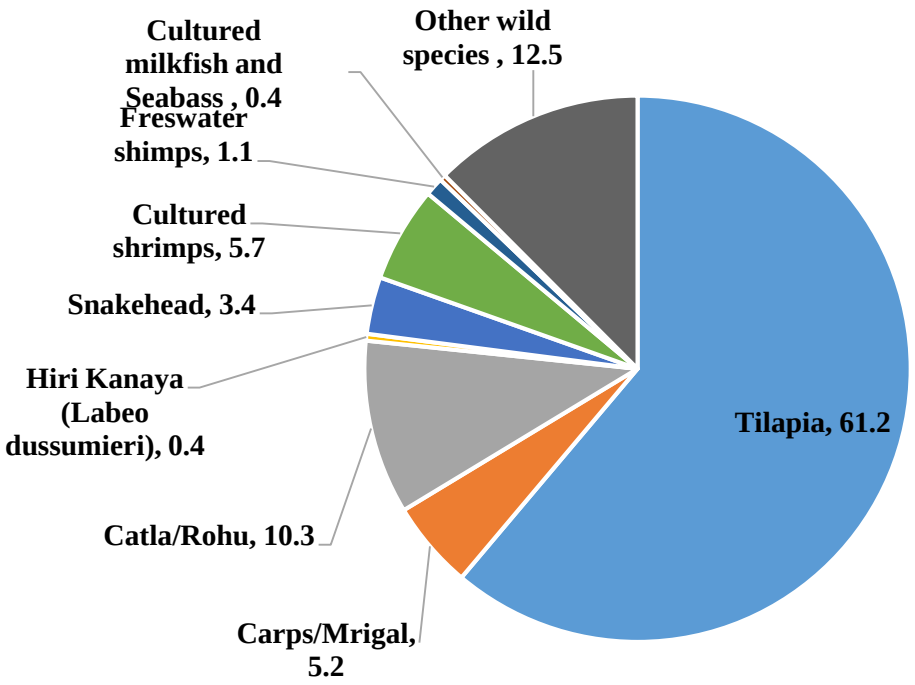

Figure 8. Percentage composition of fish species in inland fish landings in year 2017. (Data source: Ministry of Fisheries 2018).

The entire inland fish production of the country is utilized for the domestic consumption. There is an increasing demand developing for the Giant freshwater prawn (GFP) in inland water bodies. At present three exporters are exporting giant freshwater prawn (Pushpalatha 2019). It was reported that 896 Mt of produced freshwater prawns in the country and 115 Mt had exported in year 2017. The uniqueness of the Sri Lankan GFP is the large size. The average farm gate price per 1kg of GFP varies 900–1200 of Sri Lankan rupees. Government concern has drawn to enhance the GFP production in inland water bodies as a strategy to increasing the income of inland fishers.

Freshwater pond fish farming attempts were started in early 1980s but were failed. During the period of 2011-2014, Government of Sri Lanka through Ministry of Economic Development attempted to develop backyard/home garden ponds with the objective of enhancing nutrition and to provide supplementary income and livelihoods for rural communities (Pushpalatha et al. 2016). Total area of 105.4 ha of fish ponds were constructed under this project in Gampaha, Puttlam and Ampara districts. However, still freshwater aquaculture is at a primary stage in the country. The use of abandoned shrimp farms in North-western coast line have drown interest with stocking all male tilapia, red tilapia and saline tilapia during past few years.

4.2 Policies, strategies /trade policies and investments those influence the aquaculture and fisheries production and nutrition objectives and indicators incorporated

The contribution of fisheries and aquaculture to food security and nutrition now and in the future is driven by many interactions between several environmental, development, policy and

governance issues. Ministry of Fisheries and Aquatic Resources Development (MFARD) has the responsibility of development, management and supervision of the fisheries and aquaculture sector of the country. It formulates the national fisheries development policy, strategy and the implementation plan about every 6 year. The current National Fisheries and Aquaculture Policy has been developed in 2018 and the previous policy had been established in 2004. The Government envisages achieving the following objectives from implementation of the Policy developed in 2018 for the fisheries and aquaculture sector (Ministry of Fisheries and Aquatic Resources Development, 2018).

1. Sustainable management of resources using science-based information
2. Compliance with regional and international obligations
3. Increased marine fisheries production
4. Increased aquaculture and inland fisheries production
5. Minimized post-harvest losses and increased value addition
6. Increased per capita consumption of fish
7. Increased export earnings
8. Improved opportunities for leisure, employment and enterprises development
9. Improved socio-economic conditions of the fisher community.

There are nine policy objectives in the National Fisheries and Aquaculture Policy-2018 of Ministry of Fisheries and Aquatic resources of Sri Lanka. The policy is based under five areas, i.e. marine fisheries, aquaculture and inland fisheries, consumers and markets, blue economy, and other areas. Policies applicable to marine fisheries and aquaculture and inland fisheries are listed as follows; sustainable management of resources, strengthening of governance, increasing of fish production, compliance with regional and international agreements, infrastructure facilities, fishing vessels and safety at sea and occupational safety.

According to the fisheries and aquaculture policy sound steps were taken to promote the fisheries production in the country. The main policies targeted the increasing fish production are coming under the area of marine fisheries and aquaculture and inland fisheries. According to the National fisheries and aquaculture policy 2018 of Ministry of Fisheries and Aquatic Resources, inland fisheries and aquaculture had identified as a viable sector for increasing national fish production. In the act following aquatic resources are categorized under inland aquatic resources; lagoons, estuaries, rivers, perennial and seasonal reservoirs, and villus (flood lakes). Sustainable management of inland aquatic resources, sustaining of governance and increasing of fish production are the three policies under inland fisheries and aquaculture, under area 4.2 in the policy document.

Policy aspects related to food security and nutrition, is coming under the area of consumer and market and common for the marine and inland sectors. . There are three polices stated under this section namely: food security, food safety and nutrition; elimination or minimizing of post-harvest

losses; and increasing of exports. Food security, food safety and nutrition; elimination or minimizing of post-harvest losses are directly related to the food and nutritional security. These two policies together provide provisions to create employments, ensure quality and food safety, promote consumption of fish, fish storage during gluts periods and managing price during lean periods, traceability and transparency along value chain proceeds, and develop quality infra structure facility for production and value chain. The fisheries policy adequately provides opportunities to achieve the four pillars of food security assuring the availability, access, utilization and stability of fish and fisheries products.

There are several legislations related to inland fisheries and aquaculture. Some details of the most influential acts are briefly indicated here. The Fisheries and Aquatic Resources Act No. 2 of 1996 (as mended by Act No. 4 of 200, No, of 2004 No.35 of 2013, No.2 of 2015 and No.2 of 2016): address the regulation, conservation and development of fisheries and aquatic resources are addressed in which comprises a number of regulations and provides for conservation and management at both national and regional. In relation to the inland fisheries development and aquaculture, National Aquaculture Development Authority of Sri Lanka Act, No. 53 of 1998 and the Agrarian development ACT, No. 46 of 2000 are important documents. The establishment of National Aquaculture Development Authority (NAQDA) was done under Act No. 53 of 1998 and the authority to promote aquaculture and inland fisheries development activities were given to NAQDA under this Act. Under Agrarian Development ACT fisheries activities in reservoirs had identified as agriculture activity, which supports to conduct fisheries activities in seasonal reservoirs by harmonizing the paddy farming community with aquaculture committees. Puspalatha (2019) listed 11 related Acts are to fisheries and aquaculture development.

The Fisheries and Aquatic Resources Act, No. 2 of 1996, is the principal legal instrument governing the fishing industry of Sri Lanka. This Act replaced the Fisheries Ordinance of 1940 and all the amendments to it. The main objectives of the Fisheries and Aquatic Resources Act are the management, conservation, regulation and development of the fisheries and aquatic resources of Sri Lanka. Under Sections 31 and 32 of the Act, fisheries management areas and fisheries management authorities have been introduced to manage the fisheries resources of the country. By 2004, seven management areas had been declared under the Act for the management of fisheries resources through community participation. In addition, resource conservation and regulatory functions were also identified and regulations introduced. Areas addressed included registration of fishing craft; Fishing operation licenses; prohibition of destructive fishing practices and dynamiting of fish; prohibition or regulation of export and import of fish; declaration of closed and open seasons for fishing; declaration of fishing reserves and Aquaculture management licenses.

All these fisheries policy and fisheries Act have been mainly concentrated on sustainable management of resources, strengthening of governance; increasing of fish production; compliance with regional and international agreements; infrastructure facilities; fishing vessels and safety at sea and occupational safety which ultimately ensure the enhancement of fishery production in a sustainable manner. These ultimate objectives will contribute for food security of the nation. In

addition the “Blue Economy” economy aspects will ensures the sustainable use of ocean resources for economic growth, improved livelihoods and jobs, while preserving the health of marine and coastal ecosystems which will also ultimately cater for food security. Anyhow policies to ensure “consumers and markets” have specifically address food security, food safety and nutrition (See Ministry of Fisheries and Aquatic Resources Development, 2018).

4.3 Availability and promotion of sustainable fishing opportunities

In addressing the growing demand for fish by the increasing population impose pressure on natural resources and challenge the sustainability of fishery resources and aquaculture development. Moreover, the roles and contributions of the various actors (fishing communities, smallholders, politicians and fishing companies, etc.) in this highly diverse and heterogeneous sector, creates significant pressure in achieving sustainability goals. In this context, recognizing the importance of fish for food security and nutrition and how to maintain the balance between sustainable resource usage while maximizing profit need extra care in picking correct management strategies in achieving the SDG 2030.

Poor fisheries management, lack of managed access and illegal fishing have been reported to threaten the natural productivity of coastal waters, the most productive areas on earth. Unsustainable fishing practices are mainly caused by anthropogenic pressures rather than natural causes. High rates of resource exploitation, unregulated technological change, increasing fishing pressure, etc. are the main causes of threats to aquatic ecosystems, leading to resource degradation. Unsustainable fishing have led to over exploitation of resources and destruction of habitats of the fishery resources and incidental catching of non-targeted fish creating serious issues in food security. For sustainable management of marine fisheries, Illegal, Unreported and Unregulated (IUU) fishing is treated as actions, which do not comply with national, regional or global fisheries conservation and management obligations. According to the definition of the FAO international plan of action to prevent IUU includes deter and eliminate IUU fishing activities conducted by national or foreign vessels in waters under the jurisdiction of a state (i.e., exclusive economic zone or EEZ), without the permission of that state, or in contravention of its laws and regulations (FAO, 2001). The IUU fishing is a major threat to the sustainable management and conservation of world fisheries (Petrossian, 2015).

Monitoring, control and surveillance (MCS) of marine fisheries, which is the mechanism for implementation of agreed policies, plans or strategies for oceans and fisheries management (Flewwelling, 1995), has been recognised globally for sustainable management of marine fisheries. Even in Sri Lanka, a logbook monitoring system was introduced in 2012, as part of MCS of multi-day fishing. However, Sri Lanka failed to fulfil the international standards for preventing IUU fishing. As a result, European Commission (EC) issued a ‘yellow card’ and “red cards” to Sri Lanka subsequently in in November 2012 and January 2015 under the legal provisions of EC Council Regulation No. 1005/2008 with regard to export of fish and fishery products to EU countries. Subsequent impact of these banning were alarming and cause huge pressure on foreign

income generation and even food security. On the other hand, even the massive fish harvest taken out from Sri Lankan waters by the thousands of illegal trawlers of the neighboring country have been created serious food security issues due to rapid depletion of marine resources; habitat destruction and threatening the livelihood of fishers specially small-scale fishers in Jaffna peninsula (Yogarajah, 2017).

Issues of IUU fishing or the use of banned and destructive fishing gear and methods which will degrade the resources and habitats in the long run and cause livelihood issues to the poor and vulnerable. In contrast, another serious threat on the food security is cause by pollution. Highly polluted waters, mainly due to human activities and subsequent results of creating algal blooms, dead zones and ocean acidification will directly affect on the sustainability of marine resources and subsequently the food security.

The importance of the sustainable development of fisheries for the food security and nourishment, specially poor nations, has been fully-realized and documented. The role of offshore/multiday fisheries for the sustainable development food security of the country has been formulated by the FAO by developing guidelines for responsible fisheries (FAO, 2012). Even the FAO has developed a vision for small-scale fisheries.

Under fisheries and aquaculture policy the sustainability of the inland fisheries has given a sound attention. The viability of inland fish production sector depends on the decisions of sustainable management. During early 1980s CBFs development in seasonal reservoirs was initiated. The increased attention on inland fisheries development in the country have drawn the research interest of universities, research organizations and NGOs. Several foreign funded research grants were obtained for the development of inland fisheries in late 1990s and the beginning of this century. GTZ sponsored Fisheries Community Development and Management Project during 1999-2004, FAO supported special programme for food security during the period of 2002-2008, Australian Centre for International Agricultural Research (ACIAR) funded research for scientific management of reservoir fisheries of Sri Lanka during 2001-2006 and Asian Development Bank-funded "Aquatic Resources Development and Quality Improvement Project" (ARDQIP) during the period of 2002-2009 are some examples (Amarasingeh and Wijenayake,2015 and Chandrasoma and Pushalatha 2018). Result of these projects had positive influences on the development of technologies, management strategies in reservoir fisheries and development of infrastructure facilities for in inland fisheries and aquaculture. Chandrasoma et al. (2015); Chandrasoma and Pushpalatha (2018); Pushpalatha et al. (2009); Pushpalatha et al. (2015a and b); Pushpalatha et al. (2017), have reported the establishment of effective co-management strategies for reservoir fisheries management, increased fish production and increased income of reservoir fisheries communities during two decades of time. Sustainable fishing opportunities in inland aquatic resources are mainly assured through strengthening co-management and community based management systems (Chandrasoma and Puspalatha 2018). Also government subsidy schemes for inland fishing fleets, technical support by aquaculture extension, training opportunities for fishers on different aspects of inland fisheries management, coordination among key institutions through

aquaculture extension services and develop partnerships and collaboration of private sector had significance influence on the improvement of inland fisheries (https://www.naqda.gov.lk).

Fish seed or stocking materials for enhancement and aquaculture is a constraint over many parts of the world. In Sri Lanka, all fish species used for CBFs and aquaculture are being bread under controlled conditions in government hatcheries. Fish post larvae or fry stage is sold to outside for nursery rearing up to fingering size. Improvement of fingerling production and production of Giant freshwater prawn post-larvae through Government owned NAQDA hatcheries and promotion of community based mini-nurseries and private sector participation in fingerling production have significant influence on fish seed production. According to the NAQDA statistics and ministry of fisheries (2018), 67% of fish fingerlings were produce in private and community based mini-nurseries in year 2019. The total number of 59.42 million fingerling were produced by these two sectors in year 2019. Fingerling production was also promoted in cages and pence in reservoirs and mainly fisheries societies are involved in this activity with the objective of reducing the cost for seed materials. Fingerling production has now developed as an alternative livelihood opportunity in rural areas and women participation in fingerling rearing have been observed as a family business (Amarasinghe and Wijenayake 2015).

In order to achieve the sustainability of inland fisheries and aquaculture Sri Lanka has developed various links with regional, intergovernmental and international agencies (Puspalatha, 2019). The main objectives of these links to transfer and improve technologies, develop human resources, obtaining financial assistance and promoting fisheries and aquaculture in the country.

Fisheries welfare is important for the promotion of fisheries activities. There were several such activities were launched to ensure the social welfare of fishing communities in Sri Lanka during recent past. Fishers' community organizations, which have been commencing from 2010 aimed at providing assistance for fishers and their families. The "Diyawara Diriya" concessionary loan scheme, with a subsidy from the Ministry of Fisheries, was introduced in 2010 with the support of the Bank of Ceylon. An insurance scheme has been introduced by the Ministry of Fisheries for fishers' welfare. The Ministry of Fisheries initiated a development programme called "Wawak Samaga Gamak" for the socio-economic enhancement of the fisher community across Sri Lanka in 2016 (Atauda et al. 2015)

4.4 Level of post-harvest losses/management of losses and processing techniques and facilities

It is well known that, post-harvest losses in fisheries remain considerably high; rough estimates indicating losses as high as ~40% of the fish harvested causing serious losses in income thus, a considerable interest in the post-harvest sector has emerged. Therefore, efficient post-harvest handling of fish is an important not only in reducing post-harvest losses, but also in providing a quality fish product at affordable prices to the nation.

Postharvest loss reported to be take place in all stages along the market chain since the onboard handling to the consumer level. Issues in post-harvest handling can broadly be categorized into thee; pre-harvest, landing site and post-harvest. Lack of on-board preservation facilities is the only

issue highlighted during the pre-harvest stage while at the landing site several issues could contribute for postharvest loss, which includes, shortage of labour for removing fish from the nets, lack of cold storage facilities on the beach, absence of electricity and water in most landing sites, absence of facilities for waste removal and poor sanitation. Off the landing site issues included (except marketing), lack of space on the beach for fish drying, lack of technological knowledge, the dilapidated condition of roads and problems of transportation of produce could contribute for postharvest loss. But unfortunately comprehensive studies in analyzing the postharvest loss along the value chain are rare for the Sri Lankan context unless a symposium presentation of Saranhi et al., (2017).

With more and more value being added to fish that have been landed, to reach the final consumer in the form of diverse products, from fresh fish to a range of fish products significant post-harvest losses has been reported. It has been reported to generate around 50-70% of fish waste materials within the various preparation steps from catch to consumption, depending upon the level of processing and type of fish (Kittiphattanbawon *et al.*, 2005). Most of the off shore fish catch in Sri Lanka, mainly tuna, are and exported after processing. These processing requires the removal of damage muscle parts, skin, bones fins and scales (Nagai and Suzuki, 2000). Although the nutritional value of fish skin, bones and fins are also nutritionally high as the edible part, only a limited attention has been given for its utilization (Nagai & Suzuki, 2000). In addition process of drying fish, has also been a key component in the fish value chain, as the processing activities are done by most of the coastal communities. Dried fish making (both dried fish and *maldive* fish) has been traditionally undertaken by women, providing fishing families with an important source of supplementary income. Thus, contribution of dried fish making towards food security, nutrition, sustainable livelihoods and poverty alleviation is significant. Moreover, fish processing has also provided women fisher folk with avenues of employment and empowerment. But poor status of the dried fish industry and the poor quality of products; obsolete technology and poor hygienic conditions maintained at processing sites seems to be the main critics (Saranhi et al., 2017). Thus, few programmes have been implemented by the Ministry include: training of fisher communities in production of fish-based products (dry fish, Maldive fish, Jaddi and smoked fish) as a livelihood option; encouraging domestic fish canning; encouraging the domestic production of fish and fisheries product through the Divineguma programme in collaboration with the Ministry of Social Welfare; and conducting awareness programmes for target groups to enhance the consumption of fish and fisheries products through the Ministry of Health (WFP, 2017).

Information of postharvest losses of inland fish in the county is scant in the published information. According to (Perera, 2017) minimum post-harvest techniques were practiced by fish venders in three perennial reservoirs in the country. High market demand at the vicinity of the landing sites would be the main reason to neglect the proper preservation and storage of inland fish. Mostly fish venders use water to moist the fish or use wet gunny sacks to cover the fish. However, the wholesalers visiting to landing sites used crushed ice or coming with freezer trucks for storage of fish. However a company collecting giant fresh water pawn from reservoirs have appointed collectors to purchase the prawn were provided cooing containers. Along the marketing channel,

especially in roadside fish stalls in rural areas fish were kept open and no ice or proper preservative mechanism unless moist the fish using water. Figure 6, illustrates the increase of fish landings during the period of July to October. In some instances fish were discard due to lack of storage facilities or sell at low prices in the market. Also in some years huge fish harvests were landed with the onset of rain fall in Udawalawa reservoir and large amount of fish landings have buried due to inappropriate marketing and storage facilities (Personal communication form fishers). In some Provincial Fisheries Ministries have constructed road-side fish stall for selling fish with the purpose of improving the postharvest quality, but lack of awareness or negligence, fish venders are not practicing proper post-harvest handling of fish. The main post harvest processing in inland fisheries are dry fish production and production of smoked fish (Perera 2017). Still the under developed traditional techniques are used in these processing. With the increase of inland fish production, advance processing of inland fish have started by a private sector company very recently. Canned Catla (Catla catla) and canned fish paste using Chinese carp species are the new product initiated to produce commercially based on inland fish (Puspalatha 2019).

4.5 Promotion of small fish (nutrient dense) consumption

Fish is the most widely traded food commodity on the global market but many national food security plans do not include wild foods such as fish (FAO, 2019). It has been estimated around 20-30% of wild fish caught are used as fishmeal, primarily exported for aquaculture; these small fish supports significantly for food security; livelihoods for coastal communities and for healthy ecosystems (FAO, 2019). In 2011 the value of fish exports from developing countries was over $20 billion which is greater than the net exports of rice, coffee, tea, tobacco, and meat combined (FAO, 2019). In contrast, exports of fish can endanger domestic food security if an inclusive approach to economic growth is not taken. Even from Sri Lanka bulk of the major tuna species come from marine water are exported while small fish, which are nutritionally rich in essential nutrients, are mainly targeted by small-scale fishers. Anyhow, a little attention has been given on the nutritional quality of small-marine species. The current global per-capita fish supply is 17 kg per year (FAO, 2019). In 2016, per capita fish consumption in Sri Lankan household sector was 11.8 kg/year while the contribution of large marine fish and small marine fish for the per capita fish consumption remain similar as 4.5 kg/year (Fisheries statistics, 2018). In recent past daily fish consumption has been increased from 41.3 g to 46.7 g from 2013 to 2016 because fish is a common complement with rice in Sri Lankan diet (Naveenan, (2018). About 285 000 t of fish was landed, of which 90 percent was consumed locally and 10 percent was exported. However, in order to satisfy increasing local demand for fish protein, Sri Lanka has imported annually an additional 70 000 t of dried and canned fish. Catch data by the main species groups for the past few years can be found in Fisheries Statistics (2018) (Figure 9).

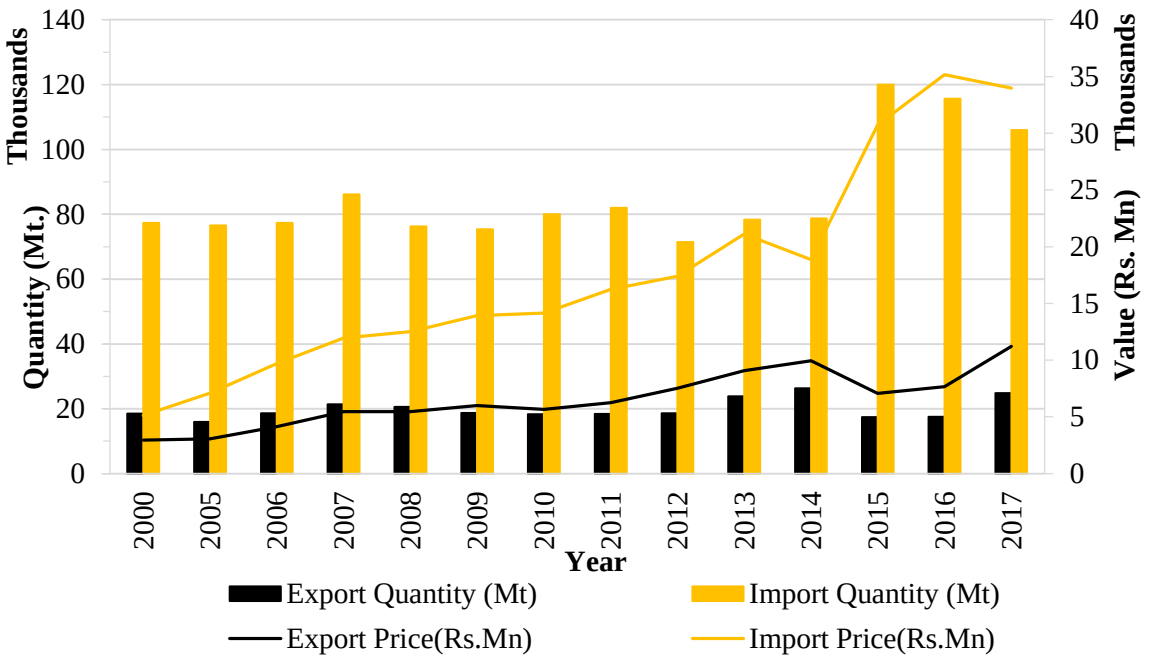

Figure 9. Export and import fish and fishery products from 2000 to 2017: total quantity and value (Graph constructed using data from Fisheries Statistics 2018)

Though the health benefits of seafood consumption have primarily been associated with protective effects against cardiovascular diseases (CVD), it is also been important for improved foetal and infant development, as well as several other diseases and medical conditions. The health promoting effects of seafood have chiefly been attributed to the long-chain n-3 polyunsaturated fatty acids (n-3 PUFA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). In addition, the general fatty acid profile is considered. Moreover, seafood proteins and other seafood derived components also contribute to the health effects. Health benefits of marine foods and ingredients have been reviewed by many authors (Larsen et al., 2011; Béné et al. 2015; Hamed et al., 2015). Apart from these unified nutritional features, large variations in nutrient content among marine fish species have been established. But according to FAO nearly 821 million people, or one in nine of the global population, were undernourished in 2017(FAO et al., 2018). Severe food and nutrition insecurity may result "chronic hunger" with severe implications such as undernourishment; wasting and stunting in children; anemia in conditions and various forms of micronutrient deficiencies (FAO et al., 2018, WHO, 2014).

However, existing data on the nutrient composition of fish in Sri Lanka is highly outdated and very limited, and does not reflect the large diversity of fish available. But limited number of studies reveled on the species specific nutritional facts found from Sri Lankan waters. Nutritional composition of 19 common marine fish species, including twelve small fishes have been documented by Moxness (2019). Apart, individual species or groups have been studied in evaluating their proximate compositions (Sutharshiny & Sivashanthini, 2011); lipids and fatty acids profiles (Devadason et al., 2016; Hirimuthugoda et al, 2016); micro nutrients (Deraniyagala,

200; Wijesekara eta al., 2011) and nutraceuticals (Ranadheera, C. S., & Vidanarachchi, 2013;). Moreover, how the lipids and fatty acid content are affected by different aquaculture conditions (Anas et al., 2010; De Croos et al., 2005); habitat related variations (De Zoysa et al., 2019); disease conditions (De Croos et al., 2004) and processing methods (Komatsuzaki et al., 2019; Nishanthan et a;, 2018) have also documented.

In Sri Lanka huge quantities of marine sector fish catch are comprised by variety of small fish species than the major commercial groups (Figure 10). Most of these small fish are harvested by small-scale fishers those who have limited facilities and infrastructure compared to commercial multi-day fishing facilities, thus chances are high to discard considerable portion of catches due to quality issues. Anyhow, these small fish is easily affordable by poorest of the society. In addition, the small fish are consumed in different ways as whole with heads; bones, and viscera thus have the potential to contribute substantially to the Recommended Nutrient Intake (RNI).

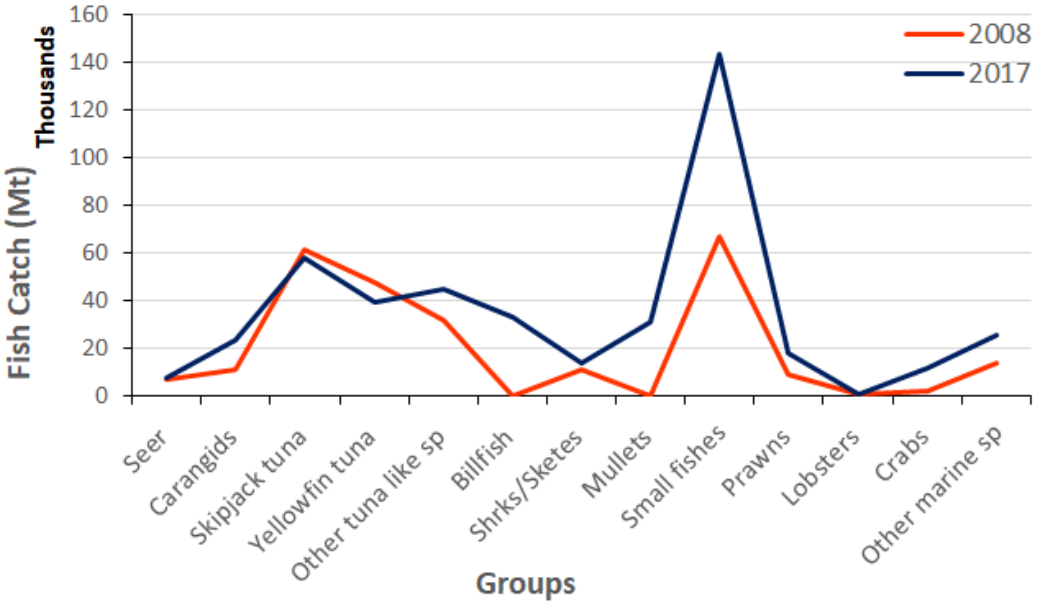

Figure 10. Marine sector fish catch by major commercial groups (Mt) in 2017 and 2018. (Graph constructed using data from Fisheries Statistics 2018)

Trash fish are generated at fishing, landing and marketing sites due to destructive fishing practices and inadequate cooling facilities. In addressing food security issues it is suggested to promote the consumption of small fish varieties and establish processing factories for trash fish. Moreover, comprehensive knowledge of the nutrient content in commonly consumed fish species is of great importance to further improve the food and nutritional security in the country.

There were several research publications revealed about the potential of utilization of minor cyprinids in Sri Lankan reservoirs (De Silva and Sirisena, 1987; De Silva and Sirisena, 1989; Pet et al., 1996; Pet et al., 1999). Poor consumer preference would be a reason for non-development of a fishery based on minor cyprinids (Piet and Vijverberg 1998; Amarasinghe et al. 2002). Existing fishing gear regulations in reservoirs may have some influence on none harvesting of

minor cyprinids. The accepted mesh size for the inland fisheries is >8.5 cm, which is larger than the size of minor cyprinids and allow them to escape from the gear. Ajith Kumara et al., (2009a and 2009b) stated that the strategies to harvest minor cyprinids without damaging other stocked fish species used for fisheries enhancement in reservoirs. Amarasinghe et al (2009) estimated that potential of harvesting 22000 Mt of this untapped fishery resource, which would be equal to 24% of the total inland fish production of the country in 2019. Amarasinghe et al (2016) highlighted the potential of minor cyprinids in combating malnutrition and micronutrient deficiencies in rural populations and increasing the fish production significantly. However, there is no action was taken to promote the fishery of minor cyprinid resources in Sri Lankan reservoirs. (Jayasinge and Amarasinghe 2018) stated that in many reservoirs of the country, fishers have also been exploiting the small-sized indigenous cyprinid resource since 2006, using 20-25 mm mesh gillnets. Although, it has not been reported in official statistics, in rural areas unreported harvest of minor cyprinids is being doing for human consumption. However, dried small fish are being sold in rural markets but not appeared in statistics. There must be some representation of minor cyprinids in fish catches categorized under other wield spices (12.5% estimated contribution) in the inland fish statistics (Figure 8).

4.6 Opportunities and barriers of inland fish farming and aquaculture

The Sri Lankan government focus on developing aquaculture has two folds. First, is to safeguard the food security – i.e. to increase domestic availability/consumption of seafood by developing especially the output from culture based capture fisheries in the reservoirs/tanks, as carps and tilapia are affordable for local people. Secondly increasing marine aquaculture in general has the purpose of especially increasing the export earnings.

The countries' brackish water aquaculture potential includes 158,000 ha of lagoons and river estuaries, and 71,000 ha of mangrove, mud flats and salt marshes. In addition to this there are the marine areas – the deeper Koddiyar Bay and several "100,000 ha" of shallow marine water areas specially in Mannar and north. As a tropical country which has multispecies of fauna and flora, Sri Lanka has huge potential of farming many species. Several species such as, seaweeds, sea cucumber, shrimps (both *Penaeus monodon* and *Litopenaeus vannamei*, formerly *Penaeus vannamei*), spiny lobsters, crabs and bivalves such as oysters, clams and mussels are successfully been cultured by both local and foreign partnerships. In addition several marine and brackish water finfish species, seabass, milkfish, are also been cultured. In 2014, 70 tons of seaweed has been harvested from Valaipadu and 424,000 juveniles sea cucumbers has been produced from a hatchery at Ambakadawila while 595.2 kg of sea cucumber were harvested (Thassim et al., 2019).

Continuous supply of fish fingerlings and prawn post larvae is one of the main issues for the development of marine aquaculture sector due to constrains in capital; expertise and maintaining cost. Nevertheless, a multispecies marine (fish) hatchery has been established at Batticaloa with the EU funding. There had been a few other attempts to start up marine fish hatcheries.

In addition, Ministry of Primary Industries (MPI) has been involving in developing 33 Mega Zones by 2020, 23 in agriculture and 10 in fisheries/aquaculture. Of this some has already started the operations. These mega zones are also focus for commercial farming of sea cucumber, sea bass, milkfish, tilapia and seaweeds. In addition at Kalpitya and Oluvil different bivalves such as oysters, pearl oyster, mussels, clams and cockles will also be farmed. These products are expected to be a major source of foreign exchange.

The establishing Mega Zones, with good value chain interlinkages, can be a very useful intervention to manage some of the constraints and risks for marine aquaculture development. One important issue is creating market access for the smaller farmer, which would be covered by a successful value-chain approach. Another main issue in the marine aquaculture development is that at present there are no local feed production for marine fish. This combined with very high import taxes on feeds is an additional major constraint in achieving economic profitability. Thus aquaculture need to be promoted by providing sufficient incentives and support for fish farmers to commercialize their activities, one of which should be to reduce the import taxes on input factors, if they are not locally produced. Or to support the local feed production possibly in combination with a feed production for poultry/livestock. The weakness of the approach is that it is a cluster development approach. With the experience from other countries, it has the risk of being a top down approach, where the sustainability depends on the financial support of the 'program'. It is therefore crucial that a solid exit strategy (from the government support) is in place (Norad for the Royal Norwegian Embassy, Colombo, Sri Lanka, 2017).

Having 517, 000 km^2 Exclusive economic zone, which is 7.8 times larger than the land area of the country and 1700 km long coastline in Sri Lanka has potential for off-shore aquaculture. But offshore aquaculture is challenging due to inadequate technology; facility and expertise which required to culture aquatic organisms in highly dynamic marine environment. Naveenan, (2018) has conducted a feasibility study in evaluating the potential of offshore aquaculture in Sri Lankan waters by considering several factors such as water depth; cost-effectiveness; distribution of water temperature and the existence of Marine Protected Areas (MPAs) in offshore areas. The SWOT analysis outcomes of the study of Naveenan, (2018) provide some insight on the feasibility of initiation offshore aquaculture in Sri Lanka. The recent interest towards the development of offshore aquaculture in Sri Lanka is evident with the entering of several public and private institutions in establishing sea cage farming. However, it is necessary to address the environmental, social and economic challenges of establishing offshore aquaculture in Sri Lanka (Norad for the Royal Norwegian Embassy, Colombo, Sri Lanka (2017).

Sri Lanka has great opportunities to increase fish production due to availability of inland aquatic resources suitable for inland fisheries enhancement (Amarasinghe and Wijenayake 2015). According NAQDA statistics seasonal reservoirs stocked with fingerlings were reported as 453 and 303 respectively in 2015 and 2016. Also the distribution of reservoirs over rural areas have an added advantage to produce fresh animal protein sources at the vicinity of rural communities and to improve food and nutritional security of rural people. Seasonal and perennial reservoirs in the country are very productive in the terms of primary productivity (Jayasinghe et al., 2005 and

Nadarajah et al., 2019) and this is an added advantage for obtaining high fish yields from seasonal and perennial reservoirs under good management practices (Wijenayake et al., 2005; Amarasinghe and Nguyen 2010; Chandasoma et al 2015; Puspalatha et al 2017). There are large number of reservoirs still remain suitable for stocking fingerlings but most of the reservoirs are being underutilized for fish production. Well established aquaculture extension service in inland fisheries and aquaculture in the country is a good opportunity to transfer technical knowledge to fish farmers and community leaders to improve the inland fish production. Training facilities and available infrastructure under NAQDA for training and knowledge transferring to stakeholders, the current initiatives of genetic improvement of cultivable fish species are good opportunities to enhance the inland fisheries and aquaculture in the county. Government support and policy support for inland fisheries and aquaculture is another advantage to promote fish production in inland waters. Increasing interest of private sector participation in inland fisheries and aquaculture i.e. in fingerling production, product development based on freshwater fish species, and investment in pond fish aquaculture, are some positive moves to develop inland fisheries and aquaculture in the country (source of information: https://www.naqda.gov.lk).

Climate driven influences are becoming the most critical issue in inland fisheries and aquaculture in reason past. Changes in the precipitation and changes in year-round rainfall distribution creates water scarcity in reservoirs. CBFs in seasonal reservoirs is severely affected and shorter water retention periods create low production in this reservoirs. Delays in onset of monsoonal rains shorten the culture period and this very often discourages farmers as shortened culture period results in low fish production (NACA 2012, Chandrasoma and Puspalatha 2018). Reduced precipitation and changes in rainfall distribution also create changes in water demand and create conflicts with other water uses affecting the sustainability of fisheries activities. Fingerling availability at the correct time and with required species combinations are key factors for the sustainability of CBFs in seasonal reservoirs. Climate driven change in precipitation create difficulties in induced breeding of fish (Cochrane et al., 2009; NACA, 2012). Timely availability of fish fingerlings with required species combinations for stocking reservoirs will be affected due to failures in fish breeding (NACA 2012, Chandrasoma and Puspalatha 2018). Conflicting situations between resources uses and illegal fishing sometimes obstacle the sustainability of CBFs in small reservoirs. Inconsistency of good management strategies such as violation rules and regulations, use of illegal fishing gear causes detrimental impact of fisheries in some reservoirs. Spreading aquatic invasive species including flora and fauna have created harmful impacts to fisheries in reservoirs. Currently South American Sailfin Catfish species (Pterygoplichthys spp.) have become a severe threat to fishing activities in Sri Lankan reservoirs (Sumanasinghe and Amarasinghe 2013; Wikrmaratne, 2019). Development of freshwater pond fish aquaculture is still at rudiment stage and few private sector projects were initiated to culture tilapia in ponds. Competiveness for land for agriculture and other development activities and the production cost would be main constrains for the development of freshwater aquaculture in the country. The most attractive fish for inland aquaculture is tilapia species. The bulk production of tilapia landed from the reservoirs determined the market price compared to the production cost in ponds profit margin

will not be at an attractive levels for investments in tilapia aquaculture. Although there was no such analysis available in the literature cost benefit analysis done by Pushpalatha et al. (2016) indicate evidence for this factor. Lack of aquaculture feed industry established in Sri Lanka and high input price may also be restricted the development of freshwater aquaculture in the country.

4.7 Income and socio economic factors of producers

With respect to the income and socio economic factors of producers, small-scale fisheries deserve greater attention not because of their unique problems, such as poverty; poor infrastructure etc. but also for the opportunities they provide in addressing important social concerns that exist beyond the sector, such as providing safe and nutritious food for the nation and for sustaining thousands of livelihoods. But small-scale fisheries do more than just provide society with a `service', but they are important in themselves. According to the Central, Bank of Sri Lanka (2018) the number of different types of fishing crafts remain more or less constant within the last 5 years and the crafts used by small-scale fishes i.e traditional non-mechanized; traditional mechanized; fiber glass boats with out-board engine and single day fishing crafts with in-board engines were 12.5 times higher than the multi-day fishing crafts, which operate offshore fisheries. The number of traditional non-mechanized crafts used by small-scale fishers accounted 26992 in 2017 while the traditional mechanized crafts were 2185. Total multiday crafts operated in offshore areas were only 4196 (Central, Bank of Sri Lanka, 2018).

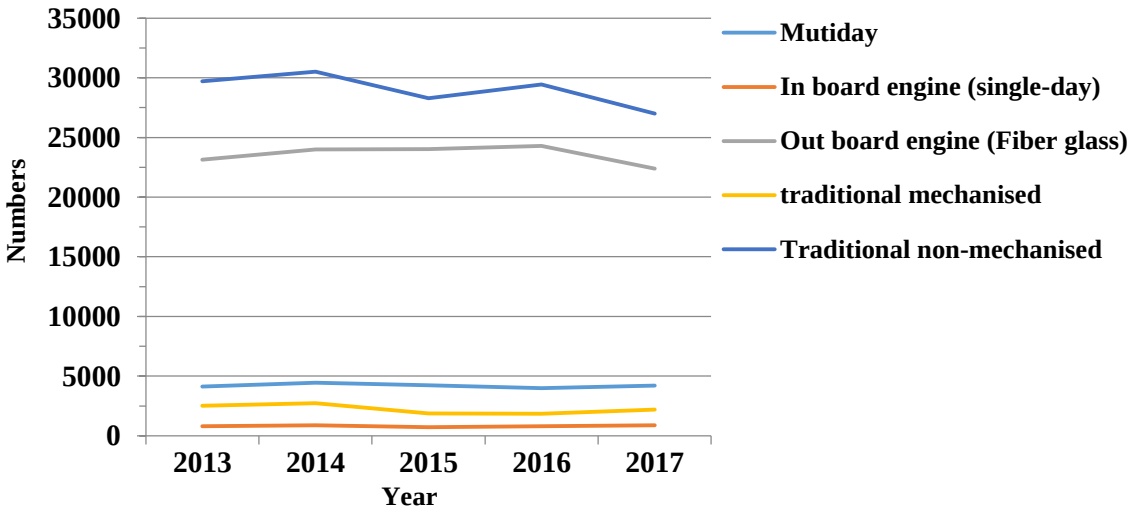

Figure 11. Dynamics of the different types of fishing crafts in Sri Lanka from 2013 to 2017 (Graph constructed using data from Central Bank Report, 2018)

The most common issue in fish marketing is the functioning of high bargaining power of the middlemen to push down fish price which is common in the both coastal as well as inland fisheries. Such middlemen generally have strong links with the villages, officers, and use both economic and political power to maintain monopoly in the market without allowing outsiders to enter into

the trade. Another aspect that pushes down the fish prices is the dumping of huge quantities of fish from one province to another within a few hours via newly constructed express ways. Similarly, export trade is controlled by middlemen/exporters, for high value blue swimming carbs; sea cucumbers; freshwater prawns etc. The fish purchased from fishers are sold to the export market by keeping huge profit margins but prices are not known to fishers. So lack of such market information hinders fishers to exploit opportunities that exist in the export fish market. Anyhow, poorer fishers are ready to get whatever the price for potentially exported fishes. In contrast, increasing export of fish causes reduced fish consumption at household level, even among kids and women. Moreover, this tends to increase the local prices of small fish varieties, which are generally consumed by poorer groups. Anyhow, Examination of a 30-year time series of exports and per capita domestic availability of fish in 14 countries suggests that fish availability has increased along with increases in exports for 7 of the 14 countries (World fish center, 2011).
Lack of inappropriate infrastructural facilities such as lack of landing centers; cold storage facility, clean ice (Figure 12), boxes and water have substantially contribute for the quality of fish while release of waste water and industrial effluents to the lagoons causing pollution of lagoons; land filing of mangrove areas for illegal coastal constructions and poor road network etc. have also been of serious concern which ultimately contribute for the serious hygienic issues of sold fish.

It is clear that none of the development efforts in maintaining the food security by providing hygienic nutritious fish supply from small-scale fishers, who are responsible of harvesting large amount of nutritionally rich small fish, will not be succeeded unless the communities are provided with basic social services, such as education, health, housing, etc. at the same time. Because it is difficult to convince a poor fisher, who is at the verge of starving and using destructive gear on the food security and sustainable utilization of resources. Thus, basic social services should be provided to fishing communities, if their active participation is to be obtained nutritious and hygienic food through sustainable management of fishery resources.
Some of the less important socio economic concerns, which are not directly related to the food security, are the occupational health and sea safety issues. Most of these issues are related to offshore and deep sea fisheries however, instances of accidents causing serious ill health and death of small scale fishers have been reported. Most of these health and safety issues are pertaining to the lack of safety and protection facilities; poor quality of available safety devices; high cost and lack of access etc. Anyhow if skilled fishers get injured it will directly effect on the food security as the number of people engaged in fisheries are reducing with time.

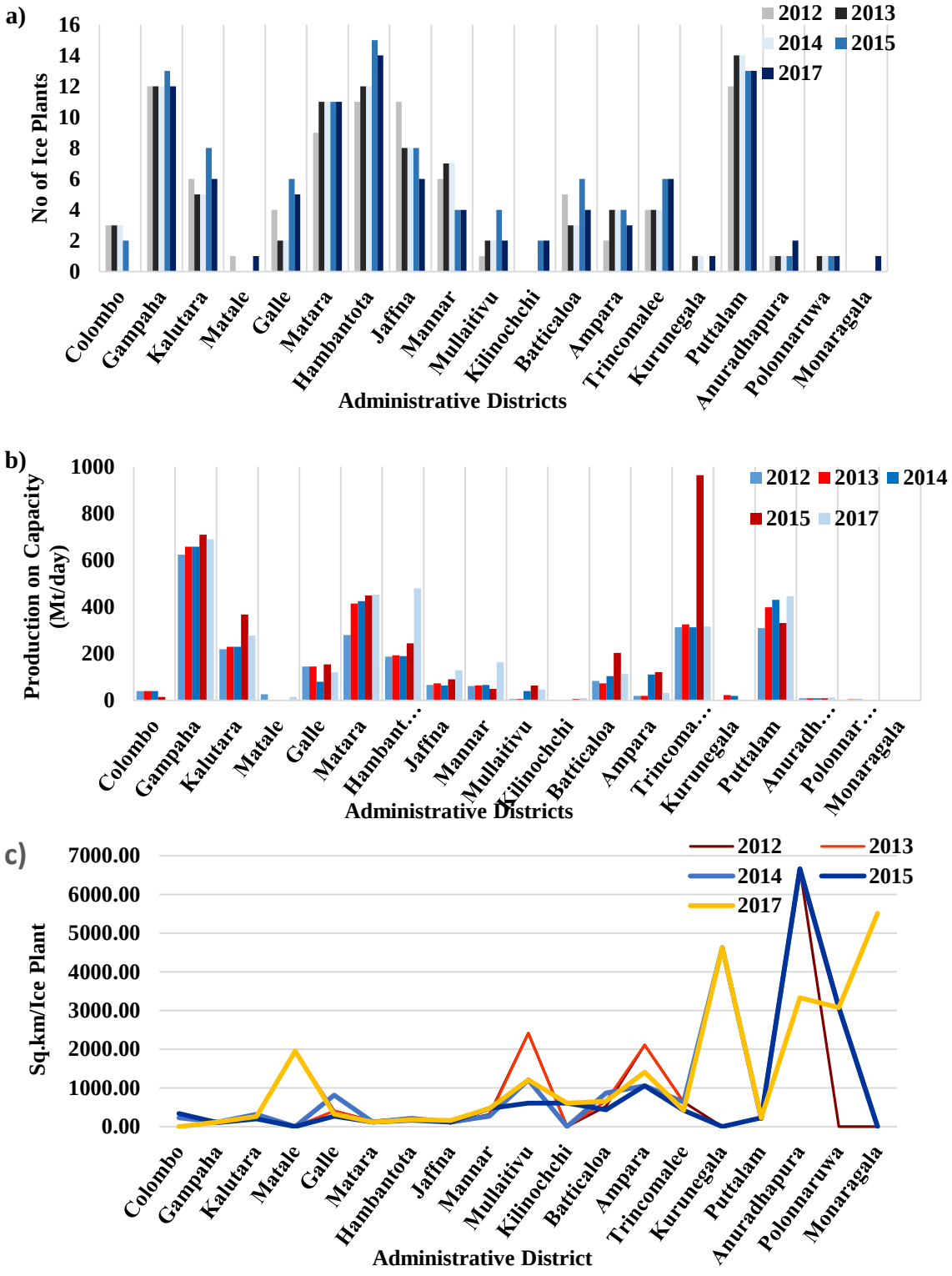

Figure 12. Distribution of ice plants in different administrative districts a) number of ice plants in each district b) daily production of ice in each district c) total area covered by active ice plants in each district (Graph constructed using data from Fisheries Statistics 2018)

Socio-economic status of fishing communities of inland reservoirs may have significant differences among reservoirs. This would be determined by the availability of alternative livelihood opportunists and the level of fish harvest obtained from the reservoir. Similarly the level of managerial interventions in the reservoir fisheries is also determined by the profit. As an example profit of fisheries in three medium perennial reservoirs namely; Amparawewa, Hambegamuwa and Aluthdiulwewa were respectively 18.517, 44.269and 16.756 million Sri Lankan rupees during the period of 2012-2014 (Puspalatha et al 2017). Puspaltha et al. (2015b) indicated the assets obtained by fishers in Ampara Reservoir after introduction of CBFs and the support of income to improve their living standards. Keerthana (2016), also reported the significant contribution to household income in Giant reservoir in Mannar by inland fisheries. When considering the seasonal reservoirs most of the people engaged in CBFs are paddy farmers therefore, the income generated from the fish culture practices are an additional income for the community members which supports to increase their annual household income. Amarasinghe and Nugyen (2010) indicated the income generated through CBFs in sixteen reservoirs and 14 reservoirs have earned considerable amount of money from fish culture. However, recent studies on socio economic aspects on inland fishing communities were scant. It can be predicted that the average socio economic status of inland fishers would be more or less similar to the paddy farming communities as most of them are involving in agricultural activities. Keerthana (2016) reported that the fishing flocks did not have additional livelihood opportunities were suffering from financial difficulties in Giant tank in Manner during lean seasons. Most of them were obtained finance from local money lenders. Similar observation was made by Bernard (2014) at Iranamadu reservoir fishing communities. Alcoholism is one of the main social issue in inland fisheries of some parts of the country (Bernard 2014 and Keerthana, 2016).

4.8 Gender issues and influence on nutrition at households

There are large gender disparities in access to and control over resources (e.g. land, water and inputs), access to markets and access to skills training, all of which are critical for agricultural production and livelihoods (FAO, 2018). In fisheries, many of the women are involved in marketing and post-harvest processing and direct fishing by women is restricted to couple of coastal fisheries such as bivalve and cucumber harvesting and some artisanal inland fisheries. Thus, gender issues in fisheries have not received much attention also women participation in fisheries decision making bodies still remains quite low (Figure 13). But as women play the main role in household responsibilities, even in most of the fisher families, a greater concern has been drawn to recognize the role of women in fisheries activities and fisheries decision making.

The labour force participation rate of women of the total female population over 15 years, is 36.4 percent (Department of Census and Statistic, 2017c). In addition, of the total women employed in the country, 29.7% are working in the agriculture sector (Department of Census and Statistics, 2017c).Moreover, Nearly 60 percent of the country's university students are women (UGC, 2016 in FAO, 2018 *Country Gender Assessment of Agriculture and the Rural Sector in Sri*

Lanka.Colombo.80 pp) but unfortunately equal access for education has not led any improvement in engaging women in fisheries labour force. Many cultural; religious and social barriers are the key components which prevented women been involved in fisheries activities. In addition, responsibilities of taking care of children at home; distance from home to the fish landing sites; oligopsonistic buying practices by traders and poor access to technology and capital to take up fish processing are also significantly contribute to keep women away from fisheries related activities. But recently women involvement in processing, especially in shrimps; crabs; sea cucumbers; fish etc. has been increasing. So, if women can be empowered through training and capacity building to contribute along the market chain, especially for processing; packing; marketing etc., more entrusted food security can be assured.

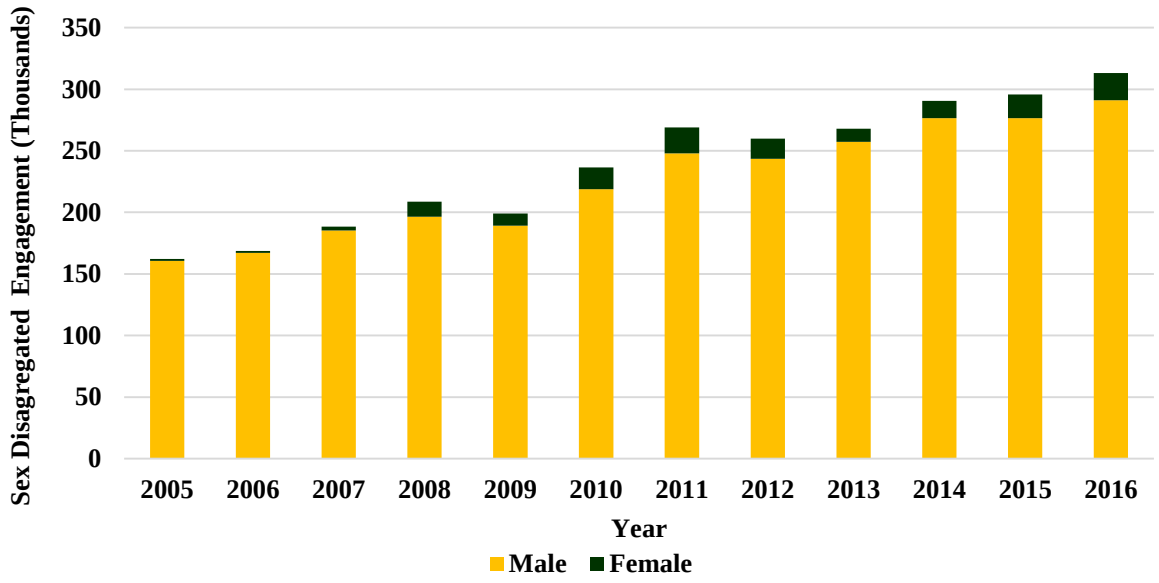

Figure 13. The sex-disaggregated engagement in the primary sector of fisheries and aquaculture (Graph constructed using data from Fisheries Statistics 2018)

In some parts of the country women has been empowered based on groups-wise activities, mostly under different fisher communities, such as net mending groups, processing groups, selling groups etc. Fish processing factories have been developed for shrimp and crabs specially in northwestern and northern part of the country. Production lines which solely operated by women in export oriented shrimps and crabs processing factories are significantly contributing in gaining foreign exchange as well as food security. However, there is considerable room for improvement in the nutritional status of women. At least 31 percent of pregnant women are anaemic and over 35 percent of urban women of reproductive age are overweight (FAO, 2018). Little research had been conducted in calculating losses of productivity and reduced economic gains in national level due to gender inequality and what could be the added benefits if women were given the same opportunities as men to reach their full potential.

In the fisheries policy document of Sri Lanka under area 4.5 gender has identified as a policy. It promotes equal opportunities to participate in activities in the sector, provides opportunities to gender mainstreaming in small scale fisheries development strategies, promotes equal access to resources and benefits and encourages the joint participation in finding solution to their problems. Although fisheries policy encourage the women participation in fisheries activities, women involvement in inland fisheries and aquaculture is very low (Table 1). It should be noted that this percentage is calculated based on the total employed in inland fisheries and aquaculture only. When it comes to the total workforce the women involvement in this sector would be negligible. According to the Department of Scenes and statistics, economically active women population in the rural areas in the third quarter of 2019 was reported as 34.6%. Poor participation in inland fisheries and aquaculture is not a unique situation to Sri Lanka. In the South Asian region poor engagement of women in fisheries sector has reported by Siason et al. (2002). Similar to the less women participation in fisheries activities, poor decision making power in their household was reported by Gunawardana (2017) based on the study conducted in three districts; Ampara, Hambantota and Polonnaruwa. Similarly women have poor ownership of fishing equipment and other Family assets.

Table 1. Gender representation in inland fisheries and aquaculture in year 2017.

Inland fisheries				Aquaculture			
Total employed	**Male**	**Female**	**Female %**	**Total employed**	**Male**	**Female**	**Female %**
37697	36381	1316	3.49%	22898	21457	1441	6.29%

(Data source: Ministry of Fisheries 2018)

Although, direct women participation in statistics are not appeared in the reports, their hidden contribution in the sector is important in social aspects, but not have been appreciated. In rural communities, traditionally family care responsibilities are given to women. Engaging in child care, support for the child education and food preparation may prevent them in fisheries activities. Also the fisheries activities in most of the medium and large perennial reservoirs happened in late evening and the early morning, this will be another factor hindering the direct women involvement in fishing activities. Basically this may relate to their personal security. Above factors were more or less similar to the factors preventing coastal women in fishing activities mentioned in (FAO 2018).

Although published information are not available, some ladies are actively engaging in fishing activities in some medium and large perennial reservoirs. Considering the safety of the fishing women, some fisheries organizations have demarcated shallow arrears of their reservoirs for ladies, who involve in fishing. Also in some reservoirs, ladies were allowed to use small mesh gill nets targeting minor cyprinids in the reservoir. Some widows, who are having the membership in the fisheries committee hire laborer to catch fish and actively engaged in fisheries (Personal

communication from Pushpalatha). Mainly women participation in fisheries related activities are dried fish production, cleaning and meandering nets (Bernard 2014; Keerthana 2016). Also women involve in fish marketing in inland sector. Women have a deeply subordinate role in inland fisheries organizations in Sri Lanka. Women are supporting fisheries organizations as office bearers. Fish harvest data collector in most of the well managed fisheries communities are a leady selected from the society. Women participation also can be seen in fish seed production in inland fisheries. There were some initiatives started to promote empowering woman in inland fisheries communities under "Aquatic Resources Development and Quality Improvement Project" during the period of 2008-2009. Women sub committees were established under reservoir fisheries organization with the objective of capacity building and creating livelihood opportunities for ladies (Personal communication from Pushpalatha). According to NAQDA "Diyawara Liya Diriya" Programme was launched to empower the fisher women by directing them for fisheries related livelihoods in this year (https://www.naqda.gov.lk).

Low nutritional status is one of the most important health and welfare problems in Sri Lanka. Bennett et al. (2018) categorized Sri Lanka under the group of countries where more than 20 percent of total population were undernourished in 2015 Young children and women of reproductive age are especially vulnerable to nutritional deficits and micronutrient deficiencies (Abeywickrama, 2018 and Department of census and statistics, 2017a). Food security, nutritional status and the health associated information are very rear/scant for the inland fishers separately in statistics. Mostly these statistics are available for agriculture communities. Probably, some families of fishing communities may include in these samples, as they are engaging in agriculture livelihood practices too. As such, trends would be appeared in food security, nutrition and health status of inland fisheries communities may similar to rural farming communities. It should be noted that main livelihood practice of some families is reservoir fisheries, and real status of food, nutritional and health status may not be appeared in this statistics. Table 2 indicates food security and some helth parameters of selected nine districts, which where contributed to the 80% of total inland fish production in year 2017. According to the statistics, stunting, wasting and underweight children (less than 5 years of age) are comparatively high in these districts. The national status of these three parameters were also high in Sri Lanka. Stunting is of crucial importance to understand the health of children in a country. Percentage stunting children in four districts in this sample were below the national levels. The wasting children percentage in five districts were less than the national average and in two districts namely, Hambantota, Anuradhapura and Moneragala wasting is comparatively higher than the national levels. Percentage underweight children population was higher above the national levels in six districts (Table 2). Anaemic condition of children in five district of this sample are lower than the nation average and in Hambantota, Baticaloa, Ampara and Monergala districts this value is significantly higher than the national standards. A cut-off point of Body Mass Index (BMI) 18.5 is used to define thinness or acute under-nutrition. The percentage thinness of women in the selected districts were distributed around the average thinness of rural population. However, the rates are still higher (Table 2). On the other end of the continuum, chronic energy deficiency of women leads to low work productivity and reduced resistance to

illness. The obese (BMI>25) percentage of women in selected districts were comparatively less than the urban areas. Any type of anemic condition in women population in five districts were less than the national average but all values are significantly high and a sever threat to the national health security.

Micronutrient intake can improve the nutritional and immune status of pregnant women and consequently, prevent maternal and neonatal deaths (Department of census and statistics 2017a). World Health Organization stated that micronutrient deficiencies during pregnancy may caused by inadequate intake of meat, fruits and vegetables or by infections. FAO (2016) stated that fish are rich in micronutrients such as calcium, phosphorus, zinc, iron, selenium and iodine as well as vitamins A, D and B. Allison et al. (2013) stated that micronutrients are helping to reduce the risks of both malnutrition and non-communicable diseases which may co-occur when high energy intake is combined with a lack of balanced nutrition. However, no statistics are available over micronutrient deficiencies of fishing communities in inland fisheries in Sri Lanka. Based on a review on micro nutrient status of Sri Lanka since year 2000; Abeywikrama, (2018) stated the higher prevalence of iron, zinc, calcium, folate, and vitamin A deficiencies in the country. It is interesting to know, whether fish producers receive adequate nutrients through their own products and have a balance nutrient intake with other resources available in rural areas.

Fish and fish products are considered excellent sources of high-quality protein; bioavailability of protein from fish is approximately 5 to 15 percent higher than that from plant sources (FAO 2018). Fish contains several amino acids essential for human health, such as lysine and methionine. Many fish (especially fatty fish) are a source of long-chain omega-3 fatty acids, which contribute to visual and cognitive human development, especially during the first 1 000 days of a child's life (Roos, 2016, FAO 2016). Nutritional content is especially high in small fish species consumed whole and in fish parts that are not usually consumed (such as heads, bones and skin). Table 3 indicates some nutritional values of selected freshwater species available in Sri Lanka.

Table 2. Some selected parameters of nutritional deficiencies and food security in nine districts, which contributed to 80% of total inland fish production in year 2017. Each district produced more the 3000 Mt of fish in year 2017.

District/Category	Children (age under 5 years)				Women			
	Stunting*	Wasting*	Underweight *	Any type of Anaemia (Haemoglobin Below 11.0 mg/dl)**	Any type of Anaemia (Haemoglobin Below 11.0 mg/dl)**	Total thin (BMI <18.5)*	Obese (BMI>25)*	Food insecurity ***
Hambantota	11.8	21.8	22.4	37.5	36.8	10.7	41.5	14
Baticloa	20.6	14	21.4	45.6	37.1	10.7	48.7	14.4
Ampara	21.9	12.4	18.1	50.7	49.3	8.4	46.2	24.8
Trincomalee	15.5	12.3	22.7	28.5	21.1	7.4	51.5	13.9
Kurunegala	17.7	13.5	21.9	29.1	45.6	9.5	42.2	15.4
Putalam	11.7	17.2	20.1	27.4	40.3	7.6	51.1	6.1
Anuradhapura	19.1	19.7	24.7	31.0	26.0	7.4	44.7	21.6
Polonnaruwa	11.1	11.4	18.7	15.2	18.5	12.0	38.7	6.7
Moneragala	15.9	25.4	24.2	36.3	47.9	9.7	42.2	7.5
National	**17.3**	**15.1**	**20.5**	**32.6**	**39.1**	-	-	**10.3**
Urban	**14.7**	**12.9**	**16.4**	**32.0**	**43.9**	**5.6**	**55.8**	**9.7**
Rural	**17.0**	**15.6**	**20.8**	**33.2**	**38.4**	**9.1**	**44.2**	**10.4**
Estate	**31.7**	**13.4**	**29.7**	**28.1**	**41.6**	**12.7**	**23.4**	**11.5**

Data sources: Department of Senses and Statistics (2017a)*, Demographic and health survey, Department of Senses and Statistics (2009)**, Demographic and health survey 2006/2007, Department of Senses and Statistics (2014)***, Household food security survey 2013/2014

Table 3. Micronutrient contents in 100g of selected freshwater food fish species. Data source for Tilapia and Common carp (Albert and Metian, 2013); Data source for minerals and vitamins of Catla, Mrigal, Rohu, Climbing perch and Stringing catfish (Mohanty et al 2016); Data source for Protein of Catla, Mrigal, Rohu, Climbing perch and Stringing catfish (Mohanty et al., 2014); Data source for fatty acids, EPA and DHA of Catla, Mrigala and Rohu (Paul et al., 2015). "nd" denotes not detected

Fish	Protein (g)	Total lipid (g)	SFA (g)	MUFA (g)	PUFA (g)	20:5 n-3 (EPA), (mg)	22:6 n-3 (DHA) (mg)	Cholesterol (mg)	Calcium (Ca) (mg)	Ion (Fe) (mg)	Magnesium (Mg) (mg)	Phosphorus (P) (mg)	Potassium (K) (mg)	Sodium (Na) (mg)	Zinc (ZN) (mg)	Copper (Cu) (mg)	Manganese (Mn) (mg)	Selenium (Se) (mg)	Vitamin A (IU)	Vitamin D (IU)	Niacin (mg)	Vitamin E (IU)	Vitamin K (IU)
Tilapia*	20.08	1.70	0.585	0.498	0.363	5	86	50	10.0	0.56	27	170	302	52	0.33	0.08	0.04	41.8	0	124	3.90	0.40	1.40
Common carp*	17.83	5.60	1.083	2.328	1.431	238	114	66	41.0	1.24	29.0	415	333	49.0	1.48	0.06	0.04	12.6	30	988	1.64	0.63	0.10
Catla **	16.2	–	21.43	47.01	31.74	6.64	4.60	–	161.1	1.6	nd	146.8	238.9	198.3	1.3	nd	0.8	0.3	12.2	59.5	–	0.5	0.5
Mirigal**	15.5	–	31.19	27.01	41.81	1.34	nd	–	222.5	1.9	nd	131.9	273.4	205.7	1.1	nd	0.5	0.3	30.9	152.3	–	0.6	0.2
Rohu	15.9	–	70.69	11.32	18.02	0.99	0.47	–	205.7	2.2	nd	124.9	267.5	202.1	1.9	nd	0.4	0.6	8.7	84.4	–	0.6	0.7
Climbing perch	16.9	–	–	–	–	–	–	–	252.6	2.3	nd	159.8	178.3	236.8	0.9	nd	0.8	0.3	89.8	64.4	–	0.9	0.8
Stinging catfish	16.3	–	–	–	–	–	–	–	164.4	2.4	nd	173.2	186.4	215.8	1.2	nd	0.2	0.1	26.8	111.7	–	0.2	2.7

4.9 Level of input and extension services availability to increase production and consumption

The Ministry of Fisheries and Aquatic Resources Development is responsible for the overall planning, development, promotion and management of the fisheries sector in the country. The Ministry directly involved in the formulation of plans, policies and strategies in the areas related to fisheries and aquatic resources. The Ministry has four statutory bodies, a Department of Fisheries and Aquatic Resources (DFAR), and a public company under its purview namely, Ceylon Fisheries Corporation (CFC), Ceylon Fishery Harbors Corporation (CFHC), National Aquatic Resources Research and Development Agency (NARA), National Aquaculture Development Authority (NAQDA).

- CFC is responsible in purchasing and sale of fish, production and sale of ice, provision and maintenance of cold storage facilities and production and sale of fishery by-products.
- CFHC was established to provide and maintain fisheries infrastructure facilities such as proper landing facilities through construction, maintenance and management of harbors and anchorages. CFHC is also responsible for carrying out maintenance dredging activities at its fishery harbors as well.
- The NARA is the research arm of the Ministry and conduct research on all living and non-living aquatic resources in Sri Lanka. Besides this, it is also responsible for development, management and conservation of aquatic resources. Knowledge dissemination activities and provision of advisory services are also important functions performed by the NARA.
- The NAQDA has been vested with functions of development and management of all freshwater aquatic resources in the country. It promotes development of aquaculture and sea farming too.
- The DFAR Management, regulation, conservation and development of fisheries and aquatic resources are the functions of the Department of Fisheries and Aquatic Resources

In Sri Lanka, fishing activities take place all around the entire coastline. There are 19 fisheries harbors in operation and one is under construction at Suduwela in southern coast. Moreover 8 more harbors are proposed to be developed in in north and northeast regions. Exact locations, main facilities; berthing facilities; servicing facilities and fish processing facilities of each harbor can be found at the CFHC web site at http://www.cfhc.gov.lk/Harbour_Main.php . In addition 40 anchorages and 1562 5 (marine 790 & 772 inland) fish landing sites provide fish landing facilities for fishing crafts except multiday boats.

Generally fish landed at fishery harbors are transported to the wholesale market for local consumption and processing factories for exportation. Fish landed at anchorages and landing sites are directly sold either to local markets or consumers. The local market channel comprise of

wholesale market followed by retailers, wholesale dealers, urban stalls, village stalls and household distributors etc. (MFARD, 2010-2013). Many infrastructure facilities and input are available at harbors and landing sites, number of ice plants available at each district is given above under section 7. Extension services availability from each body can be found from their respective web sites.

NAQDA was established under National Aquaculture Development Authority of Sri Lanka Act, No 53 of 1998. The Authority consists of five major Divisions under the Director General namely Fresh water Aquaculture Development, Coastal Aquaculture Development, Extension, Finance and Human Resource Development which are headed by four Directors. NAQDA owns eight freshwater aquaculture breeding centers, which breed major Indian and Chinese carps, Common carp, and Tilapia species to provide fish seed (post larvae, fry or fingerling stage) for culture-based fisheries and aquaculture. Three freshwater prawn breeding centers provide post larvae for stoking in reservoirs and aquaculture facilities. To promote ornamental fish industry in the country, NAQDA maintains two ornamental fish breeding centers and multi species marine fish hatchery. NAQDA governs two training centers namely; National Inland Fisheries and Aquaculture Training Institute (NIFATI) and ornamental fish breeding and training center. The first said training institute organizes training for stakeholders in inland fisheries and aquaculture. The both centers are equipped with culture facilities, laboratories, lecture theatres and residential training facilities. District aquaculture extension office are located in twenty two (22) districts of the country. Extension arm of NAQDA function under Assistant director (extension). Twenty two district aquaculture extension officers supervise the district aquaculture extension activities with the support of aquaculture extension officers (the grassroots level officer of aquaculture extension). Extension Officers are responsible for extension, regulation and management of aquatic resources which include stocking of fish seed, supervision and coordination of the activities of fisheries societies, educating the fishermen, prevention of illegal fishing, and transfer of technology related to aquaculture. NAQDA creates enabling environment for fishers in reservoirs and investors in aquaculture by enforcing regulations, issuing aquaculture licenses, introducing cultivable aquatic species including aquatic fauna and seaweed, providing laboratory facilities to diagnose diseases of seed materials and cultured organisms and coordinating cross sectorial communication etc. NAQDA supports her all services to achieve its mandatory objectives of developing aquaculture and aquaculture operations to increase fish production and fish consumption in the country, promoting the farming of high valued fish species, optimum utilization of aquatic resources through eco-friendly practices, promote and establish small, medium and large scale private sector investments in aquaculture and conserve and rehabilitate aquatic resources devastated by poor aquaculture practices (https://www.naqda.gov.lk). NAQDA's effective contribution is reflected by the continuous growth of inland fish production in the country (Figure 2).

4.10 Analysis

This review attempted to evaluate the existing literature, particularly published after 2015, to contrast up to what extent the fisheries and aquaculture contribute to mainstreaming nutritional goals such as improving nutrition and food and nutritional security. Food security and poverty reduction have been main components of the sustainable development goals-2030. Increasing populations and subsequently increasing demand for food have mounted huge pressure on future food supply. The fish, which considered to be the food of poor has the reputation of being the cheapest protein source, than any of the available protein sources, especially in developing countries. Even in Sri Lanka the fishing industry plays a major role in providing the animal protein in the diet of the population. According to the Food Balance Sheets available at the Department of Census and Statistics, fish has consistently contributed around 65% of the animal-based protein intake of the population. Being in a multi-religious and multi-ethnic society many Sri Lankans reluctant to consume animal flesh due to numerous religious and cultural biases but fish is generally acceptable and hence always in great demand. Despite to the relatively low fishery production, compared to some fishing nations, Sri Lankans have considerably high per capita fish consumption of 11.8 kg/year when the global per-capita fish supply is only 17 kg per year. Being an island nation and having considerably high coastal fishery production majority of Sri Lankan diet is comprised with small fish. In recent years, the Sri Lankan fisheries sector has also emerged as an important source of foreign exchange through the export of high value tunas. Nevertheless, in satisfying increasing local demand for fish protein, Sri Lanka has imported annually an additional 70 000 t of dried and canned fish. But in this context, government policies in addressing the growing consumer demand, while safeguarding the consumer rights; food and nutritional security and improving nutrition has not been adequately addressed, assessed and updated.

Even though the Sri Lanka expanded offshore capture fisheries production since the beginning of this decade the productions seems to be remain constant during the last couple of years. In most of the world fisheries showed such stagnant catch statistics before resulting drastic catch reduction due to overfishing. Many marine fisheries around the world believe to be either reached to its production ceiling or overexploited apart from some of the regions in Indian and Pacific oceans. As Sri Lanka, has not yet introduced any of the fisheries output control tools such as total allowable catch (TAC) limits, individual transferable quotas (ITQs) or non-transferable quotas, closer monitoring to avoid IUU fishing and distractive fishing, and on evaluate catch statistics is needed to avoid any potential collapse as such could affect food and nutritional security. On the other hand, as Sri Lanka is in the initial stages of its costal aquaculture a multi-disciplinary approach in addressing the key issues such as maintaining continuous supply of fingerlings/post larvae and to support local feed production is needed to support fish production in safeguarding food security. Moreover, to utilized offshore waters in maximizing aquaculture production a closer pros and cos analysis of offshore aquaculture is needed. Probably public-private partnership, even with foreign investors may be the approach in obtaining high-cost equipment; maintenance and expertise.

Improved postharvest practices will help to utilized bulk of the small fish verities, which reported to be high in nutrient components, come from costal fisheries as targeted as well as by-catch. Improving ice plant facilities at landing sites; proper cooling and storage systems will contribute to reduce fish discards. To understand the causes and extent of post-harvest losses and to find out means of reducing such losses comprehensive studies are needed in identifying causes and extent of post-harvest losses at different loci in the fish value chain. Limited number of studies had been conducted in identifying the nutritional aspect of small fish varieties, specially the micronutrients, vitamins, minerals contents need to be investigated with respect to different species. Even the possibility of extracting bio-active compounds from trash fish and fish waste will also be important for the maximum utilization of fish through product diversification and value addition.

Moreover, if women in fisher household can be empowered for processing and value addition, the monitory benefits can be infiltrated to entire family and further it will ensure purchasing food for entire family because most of the fishermen have reported with alcoholism. Some baseline research need to be conducted on the type and extent of women's participation in post-harvest/fish processing activities; extent of contribution of fish processing towards enhancing household income, livelihood security and wellbeing and major issues that women confront in the fish processing sector and means of resolving them (role of different stakeholder and the need for training and capacity building). Moreover, comprehensive research studies are needed in calculating losses of productivity and reduced economic gains in national level due to gender inequality and what could be the added benefits if women were given the same opportunities as men to reach their full potential.

Even the output/input control of commercial fisheries would contribute in maintaining the sustainability such an approach may not feasible with small-scale fisheries due to huge number of fishing crafts; highly diverse fishing gear and enormous landing sites along the coastline. Thus the FAO has developed Voluntary Guidelines for securing sustainable small scale fisheries is a policy instrument adopted in 2014, by addressing the most crucial issues. These policies need to be adopted or incorporated into national plans of action depend on specific contexts of countries anyhow strong political will is needed to do so. Moreover, expanding our links beyond national boundaries in establishing knowledge and experience sharing with regional and international organizations working for sustainable fisheries and aquaculture in ensuring food security will be an proactive approach. Fisheries and aquaculture has drawn the attention of national policies in many countries as a strategy to increase food production, food security, and nutrition and strengthen the economy. Most of the national policies support to policy objectives of other sectors to achieve national development of the country. When considering the National Nutritional policy of Sri Lanka, 2010 (NNP) and National Fisheries and Aquaculture Policy of Sri Lanka 2018 (NFAP); we can observe the accordance of policy objectives, although the two policies are in distinct fields. "To ensure food and nutrition security for all nation" is the 4th objective of the national nutrition policy (NNP)of Sri Lanka 2010, which is most related to some policy objectives and policy statements of the national fisheries and aquaculture policy of Sri Lanka 2018. Interestingly both policies have very closed policy statements relates to food and nutritional

security and nutritional policy. Following table (Table 4) tabulates the policy objectives closely related or orienting towards the same direction.

Table 4. Aliening policy objectives and policy statements of National nutrition policy and national fisheries and aquaculture policy orienting towards to achieve similar outcomes. Note: there were several policies under objective 3, 4, 5, and 6, which are not elaborated here for this comparison

National nutrition policy of Sri Lanka 2010	National fisheries and aquaculture policy of Sri Lanka 2018
Policy objective 4. To ensure food and nutrition security for all citizens Policy statements 5.4.1 Ensure access to adequate, nutritious, safe and quality food at affordable price throughout the year. 5.4.2 Promote consumption of a wide variety of foods ensuring intake of all macro and micronutrients to prevent deficiency disorders and diet related chronic diseases. 5.4.3 Promote and facilitate improvement of quality of commonly consumed food items (e.g. food fortification) to ensure micronutrient supplementation for vulnerable groups. 5.4.4 Enact and implement of appropriate legislations and other regulatory mechanisms to ensure provision of safe nutrition to all citizens of Sri Lanka	Policy objectives 3.Increased marine fisheries production 4. Increased aquaculture and inland fisheries production 5. Minimized post-harvest losses and increased value addition 6. Increased per capita consumption of fish Food safety, food security and nutrition Policy statement 4.3.1. Create employment with adequate income levels in the sector to ensure food security of more people. 4.3.2. Ensure quality and food safety of locally marketed fish and fishery products. 4.3.3. Promote consumption of sufficient fish for meeting nutritional requirements. 4.3.4. Stock fish as buffer stocks during gluts to ensure the availability of fish at reasonable prices during lean periods. 4.3.5. Ensure the traceability and transparency at all stages of the value chain process.

Although the two policies are serving in two sectors service (nutrition) production (Fisheries and aquaculture) both are inter dependent. If the production is not available (policy objectives of 3 and 4 of NFAP) policies of 5.4.1 and 5.4.2 in NNP will not be a reality. Policy objective 5 and 6 of NFAP support the 5.4.3 and 5.4.4 policies of NNP. Policy statement of 5.4.1 and 5.4.2 of NNP and 4.3.2 and 4.3.3 are targeting similar aspects to achieve. Inland fisheries and aquaculture in this regard plays a very important role in the country's food and nutrition security. Especially the development of inland fisheries triggered to increase the availability and the accessibility of animal protein source in the rural areas for an affordable prices. Similarly this fish are produced at near consumer centers, which provides access to fresh and quality consumer product. It is clear that the increased production of inland fish support to achieve the policy statement of 5.4.1 of the NNP of Sri Lanka. As explained in the introduction of this section CBFs is the main fisheries

enhancement strategy applied in inland waters of the country. Essentially the CBFs in Sri Lanka is a composite culture system, which utilized different fish species depend on distinct food niches available in different regions of the water body. This strategy promotes the diversification of fish species produced in the reservoir together with exotic carp species, tilapia, local fish species and giant freshwater prawn. Consumption of different species may support to ensure the intake of micronutrient requirement of rural communities (table 3). According to the health information the micronutrient deficiencies leads to hidden hunger creating serious health issues in latter stages of the human lifecycle (FAO 2016). Although, freshwater fish do not provide high levels of EPA and DHA compared to the marine fish species (Beveridge et al., 2013), still the consumption of fresh water fish provides some amount of EPA and DHA (Table 3), which supports the cognition, brain development (Albert and Metian, 2013; FAO 2016, 2018) and retinal, and immune function (Steffens and Wirth, 2005). However, Steffens and Wirth, (2005) stated that two plancktivorus freshwater fish species such as Silver carp and Bighead carp are rich sources of EPA and DHA. Policy 5.4.3 of the NNP of Sri Lanka (Table 4) is supported by the diversity of fish produced in inland waters and their rich nutrient composition to provide micronutrients for people.

Sri Lanka still have great potential to increase the inland fish production by expanding culture based in seasonal reservoirs scatter in the country. Based on the statistics available in NAQDA, only 453 and 303 seasonal reservoirs were stocked with fingerlings and obtained total fish production of 8094 Mt. This production was achieved through stoking small percentage of total number of reservoirs available in the county. According to the database of Department of Agrarian Development of Sri Lanka there are 12000 functioning village irrigation schemes are available. If consider the use of seasonal reservoirs in both year as a percentage of total available such waterbodies it will be 6.3%. Even use of 50% of seasonal reservoirs may change the inland fish production significantly. The high fish production of this reservoirs correlated with the high productivity and possibility of complete harvesting of stocked fish. The correct selection of reservoirs for CBFs is essential for its sustainability (Wijenayake et al 2016). Reliable fingerling supply at correct time with required combinations is also to be ensured for the sustainable fish production in seasonal reservoirs.

Utilization of untapped minor cyprinid resources in reservoirs is one of the main potential areas to increase the inland fish production and consumption (Amarasinghe 2013, Amarasinghe et al 2016). Small fish, which can consume as whole contains high level of micronutrients (FAO 2016 and 2018) and potentially the minor cyprinids can be played a significant role in nutritional security in the rural communities. Creation of market demand for minor cyprinids is also very important if they are going to be harvested. It is very important to introduce processing techniques, value addition, product development and best cooking methods without damaging the level of nutrients in small fish. NACA (2011) sated that species type consumed and nutritional benefits from fish consumption will be influenced by local processing methods and eating patterns. Consumption of whole fish with head, bones and viscera play a critical role in supplementing micronutrient intake because these part are concentrated with micronutrients. There were other advantages of small fish, they can store and processed more easily and affordable to poor (low price and ability to

purchase small portions). Small fish are sold in markets as fresh or processed such as sun deride, smoked, processed in to source or flour etc. Small freshwater fish are not restricted to local consumption or subsistence fishing, sometimes exported to foreign markets. The small dried fish from Africa's great lakes and large reservoirs are traded throughout east and southern Africa – including to coastal cities (NACA 2011). A Dried fish product of (Amblypharyngodon mola) is exporting by Myanmar to Australia (personal communication U.S. Amarasinghe). Therefore, more research on product development value addition in this regards can be promoted.

Although, exotic fish species have been used for CBFs in reservoirs, some species are receiving less market demand. Especially Silver carp and Bighead carp receive less demand in Sri Lanka due to the soft texture of the flesh. As such, fish farmers reluctant to stock them in reservoirs due to low value determined by the market. It should be noted that these two species are rich in EPA and DHA and good candidates to provide very important essential fatty acids (Steffens and Wirth, 2005). The production potential of these species is very high in very productive seasonal reservoirs due to their fast growth rate at the presence of plankton (Wijenayake et al. 2005). There is a good potential to increase the fish production in medium and large perennial reservoirs by increasing the stocking of these species. Innovative processing, product development and value addition techniques targeting the palatability of Sri Lankan consumers is very important to create the demand and followed by sustainable production of these species.

Globally food prices are determined by increase of agricultural inputs and some other factors such as price of oil, climate driven impacts, civil war and epidemics etc. To build the resilience of the fluctuating food prices and to ensure the food security is strengthening the economy of people. Economic development of fishers and improvement of their living standards are embedded in the fisheries an aquaculture policy by generating new job opportunities. CBFs have created increased livelihood opportunities in fishing and along the existing value chain. Chandrasoma and Pushpalatha, (2018) reported that the increase of livelihood opportunities were ranges from 50% to 323% in five reservoirs after introduction of CBFs. However, there is a lack of arising innovative enterprises based on inland fisheries to enhance the job opportunities. Fingerling production in community based mini nurseries and private nurseries have crated inland fishery based new livelihood practice in the country. Also the exporting giant freshwater prawn have created some job opportunities in the country and additional income to rural communities. Initiation of canned fish production based on Catala and fish paste out of Chinese carp species are new development in the product development sector in inland fisheries. Probably with further development and the expansion of inland aquaculture may create new value chains in the sector. Current situation also have created a competitive advantage for the inland fishing communities/rural people for starting small enterprises. If they can do value addition to inland fish to reach the supermarket chain under present scenario, it will be a good investment for their future. Present post-harvest practices should be improved from the landing sites and along the value chain to reach the high end markets. It is important to improve the present quality of dry fish and the smoked fish produced by local people to reach the high end markets. Transferring technologies, which can feasibly adapted by the rural communities is very important in this regards. Diversification of market chain through value

addition and product development can be used to empower the women in inland fisheries communities as most of them are engaging with post-harvest and value chain activities at present. Sangeetha and De Silva (2018) revealed that the women engaged in marine sector fish processing and value addition has secured a considerable amount of profit than the fisher women that sells raw fish. Therefore, women involvement in processing and value addition will have positive contribution of their income. This will increase the household income and strengthening the purchasing power of the households of inland fishers. Béné et al., (2009) stated that poor people engaged in fisheries activities in Democratic Republic of Congo spent more on the better quality food when they earned more and it has positive influence on their food and nutrition security. It should be noted that considerable proportion of the fishers are part time fishers in the inland fisheries of Sri Lanka and their main occupation is agriculture (Chandrasoma and Pushpalatha, 2018, Pushpalatha et al. 2015). So, fisheries engagements must increase their household income and probably this should have a positive influence on their food and nutritional security, which has not been much studied in Sri Lanka. In Cambodia poor rural households were found to engage in small-scale fishing in common-pool resources as a second major activity. This produced 31.2% of their total income (Chamnan et al., 2009). Additional income sources for fulltime inland fishers strengthen their economy especially in lean periods severely affecting their purchasing capacity. Poor purchasing capacity affect to the nutrient intake creating food insecurity. Especially during lean period fishers depends on loans taken from money lender for very high interests and make them difficult to pay back (Keerthana 2016).

Development of market channels to distribute inland fish should be done in a well-planned manner. The lowest fish consumption has reported from the estate sector in the country. This may be accessibility for fish, poor purchasing power and low quality of fish after long time improper storage. The demand for silver and bighead carp was observed higher in estate sector in 2002-2004 (personal observation). These two species produced in Hambantota and Moneragala Districts were transported to estate markets. Identification of niche markets is important to plan the inland fisheries production, identify markets and plan effective distribution within short period of time maintaining the freshness of this highly perishable product. Properly planned marketing can reduce the post-harvest losses, maintain the nutritional values and freshness of the products, increase the accessibility for products and consumption and finally can contribute to the food and nutritional security of the nation.

Climate change influences on inland fisheries is one of the main detrimental impact in the sector. Improving resilience of fishing communities for climate change impacts is very important for the sustainability of the inland fisheries. Negative impacts of climate change on inland fisheries affecte the livelihood and the income of the fishes and the food and nutritional security of rural communities. Multisectoral approaches should be identified to ensure the maximum efficiency of water use for the sustainability of agriculture, fisheries and other water usages. Sareeha et al. (2019) stated the impact of water level fluctuation on fish production in irrigation reservoirs in Kalawewa river basin in Sri Lanka. Also NACA (2014) have recommendations to improve resilience in CBFs of seasonal reservoirs in Sri Lanka. Wijenayake et al. (2016) have developed a

multi criteria decision making approach to select suitable seasonal reservoirs for CBFs in Sri Lanka. Aid of scientific studies and combination of indigenous knowledge would be a more appropriate strategy to improve the resilience capacity of vulnerable fisheries communities for climate change impacts.

Impacts of invasive species should be managed again in a multisectoral approach. If there is a value created for the invasive aquatic species, it will be a new livelihood for rural communities while minimizing the negative influences on inland fisheries. Promotion of community level compost production from invasive aquatic plants and food product development from invasive fish species are some potential uses of invasive species. Currently water hyacinth is used for compost production for other agricultural wests in some areas of the country, which support the organic farming concept (personal observation). Techniques for producing fish cake and fish cake based products, fish ham and fish incorporated cookie is available for South American sailfin catfish (Palpola et al., 2018). Introduction of innovative approaches to use invasive species will create new livelihood for rural communities and can increase their income.

Genetic improvement of fish species have gain positive influence on fish production in aquaculture. Genetically improved Farm Tilapia (GIFT) is one of the example and has a significant impact on increasing production. However, inventors of genetically improved species are reluctant to share the new breeds with others. Therefore, research on genetically improved fish species suitable for aquaculture and fisheries enhancement is one of the poorly developed area in the country. NAQDA has done some initiatives in this regards and should be highly appreciated. High end collaborative research with research institutes and universities should be encouraged in this field.

Government is encouraging private investment and public private partnerships in aquaculture sector to create aquaculture based enterprises (EDB 2017, Pecibility report on Sri Lanka's readiness to attract investors in aquaculture 2017). Main target of this move is to develop marine aquaculture targeting high valued species for export markets.

Aquaculture extension services are at appreciable levels and free of charge in the country under the sole authority of NAQDA. Most importantly assuring fingerling availability, improving and monitoring management practices without interrupting the fish production in reservoirs and technical transferring are the priority areas of the fisheries extension. Coordinating large number of reservoirs including seasonal, medium perennial and large reservoirs is a challenge with limited number of humen resources in aquaculture extension. Collaboration with provincial fisheries authorities provide a great support for the aquaculture extension and development of inland fisheries in some provinces. Collaboratively working with other related institutions such as Department of Agrarian development, Irrigation Department, Mahaweli Authority and other rural development programmes of the government and nongovernmental organizations (NGOs) fulfills some gaps in the aquaculture extension.

Inland fisheries is playing a main role in food and nutrition security of the country. The total fish production in 2017 was reported as 90,580 Mt contributing to 17.89% to countries total fish production (www.naqda.gov.lk/statistics). According to (Department of senses and statistics

2017b) per capita supply of freshwater fish was 4kg/year while marine fish and crustacean supplying 27kg/year. Although this figure "looks like small", actual consumption patterns of the marine and freshwater fish in region wise is not available in the statistics. The real contribution of the inland fisheries for the counties food and nutritional security is still underestimated. Probably contribution of the animal protein supply in rural areas would be dominated by inland fish. A study conducted in fifteen villages of seven divisional secretariats divisions in Kurunegala district revealed that 33% of the animal protein supply of the studied population obtained from inland fish . So it very essential to understand the contribution of the inland fisheries and aquaculture to the national food and nutritional security. The actual role of inland fisheries in the patronage of the food and nutritional security will be an eye opener to prioritize this sector and to have the due recognition in rural development agendas.

5. Summary

The importance of fisheries and aquaculture to national economies and food security has been recognized, valued and enhanced. Need to improve the quality of fish and fish related products available in the market. In contrast infrastructure facilities for fish storing, transportation need to be improved in reducing the post-harvest lost.

Regulate local and international trade in fish and fish products. Marketing is an important link all through the fish value chain. Because a number of middlemen are involved in this process and middlemen monopoly in fish buying, exploiting the fishing communities, including the women fish processors have been frequently reported. While international trade in fish and fish products have to be increased the foreign exchange earnings during the past few decades, there were complains that benefits of trade have not trickled down to the people at the bottom and that trade has threatened he nutrition of poorer groups in the country.

Research gaps in fisheries and aquaculture need to be addressed for food and nutritional security, thus a broaden multi-disciplinary research is needed followed by aligning the finding for policies and Act

Broader strategies to utilized available water bodies with novel technologies and techniques is needed while improving the quality of culturable species via genetic improvements. Probably public-private partnership strategies may cater for this aspect meanwhile, middlemen monopoly in fish buying need to be addressed.

Inland fisheries play a vital role in food and nutritional security of the county especially in the rural areas, where the most of agricultural communities are living. It provides fresh animal protein for affordable prices at the vicinity of rural communities increasing their food and nutritional security. Large number of productive reservoirs, good aquaculture extension mechanism, and research and development interventions in the inland fisheries sector have given significant contribution to the development of the inland fisheries in the country. Still the potential of the increasing inland fish production is available in different ways such as; improving good reservoir fisheries management through co-management strategies, utilization of seasonal reservoirs effectively for CBFs development and utilization of untapped fisheries resources with a sustainably, genetic improvement of cultivable species, and introduced new product development techniques for low valued species etc. The National Nutritional Policy-2010 and the fisheries and Aquaculture Policy-2018 have the similar objective of increasing food security in the county. However, the close

relation between these two sectors have to be promoted to identify the gaps in food and nutritional security of the rural communities and formulating solutions to overcome malnutrition in rural communities especially in protein and micro nutritional deficiencies. Although, Agricultural communities have been frequently targeted for the most of the research in food and nutrition, separate studies in inland fishing flocks were very much rare in socio-economic and nutritional studies. Also, real contribution of the inland fisheries and aquaculture to national and regional food and nutritional security in the country is scant in the statistics and published literature. Inland fisheries and aquaculture can be potentially utilized for women empowerment in rural arears by introducing new techniques for product development and improving conversional post-harvest processing in dry fish and smoked fish production. Alternative livelihood opportunities in lean periods is very important for the people whose main occupation is fishing. Improved the awareness of secured micro financial opportunities in fishing communities should be received much attention. Awareness on good practices of postharvest handling and management should be improved in the inland fisheries. Also fish storage and improving marketing channel will support to reduce the losses in fish harvests and increase the financial security. Climate change influences are severely affect the inland fisheries production and consequently the fishing communities and other stakeholders. Building the capacity to improve the resilience for negative impacts of climate change is essential for the nutritional security of the rural areas as well as the livelihood security of people involved in inland fisheries sector. Development of inland fisheries has a great influence on food and nutritional security in the rural areas and identification of its real contribution is very important to recognize its position in national development plantings especially targeting food and nutritional security.

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Section 5

Natural Resources Management Sector

1. Introduction & objectives

Nutrition is a key element in any strategy to reduce the global burden of disease, hunger, malnutrition, obesity and unsafe food cause disease, and better nutrition will translate into large improvements in health among the populations, irrespective of our wealth and home country. Thus, food security must be attained for all living beings to sustain the earth and its environments (WHO, 2002). The strong linkages between nutrient & food production and natural resources (water and land resources, climate), are globally and locally well recognized (Foley *et. al.*, 2005 & 2011; Godfray *et al.*, 2010; Kearney, 2010; Sangakkara & Nissanka, 2008; Senanayake and Premarathna, 2014).). Climate and topography together combine to create natural-resources-rich range of ecosystems in Sri Lanka (NARESA, 1991). Major natural resources include land, water and air, wetlands, forests, natural vegetation, varied natural ecosystems, man-made ecosystems, rich fauna & flora biodiversity, agricultural crops, domesticated animals and minerals (Arulpragasam, 2000). An ecosystem functions as a unit of nature that combines biotic communities and the abiotic environments with which they interact. A healthy ecosystem is a sustainable component of the biosphere that has the ability to maintain its structure, and function through time and in the face of external stresses or resilience (Kochtcheeva, 2000; Mageau *et. al.,* 1995). But, with modern development schemes, land use changes transformed natural ecosystems to farmlands, human settlements and urban centers at the expense of natural fauna and flora habitats. Strong linkages of present trends of land-use changes with deforestation, biodiversity loss and land degradation, has been pointed out by many studies (MoENR, 2014, Bandara, 2013, Maitima, *et. al.*, 2004, MERE, 2002). Land use management has direct link with ecosystem health which intern impact on human health (WHO & CBD, 2015). At present, affecting nutrient and food supply chain, ecosystem services and functions in Sri Lanka heavily affected due to ecosystem fragmentation, weak institutional coordination, lack of institutional synchronization, improper land governance and lack of landscape level management planning. This report aims to review present status with documented evidence, to retrieve existing gaps and generate guiding information for recommendations toward better natural resource management linked with nutrition and food security of Sri Lanka.

Objectives of the review are;

1. Review documentary evidences for nutrition considerations for food production with special reference to natural resource management
2. Conduct an analysis of nutrition related gaps in policies, sector plans, strategies, budgets, institutional mechanism and service provision at national and decentralized levels (provincial/district/grassroots levels) in relation to natural resources

2. Compile the situational assessment and prepare a report on findings and recommendations.

2.Methodology

The methodology followed in this task is four stepped. Initially, rapid scoping review was done to assess availability of published articles to address focused questions (see table 1: TOR - area of natural resources). Secondly group the literature based on type of article (Abstracts, reports, review articles, project reports, research news, etc.) under each question or group of questions. After literary warrant, article screening was done following inclusion and exclusion criteria described in section 3. Next the information was extracted for all the sections after a comprehensive review of screened articles. Finally, the analysis report was completed using that information under each sections document was prepared. In addition to the information also collected for descriptive reviews when needed for some specific sections.

Table 1: Focused questions (based on TOR)

No	Focused area in nutrition & food production linked to natural resources
1	Availability of policies and to what extent they are implemented to sustain the base of natural resources (soil, water, air, biodiversity, climate, forest) in food systems
2	Extent of securing sustainable water sources at households
3	Availability of Promotional programs for biodiversity and their impacts
4	Extent of access to food sources from natural forests such as bee honey, fruits (wood apple, gooseberry) and green leafy vegetables and impact on nutrition at household level
5	Involvement of different institutions and agencies for the implementation of strategies and policies and their impact on sustainable nutritious food production and consumption
6	What programs are available and their impact to ensure improving nutrition in a sustainable manner

3. Inclusion & exclusion criteria of evidences

Information on evidences for each section were evaluated and selected based on following inclusion and exclusion criteria for each questioned area of the ToR.

Table 2: Study inclusion and exclusion criteria

Category	Inclusion	Exclusion
Authentication of information	Published articles, important articles from reliable sources, reports pertaining to past projects with authentication.	Articles with no authentication
Subject relevance	Information which are directly or indirectly linked to relevant to both investigating subject areas 1. food & nutrition and 2. natural resources	Others exclude
Locational relevance	Mostly include information related to Sri Lanka specially for information related to policies and operational programs	Examples from other countries
Spatial coverage	Information on national level programs and projects	Local level study related information
Time period	Most recent available articles were used for each focused area	Older articles exclude when available recent articles
Publication language	English	Non-English languages

4. Evidences & analysis

4.1 Processes declining natural resources

Major forces which contribute to declining sustainability of natural resources including extreme weather conditions particularly drought and heavy rains, and human activities that pollute or degrade the quality of soils and land utility negatively affecting food security, productivity, livelihoods, and the production and provision of other ecosystem goods and services. Comprehensive review and detailed descriptions have been given in National action program for compacting land degradation in Sri Lanka (MoENR. 2014). In Sri Lanka, acceleration of several processes has been identified as major causes for land degradation (Nayakekorala, 1998). Description of twelve major processes is given below.

I. **Soil erosion**: loss of surface soil by water and wind. The productivity of 50 % of land in the agricultural sector is significantly affected due to soil erosion.
II. **Fertility decline:** Net decrease in available plant nutrients and organic matter content in the soil. This results from soil erosion and continuous crop cultivation without application of proper nutrient management practices.
III. **Dystrification**: Lowering of soil pH by increasing acidic compounds in soil. The productivity of agricultural lands particularly cultivated with tea, potato and vegetable in the up-country wet zone are significantly affected due to acceleration of the dystrification process.

IV. **Eutophication:** Net increase in plant nutrients in the soil making imbalances among various type of nutrients affecting plant uptake. This happens due to improper fertilizer application by the farmers. It's a very common incidence in many vegetable farms.

V. **Salinization/alkalization**: Net increase in salt content/sodium content of soil leading to significant decline in crop productivity. The productivity of low lands particularly in the low country dry zone are affected due to acceleration of salinization/alkalization processes.

VI. **Sealing and crusting**: Clogging of pores in soil surface with fine soil material and development of a thin impermeable layer. It has been very common in lands exploited for seasonal agriculture in the Alfisols region in Sri Lanka.

VII. **Compaction:** Deterioration of soil structure and formation of dense soil layers due to constant trampling by animals and running of heavy machinery. This problem is experienced in paddy fields in some dry zone areas and tea plantations.

VIII. **Water logging:** Net increase in soil pores filled with water. This situation develops due to poor drainage in low-lying areas.

IX. **Soil subsidence:** Lowering of the surface level due to oxidation of organic materials in the soils. This happens in soils with high organic matter such as Histosols (Bog soils) when they are drained. Not very common incidence in Sri Lanka .

X. **Aridification:** Net decrease in soil moisture content due to increase of overland flow of rain water due to various human activities and reduction of infiltration**.**

XI. **Pollution**: Addition of materials to soil which causes toxic effects in soil. It has been reported in areas where industrial and urban waste is disposed over the land. Surface and ground water pollution due to over application and misuse of agrochemicals, over irrigation and improper garbage disposal.

XII. **Conversion of agricultural lands/ loss of agricultural lands:** Fertile agricultural lands are converted to other uses / lost due to natural or manmade hazards.

Many aspects of natural resources degradation in Sri Lanka has been addressed and documented by many documents (ME, 2010a & 2010b, NARESA, 1991). Sri Lanka is recognized as a biodiversity hotspot of global importance (Marchese, 2015). Its diverse climate and topographical conditions have given rise to many ecosystems. These ecosystems are the basis for this rich species diversity which is believed to be the highest in Asia in terms of diversity per unit land area (MoENR, 2014). The diversity of ecosystems in the country has resulted in a host of habitats, which contain high genetic diversity. Descriptive review of importance and status of biodiversity is available in Biodiversity of Sri Lanka Gunathilleke, *et al*. (2008).

4.2 Policies to sustain the base of natural resources and food system in Sri Lanka

Nutrition and food security related national programs are mainly governed under the frame work of Sri Lanka National Agriculture Policy (SLNAP) and the National Nutrition Policy (NNP) of Sri Lanka. In the NNP, policy objective 4 is mainly focused to ensure year-round access to adequate,

safe & quality food and policy objective 5 is aiming at promoting mainstreaming nutrient in other related national and provincial policies (MOHN, 2010). Twenty-one major thematic areas were addressed by the SLNAP and six theme areas are directly focused on food & nutrition and sustainable use of natural resources (MOADAS, 2019). Information for each related thematic area and details extracted from the Sri Lanka National Agriculture Policy Document is summarized in table 3.

Table 3: Related thematic areas included in National Agriculture Policy of Sri Lanka

No	Thematic area of SLNAP	Description and Linkage with natural resource
1	Promote Agriculture Production	• Implement technically sound, economically viable environment friendly and socially acceptable programs to promote sustainable agriculture development with efficient and effective utilization of resources. • Increase productivity of water and land by enhancing crop production through the application of sustainable cultivation practices. • Promote good agricultural practices such as Integrated Pest Management and Integrated Nutrient Management for sustainable agriculture development.
2	Irrigation and water management	• Conserve existing water resources for sustainable agriculture development. • Prevent pollution of water from agriculture and industries. • Promote conservation of rain water and ground water. • Safeguard irrigation reservoirs, canals, drainage systems and other structures from natural calamities.
3	Land use	• Promote land conservation within watershed areas. • Reclamation of degraded, barren and infertile lands for crop/ forest cultivation.
4	Soil conservation	• Enforce soil conservation through Soil Conservation Act
5	Traditional agricultural crops and methodologies	• Foster, preserve and disseminate traditional knowledge in agriculture related to organic farming, pest control, and preserving and processing of food for nutritional and medical purposes.
6	Home gardening	• Promote home gardening and urban agriculture to enhance household nutrition.

There are many policies formulated targeting sustainable natural resources and they are aimed at directing land users for scientific land use. Mitigation of land degradation has been given high

priority in the policies (MoENR, 2014). Some important legislations relevant to land management as stated in National Action Plan for compacting land degradation are listed below and details can be found in MoENR (2014).

Box 1: Selected legislations relevant to land management

1. Crown Lands Encroachment Ordinance No 12, 1840 and State Lands Encroachment Act 8 , 1954.
2. Forest Ordinance No. 16, 1907
3. Land Development Ordinance No. 19, 1935
4. Fauna and Flora Protection Ordinance No. 2, 1937
5. State Land Ordinance No. 9, 1947
6. Soil Conservation Act No. 25, 1951
7. Land Reform Law (1972) and Land Reform (Amendment) Law (1975)
8. Urban Development Authority Act No.41 of 1978
9. State Lands (recovery of possession) Act No. 7, 1979
10. Mahaweli Authority of Sri Lanka Act No. 23, 1979
11. National Environment Act No 47, 1980
12. Coast Conservation Act No. 57, 1981
13. Agrarian Development Act No. 46, 2000
14. Sri Lanka Disaster Management Act No. 13, 2005

4.1.1 Support policies to combat land degradation

Summarized compilation of nine such support policies have been documented in National Action Program (NAP) for Combating Land Degradation in Sri Lanka (MENR, 2002).

4.1.1.1 National Agriculture, Food and Nutrition Strategy of 1984

The importance of agriculture in economic growth prompted the government to define National Agriculture, Food and Nutrition Strategy. The aim of the strategy was to assess agriculture and food situation in Sri Lanka and establish priorities for sector development. The strategy declared that land and water provide the basic natural resource base for agriculture and recognize that the proper management of their resource was of critical importance for the future agricultural development in the country. The two important strategies proposed in this policy document regarding land degradation were land use planning and watershed management.

4.1.1.2 National Conservation Strategy of 1988

Threats to the environment in many parts of the world and the global problem that was being created promoted the International Union for Conservation of Nature and Natural Resources (IUCN) to assume responsibility to alert governments of the urgent need to conserve their living natural resources. Guidelines were prepared by the union and presented in a document entitled

"The World Conservation Strategy". One of the first countries to recognize the importance of the objectives laid by the Union was Sri Lanka and therefore the government decided to prepare a National Conservation Strategy for the country in 1982. The strategy which was completed in 1988 was designed to restore sustainable development in the country. The strategy set out objectives of conservation; indicated the plans for overcoming such constraints and spelt out specific measures that need to be taken at the sector level to conserve the environment and the natural resource base in the country.

4.1.1.3 National Policy Framework – Ministry of Agriculture, Lands and Forestry of 1995

The framework synthesized some of the fundamental principles and perspectives for a national policy in the three sectors of agriculture, lands and forestry, which were brought under a single ministry in 1994 (MALF, 1995). Within the lands sector, the main issue that was addressed was the degradation of land resources due to over use and miss-management. The framework declared that haphazard allocation of state lands over several decades under the alienation program to allocate lands to landless, to relieve unemployment or for agricultural development without proper and systematic land use planning has caused enormous damage to the land resource base in the country and consequently to the environment. The framework also stated that "given the fragile nature of this scarce natural resource which is vital for the continuing subsistence of life in all its forms, it is essential that we manage it with care and efficiency, so that its benefits would accrue not only to our generation but also to generations yet to come on whose behalf we hold it in trust". In order to manage the limited land resources in the country with care and efficiency, several proposals and recommendations have been made.

4.1.1.4 National Forestry Policy of 1995

Since few decades back, the closed canopy natural forest cover in Sri Lanka has declined rapidly from approximately 80 % to less than 24 % by 1992, and deforestation today is regarded as one of the main environmental and social problem in the country. Deforestation and forest degradation have reduced biodiversity; made soils less productive; increased the scarcity of wood and fuel wood; and shortened the life span of irrigation canals. All these lead to a reduced well-being of the present and future generations. The forest policy has been as formulated to address a number of issues such as continuing decrease in forest cover; expanding the conflict between forestry and agriculture; ineffectiveness of the efforts at protecting the forest; inefficient management of state-owned forest; and inequities in the distribution of benefits. The forest policy comprises both policy objectives and strategies for national forestry information. Some of these have a bearing on the control of land degradation.

4.1.1.5 National Physical Planning Policy of 2002

The National Physical Planning Policy states that all lands in the country cannot be put into economic use; some lands have to be protected in order to fulfill certain objectives that will benefit the country as a whole and contribute to sustainable management. These includes watershed areas;

areas with rare ecosystems; and ecosystems of exceptional diversity; areas with concentrations of economically important or potentially important species of varieties and threatened species; fragile areas that may be easily degraded; and important aesthetic, cultural, historical and recreational areas. The policy, therefore, recommends that a Protected Area Network be established that will integrate all the areas within the country that need to be conserved. The areas included in the network will be divided into two categories depending on the level of protection afford. The category one will comprise areas that will be strictly conserved and preserved to protect biodiversity, soil, water, historical, cultural, religious and aesthetic values and scenic beauty. These will include all wildlife reserves; all conservation forests identified by the Forest department; degraded forest areas that will be restored for ecological reasons; areas of archeological and historical value where development activities are not present; areas of natural beauty and natural features of exceptional value; environmentally and hydrological important wet lands; environmentally and hydrological important lands in the up country; areas where landslides are to be expected; unutilized lands in areas of high rainfall intensity with slopes of over 60 % and highly erodible soils; and all natural and manmade water causes and water bodies and their reservations and catchment areas. The category two will comprise areas where current development activities will be allowed to continue subject to restriction. These will include forest reserves and proposed reserves other than conservation forests coming under the jurisdiction of the Forest department; degraded forest areas restored by replanting natural and economic species; archeological sites located within developed areas; tourist development areas identified by the Tourist Board; coastal and natural habitats; sensitive areas in river basins as defined by the National Water Supply & Drainage Board; areas where a modest level of landslide hazards exists; utilized lands in areas of high rainfall intensity with slopes over 60 % and highly erodible areas; stream bank reservations; major ground water aquifers that should not be over exploited or polluted; flood protection areas and natural flood retention areas; areas of natural beauty and natural features of exceptional value in the coastal areas and urban forest and urban parks.

4.1.1.6 National Policy on Agriculture and Livestock of 2003

This policy objective was to mobilize investments and guide human efforts to use the full potential of the agricultural resource base for achieving national goals. It has 22 policy statements and the 10^{th} was on land, water and inputs (MAL, 2003). The 10^{th} has initiatives to mobilize resources for conserving highlands and catchments; making soil conservation on cultivated highlands and slopes compulsory; mobilize farmers for conservation making protection of land fertility a major responsibility of the extension service; provision of scientific instruction for such protection without delay; mobilize for joint decision making on what to produce based on condition of land, weather, water and market; preparation of tract and village level plans and implementation of them to ensure cultivation of all cultivable lands; mobilize farmers to market based production avoiding disadvantages of agricultural land fragmentation; and provision of lands to landless farmers, and medium and large scale farm enterprises.

4.1.1.7 National Environmental Policy and Strategy

The objective of the National Environmental policy is to promote ecologically sustainable development through protecting the integrity of the environment and natural resource base with due recognition of the contribution of natural resources to economic development and to the quality of life. The means of achieving this objective has been defined by several policy statements. These are to guide the management of the environment and natural resources. An important policy statement is that land resources are managed to maintain and enhance their quality, productivity and their life supporting capacity and protect their ability to support a variety of land use options. In order to accomplished this, several policy options have been included which are the development and promotion of land use systems that protect soil from erosion; restoration of previously degraded land through the provision of incentives for the adoption of appropriate land use systems with an emphasis on land diversification in the upland plantation sector; provision of legislative protection for areas of significant landscape value; and prevention of the degradation of the quality and flow of waters considered to be of national importance.

4.1.1.8 National Land Use Policy

The land use policy for Sri Lanka provides a framework for the best possible use of the land. The policy also provides a framework that guides the development of land resources along a desired path so that an expected pattern of land use can be achieved. The policy has several objectives some of which are related to the control of land degradation. The objectives are promote land use that will minimize environmental damages, reduce the vulnerability of land to natural and man-made disasters, protect and manage watersheds both private and state, conserve bio-diversity, soil and water, and protect land from encroachment.

4.1.1.9 National Watershed Management Policy of 2004

The degradation taking place in the upper watershed in the country has manifested itself in the denuded forest cover, the exposed slopes prone to landslides, soil profiles truncated by erosion and poor in fertility, increasing fragmented and uneconomic land holdings worked by the people, the silting of rivers and reservoirs, and the frequent and costly floods in the coastal plains. The government has been deeply interested in arresting these ravages and preserving and managing the upper watersheds for the benefits of the future generations. A national watershed management policy was therefore prepared to protect these environmentally vital areas (MENR, 2004). The policy provides a blueprint for the formulation of legislation and implementing mechanisms that are ultimately needed to regulate human intervention in these areas.

4.1.1.10 National Agriculture Policy of 2007

This policy has 22 statements (MADAS. 2007). It intended to set the agenda and strategic directions for the development of the food and agriculture sector and has initiatives to address land degradation related issues. Under the initiatives of land use planning and soil conservation, provisions are available for restoration of degraded lands and soil conservation. The soil

conservation component includes implementation of the Soil Conservation Act and making aware the farming community on soil conservation. It has also initiatives for conservation of agricultural lands in watersheds.

The support policies have been intended to deal with issues related to land degradation directly or indirectly. However, one common weakness in many of policy initiatives has been the delay in implementing them. Some still remains as drafts. Further, some policies have not been implemented at all due to various reasons such as lack of legal provisions and constraints in physical, financial and human resources. It has been very common in under developed and developing countries like Sri Lanka. Further, most of policies have initiatives for control of soil erosion but the other land degradation related issues have not been addressed adequately. It should be taken into consideration in formulating future support policies in the country. For this purpose information system or database on land degradation must be made available for the vertical network of decision makers to enable them to make effective policies concerning the use and management of resources. Decision makers at all levels in the society should be able to participate in the design and implementation of the support policies to be formulated in the future. It positively affects the social, economic and ecological wellbeing in mitigating land degradation.

4.1.1.11 Important policy statements relevant to land degradation

There are many important policy statements relevant to land degradation introduced under various policies (MoENR, 2014).

Policy	Statements related to addressing land degradation
National Forestry Policy, 1995	• All state forest resources will be managed sustainably both in terms of the continued existence of important ecosystems and the flow of forest products and services • Natural forests will be allocated primarily for conservation, and secondly for regulated multiple-use production forestry • Degraded forestland will be rehabilitated as forest for conservation and multiple-use production, where this is economically and technically feasible, mainly for the benefit of local people. • The state will promote tree growing by local people, rural communities, NGOs and other non-state sector bodies for the protection of environmentally sensitive areas. • Nature-based tourism will be promoted to the extent that it does not damage ecosystems and insofar as it provides benefits to the local population
National Environmental Policy, 2003	• Resources such as land, water, air, minerals and biodiversity will be managed in a manner consistent with the viability of ecological processes • The economic value of environmental services will be recognized so as to assure the sustainability of such services for the benefit of the people • The institutional framework for sound environmental management will be strengthened through capacity-building, legislative instruments and improved inter-institutional coordination and linkages • Education at all levels, together with research, will be promoted in a manner designed to increase the level of awareness of all aspects of the environment

	and its care and management among all stakeholders • Socially responsible behaviors will be encouraged and further developed through an effective framework of awareness building, incentives and enforcement
National Wildlife Conservation Policy, 1990	• Maintaining ecological processes and life-sustaining systems, with particular regard to primary production, hydrological balance, nutrient cycles, and prevention of erosion, siltation, drought and flood. • Management of all protected areas in the context of their surrounding landscapes, taking into account the ecological, social and economic links between natural and human systems. • Monitoring of events and take action needed to maintain consistency between the national wildlife policy and other sectoral and inter-sectoral policies. • Promotion of co-operation among stakeholders through participatory decision making at all levels.
National Watershed Management Policy, 2004	• Watersheds or segments of watersheds be classified as strictly protected watersheds and protected watersheds • All encroached and disturbed lands in critical water sheds in the central highlands be surveyed and demarcated and recovered where appropriate • All undeveloped, steep and sensitive lands situated above 1500m elevation, shall not be released except for conservation purposes or strictly for natural restoration • High risk land slide prone areas be declared as strictly protected areas and medium and low risk areas as protected areas • All agricultural practices with conservation measures including the selection of crops, cropping patterns and land and water management in critical watersheds be according to the guidelines issued under the Agrarian Services Act, Soil conservation Act and any other Act that may seem relevant and the policies of the National Land Use Policy • Incorporate appropriate mitigation measures in the implementation of development activities in watersheds • Create awareness and consciousness among communities / stakeholders and promote commitment for sustainable watershed management through participation and partnership • Facilitate a holistic approach to watershed management by recognizing a Watershed Management Unit at the provincial level under the Chief Secretary of the respective province • Evaluate the services provided by watersheds, environmental costs and benefits, and include in the national accounting system • Allocate an appropriate portion of the GDP through the national budget, and cause

**** Adapted from MoENR (2014)***

4.1.2 Key Land Related Agencies and Governing Legislation

A comprehensive review on issues and challenges in land administration in Sri Lanka available in report of Annual World Bank Conference on Land and Poverty (Zainudeen, 2016) and the key land related agencies and governing legislations summarized in Table 4.

Table 4: Key Land Related Agencies and Governing Legislation

Institution	Scope of authority in relation to land matters	Governing Legislation
Agrarian Service Department	Securing tenancy rights of the cultivator from those of the land owner	Paddy Land Act of 1958
Board of Investment	Can acquire, sell or lease land for the purposes of industrial sites, for the use of employees or for general economic development or to lay out industrial estates for sale or lease	Board of Investment Act No.'s, 4 of 1978, 35 of 1980, 43 of 1980 21 of 1983, 49 of 1992 and 9 of 2002
Department of Agriculture (Natural Resources Management Centre (NRMC)	Optimizes land and water resources use on a scientific basis in agriculture. NRMC is engaged in: • Development and dissemination of land conservation and water management techniques for sustainable agriculture • Development and maintenance of a database on land and water resources • Soil survey, land suitability evaluation and land use planning • Technical assistance for watershed management, land use planning and farm development • Implementation of the Soil Conservation Act of 1951, amended in 1996 and training trainers in soil and water conservation.	Soil Conservation Act 1951 1996
Department of Land Settlement	In connection with land management system in Sri Lanka: • Carries out title settlement process of the state and private lands under the provisions of Land Settlement Ordinance • Conducts property investigations, investigating the documents in the land registry, calling title settlements, conducting title settlement investigations, recommending, approving and title settlement under Land Title Registration Act	Title Registration Act No. 21 of 1998 Land Settlement Ordinance No.20 of 1931.

Land Commissioner General's Department	Responsible for the protection, development, management and distribution of state-owned land, including the distribution of lands under various schemes, issue of permits, grants and leases under principal acts and laws relevant to administration of lands. There are 06 Deputy Land Commissioner's offices (Debarawewa, Ampara, Mahiyanganaya, Polonnaruwa, Anuradhapura, Trincomalee) and 02 Assistant Land Commissioner's offices (Kantale, Moneragala) • Planning, implementation of resettlement schemes under Land Development Ordinance and issuing grants for the distributed lands. • Distribution of lands under Government Land Ordinance; under this: - Issue of special and independent grants. - Issue of Temporary Deeds for Temples. - Release, lease and transfer of land necessary for government departments, statutory boards and Local government bodies. - Grant of lands under long term permits for houses, agricultural, industrial and commercial purposes. • Distribution of lands under Land Grant (Special Provisions) Act and issue of Grants • Conservation of state lands and reserves under the State Land (Recovery of possession) Act • Providing directions and guidance to Provincial Land Commissioners and Divisional Secretaries to administer lands in addition to inter provincial land development projects.	Land Development Ordinance – No. 19 of 1935, Land Grants (Special Provisions) Act – No. 43 of 1979, Land Reforms Commission Act No 01 of 1972 State Land (Recovery of possession) Act – No. 07 of 1979
Land Reform Commission	Distribution of state land to low income individuals [as specified in the LG (SP) Act] Ensuring compliance with the 50 acres ownership ceiling imposed on individuals	Land Reform Law of 1972 Land Grant (Special Provision) Act of 1979

	Ensuring that land ownership among indigenous communities increases	
Land Survey Council	Maintains standards and procedures relating to land surveying and professional discipline among persons engaged on Land Surveying.	Survey Act No. 17 of 2002
Land Use Policy Planning Department	Introduces scientific land use planning procedures to the country: • Formulates the national Land Use Policy and necessary legislations and regulations to implement the Policy • Prepares Land Use plans at National, Provincial, District, Divisional, Village and Land Parcel Levels Network: Head office at Narahenpita, 19 district offices, 265 field level officers attached to the Divisional Secretary Divisions	
Mahaweli Authority (Upper Mahaweli Environment and Forestry Conservation Division)	The management of state lands situated within the Mahaweli basin Promotes the protection and scientific management of the Upper Mahaweli catchment area, through soil, water, forest conservation activities.	Mahaweli Authority Act no. 29 of 1973
National Housing Development Authority	Development of land occupied by low income households (specifically slums and shanties) Providing opportunities for low income groups to obtain state lands for housing development via outright sale, lease or rental.	National Housing Development Authority Act of 1979
Registrar General's Department	The supervision of notaries and verification of stamp duty on deeds, the registration and custody of notarial deeds and other documents affecting property and the preservation of records and issue of copies from such records Land registration process is carried out in district level at 4 land registries	Registration of Documents Ordinance
Sri Lanka Land Reclamation and Development Corporation	The reclamation and Development Low-Lying Areas in the Colombo District	Colombo District (Low Lying Areas) Reclamation & Development Board Act No. 15 of 1968 as amended by Law No. 27 of 1976, Act

		No. 52 of 1982 and Act. No. 35 of 2006
Survey Department	Responsible for land surveying and mapping of country. General work programme includes contour surveys for irrigation and other purposes, block and topographical preliminary plan surveys and settlement demarcation surveys, town surveys, forest surveys, sporadic surveys including acquisitions, aerial surveys.	Survey Act No. 17 of 2002
Urban Development Authority (UDA).	Promotes integrated planning and implementation of economic and physical development of areas declared by the Minister to be Urban Development Areas. In any area declared as an Urban Development Area, the UDA is expected to: • Carry out integrated planning and physical development; • Prepare a development plan; • Implement development program that involve integrated planning; • Formulate and implement an urban land use policy; • Develop environmental standards and prepare schemes for environmental improvement.	Urban Development Authority Act No: 41 of 1978

As summarized in National report on desertification/land degradation in Sri Lanka (UNCCD (2000), two strategies have been adopted by the government to address the problem of soil erosion. One is to incorporate environmental safeguards in legislative enactments pertaining to land and water resources development. The other is to introduce legislation specifically designed to prevent or mitigate soil erosion.

4.1.3 Legislations for Environmental Safeguards

Environmental Safeguards have been incorporated in several pieces of legislation introduced since the nineteen thirties.

1. Land Development Ordinance No.19 – 1935

Section 8 Subject to the general or special direction of the Land Commissioner, State land may be mapped–out by the Government Agent for any one or more of the following purposes;

(g) prevention of the erosion of the soil;

Section 156 In particular and without prejudice to the generality of the powers conferred by section 155, regulations may be made for and with respect to, all or any of the following matters:

(d) the maintenance of reserves for the preservation of the sources and courses of streams and for the prevention of erosion of the soil;

2. State Lands Ordinance No.8 – 1947

Section 49 Subject as hereinafter provided, the Minister may, by Notification published in the Gazette, declare that any state and is constituted a State reservation for any one or more of the following public purposes:

(6) the prevention of the erosion of the soil;

3. Water Resources Board Act No.29 – 1964

Section 12 It shall be the duty of the Board to advise the Minister on the following matters, and on any other matters that are referred to the Board for advice by the Minster:

(d) the control of soil erosion.

4. Land Grants (Special Provisions Act) – 1979

The Act provided for the transfer to the State land vested in the Land Reform Commission and the transfer of this vested land free of charge to landless persons. The transfers were subject to certain conditions, one of which was the stipulation that the transferee should carry out on his land, such soil conservation measures, which the District Secretary of the District may require from time to time.

5. Agrarian Services Act No.58 – 1979

Section 34(2) The owner, cultivator or occupier of any agricultural land shall, in addition to such other duties as the Commissioner may in his discretion specify, ensure that:

(d) the land is properly maintained in order to ensure the maximum conservation of soil and water;

6. Mahaweli Authority of Sri Lanka Act No.23 – 1979

Section 13 Notwithstanding the provisions of any other law and without prejudice to the generality of the powers conferred on the Authority by this Act, the Authority shall in or in relation to any Special Area have the power:

(3) to take such measures as may be necessary for watershed management and control of soil erosion;

7. National Environment Act No.47 – 1980

Section 22 The Authority in consultation with the Council shall, with the assistance of the Ministry charged with the subject of Soil Conservation, recommend soil conservation programs including therein the identification and protection of critical watershed areas, encouragement of scientific farming techniques, physical and biological means of soil conservation, and short term and long term research and technology for effective soil conservation.

4.1.4 Prevention or Mitigation of Soil Erosion

Accelerating soil erosion and devastating earth slips in the hill country convinced the government that strong legislative measures would be required to address the problem of land degradation. An

Act was therefore passed to make provision for the conservation of soil resources, for the prevention or mitigation of soil erosion and for the protection of land against damage by floods and droughts.

1. 1951 – Soil Conservation Act

The Act empowered the Director of Agriculture to undertake surveys and investigations to be made for the purposes of ascertaining the nature and extent of land degradation due to various factors including floods, droughts, salinization, desertification, siltation and soil erosion.

It also empowered the Minister to declare "erodible areas", to specify measures regulating the use of land in such areas and to acquire land for carrying out measures to prevent erosion.

Several decades later the government realized that the provisions laid out in this Act were in adequate to meet present day demands for a number of reasons. The chief among these were;

(i) The identification of conservation activities as an extension function.

(ii) The implementation of the provisions of the Act and regulations could not be undertaken by normal extension staff of the Department of Agriculture as extension and regulatory functions are not compatible.

(iii) At the time the Act was enacted all land matters were handled by one Ministry. As time went on many Ministries and agencies were made responsible for the management of land. This prevented the Director of Agriculture from adequately exercising his authority and functions under the Act to achieve the objectives of the Act.

(iv) The institutional support made available under the Act was considered inadequate.

***2.* 1996 - Amended Soil Conservation Act**

The deficiency is in the 1951 Act have been rectified in the Amended Act of 1996. There has also been a shift of focus from the control of soil erosion to land resource management.

4.1.5 Legal enactments for forest and wild life resources

Nearly all the natural forests in the country covering approximately 20% of the land belong to the state. They fall mainly within the jurisdiction of two institutions, the Forest Department and the Department of Wildlife Conservation. There institutions are guided by two legal enactments the Forest Ordinance and the Fauna and Flora Protection Ordinance.

1. The Forest Ordinance of – 1907 and Amendments

Most of the natural forests coming under the jurisdiction of the Forest Department are designated Reserve Forests or Proposed Reserve Forests and the ordinance has provision to protect these forests and their produce.

2. The Fauna and Flora Protection Ordinance of 1937 and subsequent Amendments

The ordinance provides for the protection of six categories of forests coming under the jurisdiction of the Department of Wildlife: strict natural reserves, national parks, nature reserves, jungle corridors, intermediate zones and sanctuaries.

4.2 Extent of securing sustainable water sources at households

Sri Lanka is blessed with many types of water sources which include, rainfall, surface water (rivers, streams, major reservoirs, tank cascades) and ground water (springs and shallow ground & deep aquifer water). Spatially and temporally variable rainfall is the major source of water and there are three different climatic zones in the country: wet, intermediate, and dry. Annual rainfall for each climate zone is over 2,000 mm/year for wet zones, between 1,500-2,000 mm for intermediate zones and 1,500 mm/year for dry zones (Panabokke, 1996). The variation of elevation, rainfall, temperature and other geological aspects makes Sri Lanka a diverse country in terms of 46 agro-ecological regions (Punyawardena, *et. al.* 2003). Rainfall feed a radial network of rivers that begins in the central highlands and 103 distinct river basins cover 59,217 square kilometers (NARESA, 1991). The average annual volume of surface water in Sri Lanka is estimated to be ~51,300 Gm^3. The flow and storage of this volume is in 103 drainage basins ranging in size from ~10,000 km2 (the Mahaveli Basin) to < 10 km^2 in coastal rivulets. Only 18 of the country's rivers have basin areas exceeding 1000 km^2. River discharges show a wide range of spatial and seasonal variability caused mainly by rainfall variations (Gunatilaka, *et. al*. 2008). 29% of land area of Sri Lanka is serviced by irrigation infrastructure that comprises 60 large multi-purpose dams, 260 large to medium sized major irrigation schemes and 12,000 minor working village tanks (Census of Agriculture 2002). Groundwater resources are characterized by six aquifer categories based on the base material (Panabokke and Perera 2005). Shallow Karstic aquifers in Jaffna Peninsula are considered high yielding aquifers due to sink holes, caverns and stream passages in the Miocene limestone. The groundwater resources in Sri Lanka are considered to be lesser than surface water resources. The estimated groundwater potential is 7,800 MCM per annum (Inbulana *et. al.* 2006). The demand for groundwater development is specially for domestic water needs. However, the coastal sand aquifer area in the north-western region is being extensively used for agriculture. Industrial estates in the wet zone are also heavily dependent on (Imbulana *et. al.* 2006). The traditional hand-dug wells have been abstracting water from this regolith aquifer for village domestic requirements for more than 2000 years in the ancient Rajarata landscape, and it has been reported that these aquifers have relatively low yields. The agro-well farming in the north central and northwestern provinces is dependent on this shallow groundwater resource (Karunaratne and Pathmarajah, 2002).

Although Sri Lanka does not face a water resources shortage in terms of quantity, there are growing trends of stress in terms of availability subjected to seasonal variation and competition among sub-sectorial water users. Location, climate and topography are the main factors that influence precipitation and surface water availability.

About 95% of the urban population enjoys access to safe drinking water supply. The corresponding figure in the rural sector is 75%. Safe drinking water for the rural population is mainly supplied through dug wells and tube wells (Imbulana *et. al.* 2006). About 75% of the urban areas. Cost recovery is through a nationally the urban population and 14% of the rural population adopted tariff structure based on the volume of are served by pipe-borne water (Imbulana *et. al.* 2006). Water pollution severely hampers accessible safe drinking water in Sri Lanka.; about 86 percent

of households in Sri Lanka use safe drinking water. Differences exit by safe drinking water with regard to area of residence. Regarding urban and estate sectors, 97.2 percent of households in urban sector and 50.6 percent of households in estate sector use safe drinking water (Census, 2007).

4.3 Availability of promotional programs for biodiversity and their impacts

There were many biodiversity promotional programs & projects in Sri Lanka during recent past and also there are several international environmental commitments. According to GEF (2014).

4.3.1 International Conventions

Government of Sri Lanka accords high priority for implementation of international conventions and the designated national focal points are responsible for servicing the requirements of each at the national level. Most important international environmental conventions and the focal point institutions are summarized in table 5 as given by GEF (2014).

Table 5: Most important international environmental conventions and focal points (1979-2005)

Name of Convention	Year	Focal Point
Convention on International Trade in Endangered Species Of Wild Fauna and Flora (1973)- CITES	1979	Department of Wildlife Conservation
Convention concerning the protection of the World Cultural and Natural Heritage (1972)	1980	Ministry dealing with Environment and Ministry dealing with Cultural Affairs
Vienna Convention for the Protection of the Ozone Layer (1985)	1989	Ministry dealing with Environment
Montreal Protocol on Substances that Deplete the Ozone Layer (1987)	1989	Ministry dealing with Environment
Bonn Convention on the conservation of Migratory Species of Wild Animals (1979)	1990	Department of Wildlife Conservation
Ramsar Convention on Wetlands of International Importance Especially As Waterfowl Habitat (1971)	1990	Department of Wildlife Conservation
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Disposal (1989)	1992	Ministry dealing with Environment
United Nations Framework Convention on Climate Change (1992) -- UNFCCC	1993	Ministry dealing with Environment
United Nations Convention on Biological Diversity (1992) – CBD	1994	Ministry dealing with Environment

United Nations Convention on The Law of the Sea. (1982)	1994	Ministry of Foreign Affairs
The International Convention for the Prevention of Pollution from the ships (1973/78) – MARPOL	1997	Marine Environment Protection Authority
United Nations Convention to Combat Desertification (1994) – UNCCD	1998	Ministry dealing with Environment
Kyoto Protocol on Climate Change (2005)	2002	Ministry dealing with Environment
Cartagena Protocol on Biosafety (2000)	2004	Ministry dealing with Environment
Stockholm Convention on Persistent Organic Pollutants (2001).	2005	Ministry dealing with Environment

MoE (2014), by fifth national report to the convention on Biological Diversity, provides detailed information on (i) An update on biodiversity status, trends, and threats in Sri Lanka and implications for human well-being, (ii) National Biodiversity Strategy and Action Plan (NBSAP), its implementation, and the mainstreaming of biodiversity, and (iii) Progress towards the 2020 Aichi Biodiversity Targets and contributions to the relevant 2015 targets of the Millennium Development Goals.

FAO regional project GCP/RAS/186/JPN for the "Implementation of the GPA for the conservation and sustainable utilization of PGRFA in Asia and Pacific Region" become operational during 2003 and 2007. Crop wise evaluation and conservation of agro-biodiversity; in-situ and ex-situ conservation of genetic resources including wild plant genetic resources; exploration, collection and exchange selected germplasm; identification issues related to germplasm conservation and utilization; formulation of recommendations to reduce impacts of identified issues were main activities. Detailed report (203 p) available in https://www.researchgate.net (Muthukudaarachchi, *et. al*. 2007).

4.3.2 Funded programs and local initiatives

Puspakumara *et. al.* (2016), reported a detailed review and analysis on status and future direction of biodiversity in Sri Lanka and summarized major interventions as funded programs (5 programs) and local initiatives (9 initiatives) in Sri Lanka as follows.

1. National Biodiversity Planning to Support the Implementation of the CBD 2011-2020 Strategic Plan in Sri Lanka. US $ 200,000. To integrate Sri Lanka's obligations under the Convention on Biological Diversity into its national development and sectoral planning frameworks through a renewed and participative 'biodiversity planning' and strategizing process, in a manner that is in line with the global guidance contained in the CBD's Strategic Plan for 2011-2020.

2. Strengthening Capacity to Control the Introduction and Spread of Alien Invasive Species in Sri Lanka. US$ 1,825,000. To build capacity across sectors to control the introduction and spread of invasive species in Sri Lanka in order to safeguard globally significant biodiversity.

3. Mainstreaming Biodiversity Conservation and Sustainable use for Improved Human Nutrition and Wellbeing. US $ 828,000. Strengthening the conservation and sustainable management of agricultural biodiversity through mainstreaming into national and global nutrition, food and livelihood security strategies and programs (2015-2017). The Biodiversity for Food and Nutrition Project is a multi-country, multi-partner initiative led by Brazil, Kenya, Sri Lanka and Turkey and funded by the Global Environment Facility, the world's largest public funder of international environmental projects. The initiative is coordinated by Bioversity International with implementation support from the United Nations Environment Program and the Food and Agriculture Organization of the United Nations. National partners come from relevant ministries, the scientific community, non-government organizations, civil society and local communities. The project aim to provide evidences on biodiversity for food and nutrition, create market for nutrient rich biodiversity products and raising awareness among stakeholders to support conservation and use of biodiversity for food and agriculture.

4. Mainstreaming Agro-biodiversity Conservation and Use in Sri Lanka Agro-ecosystem for Livelihoods and Adaptation to Climate Change. US$ 1,450,455. To ensure agrobiodiversity in Sri Lanka is optimally conserved and used to meet the challenges of climate change and improve rural livelihoods. A UNEP GEF supported project that will build resilience and help rural communities meet the challenges of climate change through the conservation and use of agrobiodiversity. The role of agrobiodiversity in helping farmers and rural communities to adapt to climate change and to improve their livelihoods is being explored in a major new UNEP GEF supported project in Sri Lanka. The project, implemented by the Sri Lanka Ministry of Environment and Natural Resources and Bioversity international jointly with the Sri Lanka Ministry of Agriculture, will last for the next five years and includes a number of aspects that make it extremely innovative: it is concerned with a wide range of agrobiodiversity, including crops, agroforestry, animals, fish, and the associated soil and pollinator diversity found in the different production systems involved; it will explicitly explore the ways in which enhanced use of diversity can be linked with sustainable production practices; it works directly with farmers and communities in three quite different landscapes in a participatory way through trans-disciplinary approaches; and it is concerned with building national capacity, developing an improved policy framework and strengthening research on agrobiodiversity.

5. In-Situ Conservation of Crop Wild Relatives through Enhanced Information Management and Field Application (2004-2011) project was launched by Bioversity International in collaboration with the United Nations Environment Program (UNEP), Ministry of Environment and Natural Resources (MENR) in Sri Lanka, the national partner and international partners. Apart from Sri Lanka, Armenia, Bolivia, Madagascar and Uzbekistan are involved in this project. The project is co-funded by the Global Environment Facility (GEF). The other international agencies involved in the project are the Botanic Gardens Conservation International (BGCI), the United Nations Food

and Agricultural Organization (FAO), the World Conservation Union (IUCN), UNEPs World Conservation Monitoring Centre (UNEP/WCMC) and the German Centre for Documentation and Information in Agriculture (ZADI). Main objectives of the project were to enhance the capacity to use information to support conservation and sustainable utilization of CWR in selected five countries and to develop complementary information management system with national and international components. Many stakeholders were involved in the Sri Lankan component of this project. Project activities included training of nominated officers from stakeholder institutions on information management, CWR conservation, utilization, ecogeograpic surveys and increasing public awareness on Crop Wild Relatives. Coordination among stakeholders of the project was done by the project management unit which has been established at the Horticulture Research and Development Institute, under the supervision of Director General of Agriculture. The outcomes of the project were widely disseminated nationally and globally and successful strategies (best practices) were transferred to other countries with significant populations of crop wild relatives. In this way, global efforts to conserve biological diversity in general, and crop wild relatives in particular, have been accelerated and optimized for the benefit of both the global community and local users. The project has been very successfully completed.

Locally funded projects:

1. Species Conservation & National Biodiversity Hotspot Survey Program for Sustainable Development. Rs. 19.5 million. Conservation of environmentally sensitive sites and promote sustainable development through implementation of sustainable tourism programs while creating awareness at both local and global levels.
2. Palaeobiodiversity Conservation and Sustainable Tourism Program. Rs. 19.3 million. Conservation of environmentally sensitive pale biodiversity sites and promote sustainable development through implementation of sustainable tourism programs while creating awareness at both local and global levels.
3. Conservation and Sustainable Use of Microbial Diversity in Sri Lanka. Rs. 19.5 million. Formulation of a national policy and preparation of action plan for conservation of microbial diversity in Sri Lanka and to integrate the aspects of the microbial conservation and sustainable use in to the national planning process with the special emphasis of microbial bio-prospecting.
4. Conservation and Sustainable Use of Mangrove Ecosystem & Its Diversity in Sri Lanka. Rs. 19.5 million. Formulation of a national policy and preparation of action plan for conservation and sustainable use of mangrove ecosystem and its diversity in Sri Lanka and to integrate the aspects of the mangrove conservation and sustainable use in to the national planning process with the special emphasis of ecotourism enhancement of livelihood of the neighbor community.
5. National and Global Assessment of Flora & Fauna of Sri Lanka & Identification of Important Plant Areas. Rs. 18.0 million. To achieve national goals of biodiversity by conservation and sustainable utilization of fauna and flora of Sri Lanka.
6. Implementation of National Policy on Traditional Knowledge for Sustainable Livelihood. Rs. 10.0 million. Implementation of national policy on traditional knowledge for sustainable livelihood.
7. Proposal for the implementation of provincial biodiversity profiles and action plans. Rs. 19.5 million. To achieve national goals of biodiversity conservation and sustainable use through

successful implementation of the recommendations of the provincial biodiversity profiles and action plans.

8. Managing Environmentally Sensitive Areas (2016-2020). The Ministry of Mahaweli Development and Environment in collaboration with the United Nations Development Programme (UNDP) developed five-year pilot project, jointly funded by the Global Environmental Facility and the Government of Sri Lanka to improve the country capacity to manage Environmentally Sensitive Areas. The pilot project will be implemented in North Central and North Western provinces in the Kala Oya and Wilpattu region and the project sites include Kakirawa, Ipalogama, Palagala, Galnawa and Vanathawilluwa. Whilst several government policies and legislations provide for the creation of Enviornmental Sensitive Areas (ESAs), there is an unmet need to operationalise them. Following the ecosystem approach and using a land use planningand management framework, the project will pilot multiple land management techniques in a coordinated and compatible manner. This project will use the necessary governance framework at the national level, including enforcement systems and will demonstrate ESA creation and management for the Kala Oya river basin. The project, launched on the on the 2016, will look at sustainable utilization of sensitive ecosystems and ensure structural long term sustainable development of the biological diversity of Sri Lanka.

4.3.3 Recent programs targeting Sustainable Development Goals (SDG)

As stated in MSDWRD (2018), targeting Sustainable Development Goals (SDG), several national programs were launched addressing the multidimensional problem of hunger, food insecurity and malnutrition needs, with a vast number of policy and programmatic recommendations along with concrete implementation plans. These include investments in R&D, agriculture extension, irrigation infrastructure, modern technologies, marketing and value chain development, public private partnerships, disaster mitigation, and climate adaptation, as well as land and seed market reforms. Details of those programs as described by MSDWRD (2018) is given below.

The Department of Agriculture's national food production program for 2016–2018 consists of promoting the production of rice and other food crops, and a home-gardening program. Moreover, the Government has initiated several programs for developing the dairy industry, modernizing fisheries, developing agricultural "mega zones" and value chains, developing public-private-producer-partnerships, and modernizing irrigation. The development objectives of the Agriculture Sector Modernization Project for Sri Lanka are increasing agriculture productivity, improving market access, and enhancing the value addition of smallholder farmers and agribusinesses.

A number of development initiatives have been undertaken to mitigate climate risks, to enhance the resilience in agriculture and to ensure sustainable food production systems. Some of these include cascade development program, micro irrigation programs, climate tolerant varietal development and index-based agriculture insurance program which are closely related with SDG 13 (Climate Action).

To address challenges related to National Nutrition Council (NNC) which was established in 2011 under the direct purview of the President of Sri Lanka for better coordination of nutrition related activities of all relevant ministries and prepared a Multi Sector Action Plan for Nutrition (MSAPN) for 2013-2016 within which different ministries and other stakeholders have specific mandates to implement. In addition, the Government has already taken initiatives to develop strategies to promote Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) among producers. The SLGAP logo has already been developed and number of steps has been taken to

raise awareness of farmers and to promote knowledge and technical knowhow on GAP/GMP (MSDWRD, 2018).

4.4 Extent of access to food sources from natural forests such as bee honey, fruits (wood apple, gooseberry) and green leafy vegetables and impact on nutrition at household level

Bogahawatta (1999) reported non-timber forest product (NTFP) extraction from forests located in Kandy, Matara and Ratnapura Districts. The NTFP derived from the conserved forest by the village communities include fuelwood; fruits, vegetables, mushrooms, yams, meat, spices as food for households; bee honey; medicinal plants as food and medicines; poles, thatching and roping materials; clay for construction; cane for furniture or basket manufacture; and pasture for livestock feeding. The ornamental plants and gems are mainly for the market Some of the NTFP (fuel wood, yams, medicines, clay) are derived throughout the year from the forests as compared to some products (fruits, vegetables, mushrooms, meat, bee honey, spices, cane, poles, thatching and roping, resin and gums, ornamental plants, gems) where seasonality of extraction was noted. The duration of availability and the purpose of extraction have also been reported those details are given in table 6 and 7 respectively.

Blockhus (2002), studied the interactions of local communities with Ritigal forest reserve in Dry Zone, Sri Lanka and experienced significant involvement in gathering of bee honey, medicinal plants and local fruits for local consumption as well as part time income source and also observed extent of women involvement for those activities.

Table 6: Availability of non-timber forest products (Bogahawatta, 1999).

NTFP Extracted	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
Fuelwood	**********											
Fruits			**********				**********					
Vegetables						**********						
Mushrooms										**********		
Yams	**********											
Meats	**********											
Bee honey		**********				**********						
Kitul	**********											
Medicinal plants	**********											
Spices							**********					
Thatching/roping	**********											
Poles	**********											
Cane	**********					**********						
Clay	**********											
Resins/gums						**********						
Ornamental plants					**********							
Pasture/fodder										**********		
Gems	**********									**********		

Table 7: Purpose of extracting non-timber forest products (Bogahawatta, 1999)

Forest produce	Purpose	Home consumption	Market	Kandy	Matara	Ratnapura
Fuelwood	cooking	*	*	*	*	*
Fruits	food	*	*	*	*	*
Vegetables	food	*		*	*	*
Mushrooms	food	*		*	*	*
Yams	food	*	*	*	*	*
Wild meat	food	*	*	*		
Bee honey/ bee colony	food/ medicine	*	* *	*	*	*
Kitul products	food	*	*	*	*	*
Medicinal plants	medicine	*	*	*	*	*
Spices	food	*	*	*		
Thatching and roping materials	farming, house construction	*		*	*	*
Poles	farming, house construction	*		*	*	*
Cane	furniture		*	*		
Clay	house construction		*	*	*	
Resins/gums			*	*		
Ornamental plants			*	*		
Pasture, fodder	animal feed	*		*	*	*
Gems			*		*	*

4.5 Involvement of different institutions and agencies for the implementation of strategies and policies and their impact on sustainable nutritious food production and consumption

According GEF (2014), there are about 50 state institutions involved with some aspect of management and protection of the environment and natural resources in Sri Lanka (Table 8). Chief among them are the Central Environmental Authority, Department of Forest Conservation and Marine Environment Protection Authority (MEPA) that function under the Ministry of Environment and Renewable Energy (MoE & RE); the Department of Wildlife Conservation (DWLC) located under the Ministry of Wildlife Resources Conservation; the Coast Conservation Department (CCD) located under the Ministry of Ports and Aviation; and the Urban Development Authority (UDA) which is under the Ministry of Defense and Urban Development. The Ministry dealing with Fisheries, the Department of Fisheries and Aquatic Resources (DFAR), the Department of Agriculture (DOA), the Department of Animal Production and Health (DAPH) and the Veterinary Research Institute (VRI) also have major roles to play in environmental/biodiversity conservation and management.

The Sri Lanka Land Reclamation & Development Corporation (SLLRDC) is mandated with some aspects of wetland conservation while land related policy is the responsibility of the Department of Land Use Policy Planning established under the Ministry of Lands and Land Development. Land management falls within the purview of about 30 institutions, such as the Land Commissioners Department, The Hadabima Authority, The Mahaweli Authority, The Department of Agriculture (mainly its Natural Resources Management Centre), Agrarian Services Department,

and the Land Settlement Department. The Activities and mandates of the DWLC, FD, CEA, UDA and CCD also impact on the use of land in the country.

The Ministry of Finance and Planning, which deals with policy planning and implementation, is the key agency responsible for formulation of national development policies. Many non-state sector groups also influence Sri Lanka's environment, such as media institutions and personnel (press, TV, radio), civil society organizations, national and regional environmental NGOs and Community Based Organizations (CBOs). Several private sector business organizations also support environmental and biodiversity conservation mainly under their CSR projects and programs.

While it is a positive factor that many institutions are mandated for environmental management and conservation, this requires a very efficient and effective coordination mechanism for environmental policy and plan formulation and implementation of activities and projects.

Table 8: Institutions connected with environmental conservation and management (GEF, 2014)

Ministries with a role to play in environmental conservation and management	Key agencies involved with environmental management and conservation
Key ministries • Ministry of Environment and Renewable Energy • Ministry of wildlife Resources and Conservation • Ministry of Agriculture • Ministry of Lands and Land Development • Ministry of Fisheries and Aquatic Resources Development • Ministry of Ports and Aviation • Ministry of Indigenous Medicine • Ministry of External Affairs • Ministry of Finance and Planning • Minister of Botanical Gardens and Public Recreation. • Ministry of Irrigation and Water Resources Management • Ministry of Water Supply and Drainage • Ministry of Technology, Research and Atomic Energy • Ministry of Disaster Management • Ministry of Power & Energy • *Other ministries with impact* • Ministry of Economic Development • Ministry of Defense and Urban Development • Ministry of Livestock and Rural Community Development • Ministry of Construction, Engineering Services, Housing and Common Amenities • Ministry of Industry and	*Key Departments* • Department of Forest Conservation (FD) • Department of Wildlife Conservation (DWLC) • Urban Development Authority (UDA) • Central Environmental Authority (CEA), • Coast Conservation Department (CCD) • Department of Fisheries & Aquatic Resources (DFAR) • Marine Environmental Protection Authority (MEPA) • National Aquatic Resources Research and Development Agency • Sri Lanka Ports Authority (SLPA) • Department of Agriculture (DOA) and associated research institutions plus other divisions including: The Seed Certification and Plant Protection Centre (SCPPC), Natural Resources Management Centre (NRMC), Field Crops Research and Development Institute (FCRDI), Horticultural Crops Research and Development Institute (HORDI), Rice Research and Development Institute (RRDI), Plant Genetic Resources Centre (PGRC), Registrar of Pesticides. • Department of National Zoological Gardens (DNZG) • Department of National Botanic Gardens (DNBG) • The National Science Foundation (NSF) • Department of National Planning • National Agricultural Diversification and Settlement Authority (*Hadabima*) • Mahaweli Authority of Sri Lanka

Commerce • Ministry of Education (and relevant institutions under it) • Ministry of Defense • Ministry of Resettlements • Ministry of Coconut Development and *Janatha* • State Development • Ministry of Petroleum Industries • Ministry of Social Services • Ministry of Justice • Ministry of Minor Export Crop Promotion • Ministry of Transport	• Irrigation Department • Water Resources Board • Department of Land Use Policy Planning • Department of Land Settlement • Land Reform Commission (LRC) • Land Commissioner General's Department • Department of Meteorology • Disaster Management Centre (DMC) • National Disaster Relief Services Centre • Sri Lanka Land Reclamation Development Authority (SLRDA) • Geological Survey and Mines Bureau (GSMB)

4.6 What programs are available and their impact to ensure improving nutrition in a sustainable manner

In addition to programs included in government institutional normal action plans, there are several specific operational programs exists in Sri Lanka, to promote and ensure nutrition & food availability in sustainable manner. Details of several such programs elaborate following sub sections.

4.6.1 Good Agriculture Practices (GAP) in Sri Lanka

Good Agricultural Practices (GAPs) are practices that address environmental, economic and social sustainability of on farm processes and result in safe and quality food and nonfood agricultural products (FAO, 2013). The main purpose of the Good Agriculture Practices (GAP) is to produce foods that are safe and wholesome to consumers by applying ecologically sustainable agricultural methods. Agriculture department with financial and technical support of FAO, launched a program to promote high standard and quality food crops including fruits and vegetables following GAP (FAO, 2016). The project started in 2014 as a pilot project and comprised with sections for identification of the scheme owner and the certification body, adoption/adaptation of the scheme documents, strengthening certification and accreditation infrastructure for GAP, structured training sessions and awareness programs for the scheme owner and certification and accreditation personnel, as well as training of trainers programs for those individuals who would after intensive training train and counsel farmers/ farmer groups selected by these countries.

At present, the GAP program is at main streaming level for production chain of fruit and vegetable production and many producers reportedly joined for GAP program launched by Department of Agriculture. GAP program shows some achievements in potato cultivation and According to a study, 27% of potato farmers has been recorded as well adopted and 40% of them moderately adapted to GAPs in Badulla district Senanayake and Rathnayaka (2015).

Initial steps for introduction of GAP for export Agricultural crops has also been taken and draft Sri Lanka Standard for Good Agricultural Practices (GAPs) for Cinnamon, Pepper and Coffee are called for public comments (SLSI, 2019).

4.6.2 Saubagya Home Gardening Program

Targeting sustainable agriculture to ensure food security and prosperous farming community "Saubagya" program has been launched in 2020. Main aim of this program is to provide support to produce healthy and food from own home garden. This program aims 200,000 successful home gardens by utilizing spare time of family labour. More details available at http://saubagya.lk/.

4.6.3 Hela Bojun 'True Sri Lankan Taste' food outlets

'Hela bojun' is newer concept of providing access to traditional nutrient-rich food to modern society through attractive outlets which matches with present life style while providing many to better livelihood using rich bio diversity in Sri Lankan. Main aims of the program are to generate agriculture-based entrepreneurship, employment and private enterprise opportunities, especially for women, in order to provide a sustainable and stable family income; to create awareness and interest among new generations about healthy eating and the nutritional value of disappearing traditional foods and recipes, while trying to reduce the influence of the growing fast-food culture; to reduce reliance on foreign food imports, while creating demand for local produce (Rathnasekara, *et. al.* 2019). "Hela bojun: True Sri Lankan taste", market outlets sell traditional foods and empower rural women who earn a living while conserving and protecting local Neglected and underutilized species (NUS) and making healthy food available at competitive prices and women are able to earn between $ 600–800 a month by working at Hela bojun (Hunter *et. al.* 2019)

4.7 Analysis

Many dimensions of gaps that need to be filled to achieve enhanced nutritional status through sustainable natural resources in Sri Lanka, has been addressed by many studies (Somaratne. 2002; Weerahewa & Pushpakumara, 2019; UNEP, 2016; MEWLC, 2019; MoA & MNP, 2019; Puspakumara, *et. al*. 2016). An overview and analysis on gaps exists in Sri Lanka against sustainable enhancement of nutrition through better natural resources management is given in following sub section.

4.8.1Information and data gaps

Incomplete information and lack of upto date information on functions and values of natural resources, adverse impacts and trends, and benefits act as a barrier for better implementation of formulated plan at institution level as well as awareness of importance of sustainable use of natural resources at community level for motivated for judicial utilization of resource at local level. Where data is available, much of this information is incomplete, imprecise, and often out of date. Somaratne (2002) reported negative impacts of information gap for policy formulation and pointed out reasons for this situation as absence of holistic approach for allocation of funds for research in this area, absence of consistent agricultural policies. Hence it is difficult for any sector to adjust if policies are changed very often, unless there is information updating mechanism. Recent study shows information gap of community level and they are searching even for policy level information for better adjustments (Herath et al., 2019). Since information relevant to most of the institutions are not available at pertaining institutional web portals, information need of different users are trend to satisfied by alternative outside web sources located with web surfing and it will lead to ill planning, if the information located is incorrect or not up to date. So the information gap seem to have hindered the effective at implementation level.at present.

4.8.2 Policy gaps

Although sustainability of natural resources especially land, water and biodiversity have direct linkages with nutrition, collaborative link among policies seems weak. All policies which has linked with natural resources sustainability and nutrition, need to be well coordinated at implementation level for better outcomes. Though policies related to sustainability of natural resources can effectively address nutrition, they are not well synchronized. As shown in previous sections, there are many overlapping policies in agriculture, natural resources and nutrition in Sri Lanka. Those policies are not well coordinated at implementation level. Need of coordination framework for mechanism has been pointed out by many studies (Weerahewa & Pushpakumara, 2019; UNEP, 2016). Realizing the need of overarching framework for better implementation of sectorial plans, relevant authorities already taken steps to develop of overarching policies and two examples are 1. Overarching National Policy in Sri Lanka on Sustainable Consumption and Production (MEWLC, 2019); and 2. Sri Lanka Overarching Agricultural Policy (MoA & MNP, 2019).

4.8.3 Institutional gaps

Institutional gap exists not due to lack of institutions, but there are many institutions and operate in fragmented nature. Judicial and sustainable natural resource management is essential to

enhance nutritional status and food security in a sustainable manner. For that, well established multisectral institutional coordination mechanism is essential at implementation level. All the related many different activities are available in local level but separately operate according to institutional individual plans. Overlapping mandates of different institutions are prominently exist specially in agriculture sector. Institutional legal arms are not strengthened to implement several act at field level (eg: Soil Conservation Act). Information and data sharing mechanisms even among different institutions of same department is mostly not exists.

4.8.4 Knowledge gap

Knowledge gap is multifaced, Institutes & field level officers need to have up to date knowledge on current policies for better implementation, proficiency on technologies to create awareness among other stake holders, knowledge of community need to be enhanced on importance and value of food (biodiversity) & Natural resources to convince and self-motivation to act. Information and knowledge gaps need to be addressed to enhance the contribution of biodiversity for food and agriculture and to strengthen the conservation and management associated biodiversity and wild foods (Puspakumara, *et. al.* 2016).

5 Summary

Nutrition is key element in any economy and has a close link with natural resources & biodiversity. Despite its small size, Sri Lanka has a rich ecosystem diversity because of its topographic and climatic heterogeneity as well as its coastal influence. Sri Lanka is blessed many favorable stings to support nutrition and food security with wide range of ecosystem, many types of water resources, traditional cultures and high degree of biodiversity. Natural resource management has direct link with ecosystem health which intern impact on human nutrition and health. Although there are many policies and institutions exist in Sri Lanka targeting sustainable management of natural resources and enhance nutritional status, institutional gaps, policy gaps, information gaps and knowledge gaps have resulted degradation of natural resources at alarming rates hindering nutritional status of people. Multifaceted information gaps, knowledge gaps, policy gaps and fragmented nature of local level institutional coverage need to be addressed for sustainable utilization of natural resources aiming at better national status and food security. Overarching framework to link policy gaps need to be adapted. Already operational modern approaches for incorporating notorious food traditions into modern life style need to be mainstreamed and promoted.

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Section 6 –a

Food value chains in Sri Lanka

1. Introduction & objectives

The analysis of food value chains is essential to understand the challenges faced by the actors starting from producers to consumers, to identify relationships and coordination mechanisms among different stages, and to assist in understanding how chain actors deal with powers and who governs or influences the chain. A food value chain can be defined as a form of food supply chain which include the series of processes and actors that take a food from its production to consumption and disposal as waste (Hawkes and Ruel, 2011). In a food value chain, the economic value which can be a gain or loss is emphasized for chain actors at different stages in the chain. Furthermore, the value of the product produced through the functioning of the whole chain as an interactive unit is considered. A value chain is commodity specific, and as such involves only one particular food (Gelli et al, 2015). In the Sri Lankan context efficient food value chains are helpful to improve economic development as more than 25% of workforce is engaged and 10% of GDP contribution is made from the agriculture sector. Sri Lankan agriculture sector is diversified and serve the global market for years. However, the growth rate of GDP is closely associated with the nutritional status of a country (Ruel and Alderman, 2013).

The objective of this section (a) is to provide situational analysis of food value chains in Sri Lanka to understand the linkages between nutrition, and the food value chains in the food system. This understanding helps to address nutritional related gaps in food value chains to improve the nutrition situation of the population in Sri Lanka.

2. Methodology

The review was performed using available documents in the public domain, keyword search, and unpublished work from expert groups. Using data from Central Bank Sri Lanka price fluctuations of selected food products were analyzed over the time for whole sale and retail prices and different locations.

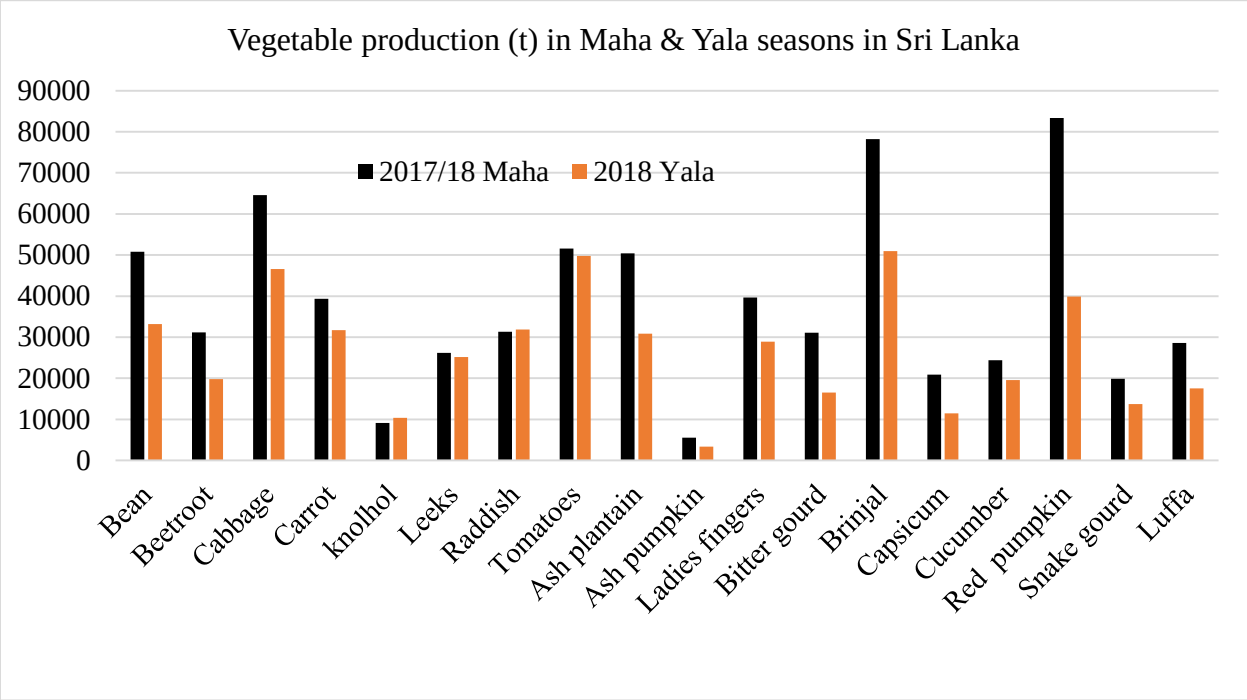
3. Inclusion & exclusion criteria of evidences

Limited information pertinent to agriculture commodities in Sri Lanka was included. Data for price fluctuations were used from the Central Bank of Sri Lanka.

4. Findings & analysis

4.1 Fruit and vegetable production in Sri Lanka

Figures 1 presents the vegetable production in Maha and Yala seasons. Generally production quantity in Maha season was higher for almost all vegetables than those of Yala. Seasonal fluctuations of production quantity can affect the price as well as availability.

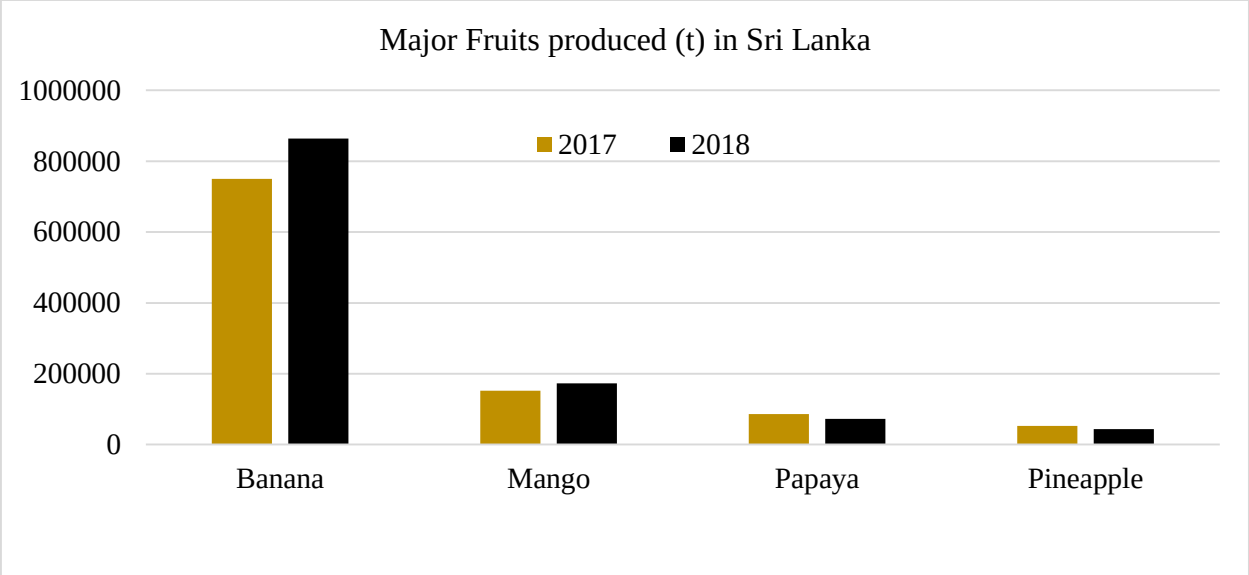


(Data source: Department of Census & Statistics)

Figure1: Vegetable production

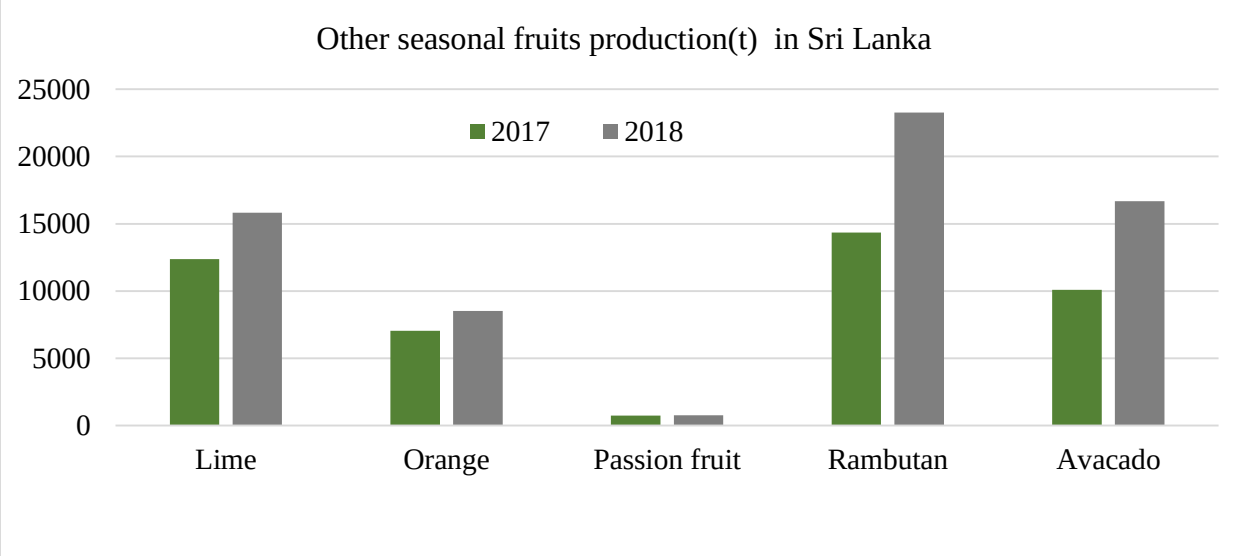
4.2 Price fluctuations of selected vegetables

Figures 4 to 10 show the price fluctuations of vegetables per kg at the whole sale and retail sale in Pettah markets for three years starting from 2017. There was a considerable gap between whole sale and retail sale prices for all vegetables. It was also noted that similar pattern for each year for peak prices depending on the reason.



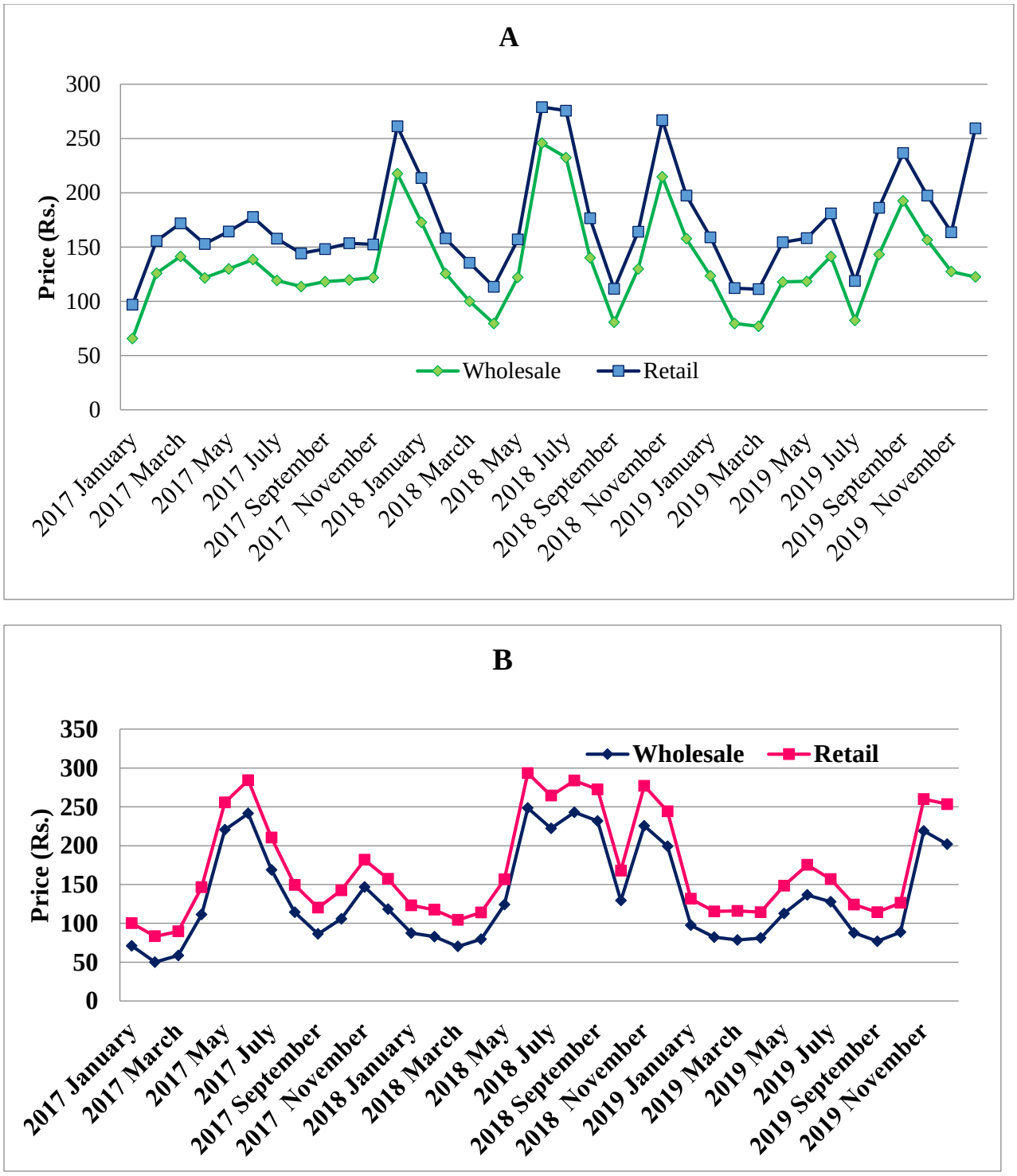
(Data source: Department of Census & Statistics)

Figure 2 Production of common fruits in Sri Lanka



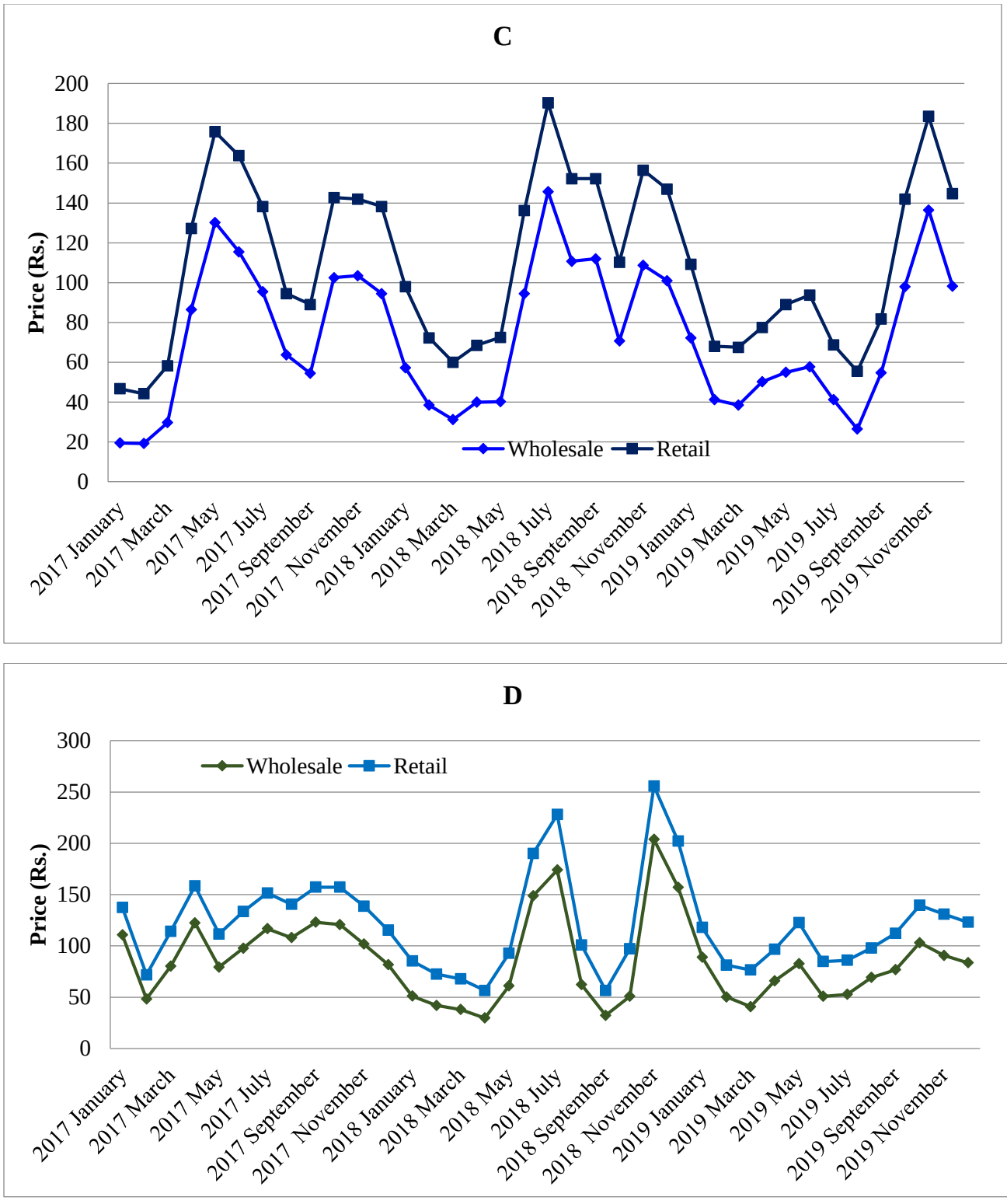
(Data source: Department of Census & Statistics)

Figure 32 Production of seasonal fruits in Sri Lanka



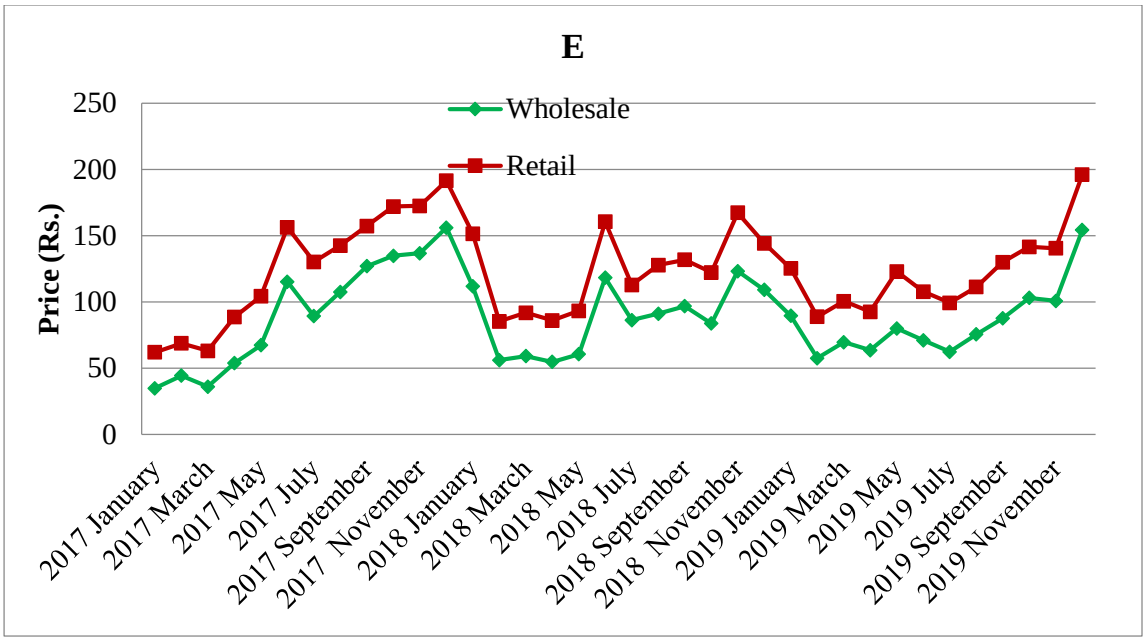
(Data source: Central Bank Sri Lanka)

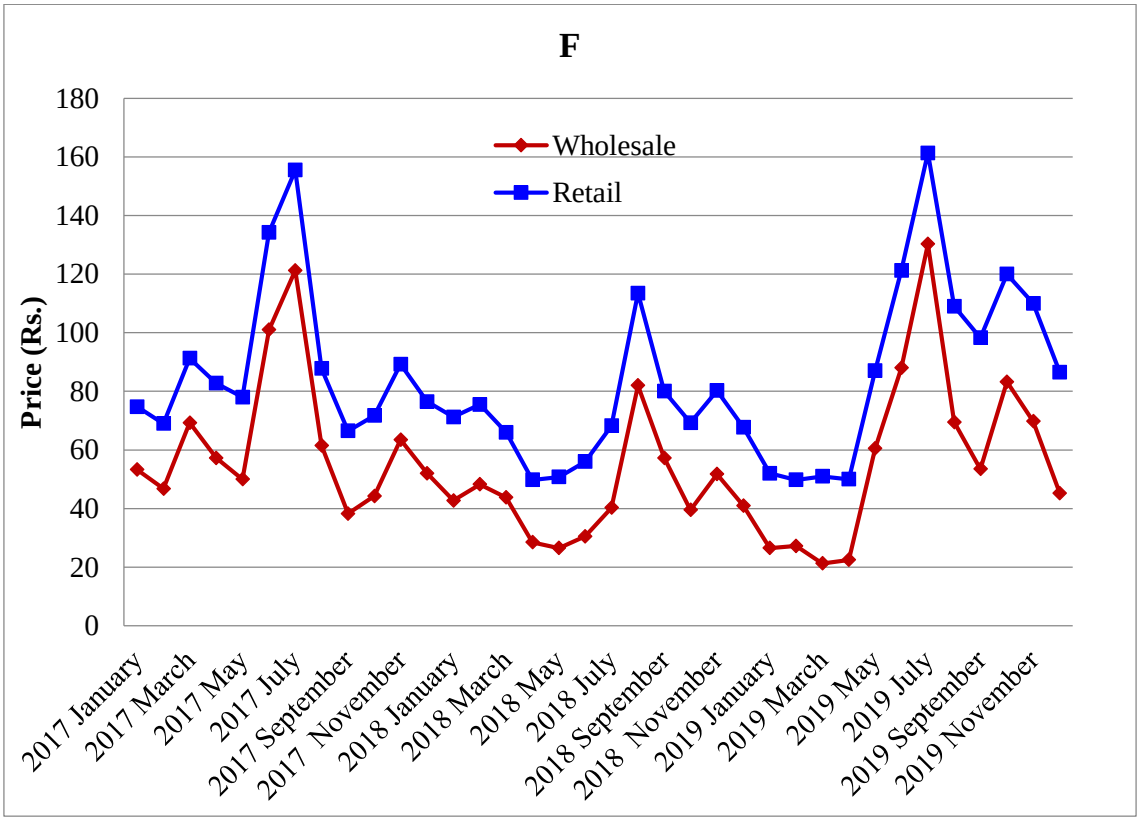
Figure 4: Price fluctuations of beans (A) and carrots (B) in Pettah market



(Data source: Central Bank Sri Lanka)

Figure 5: Price fluctuations of (C) and tomatoes (D)in Pettah market





(Data source: Central Bank Sri Lanka);Figure 6: Price fluctuations of brinjals (E) and pumpkins (F) in Pettah market

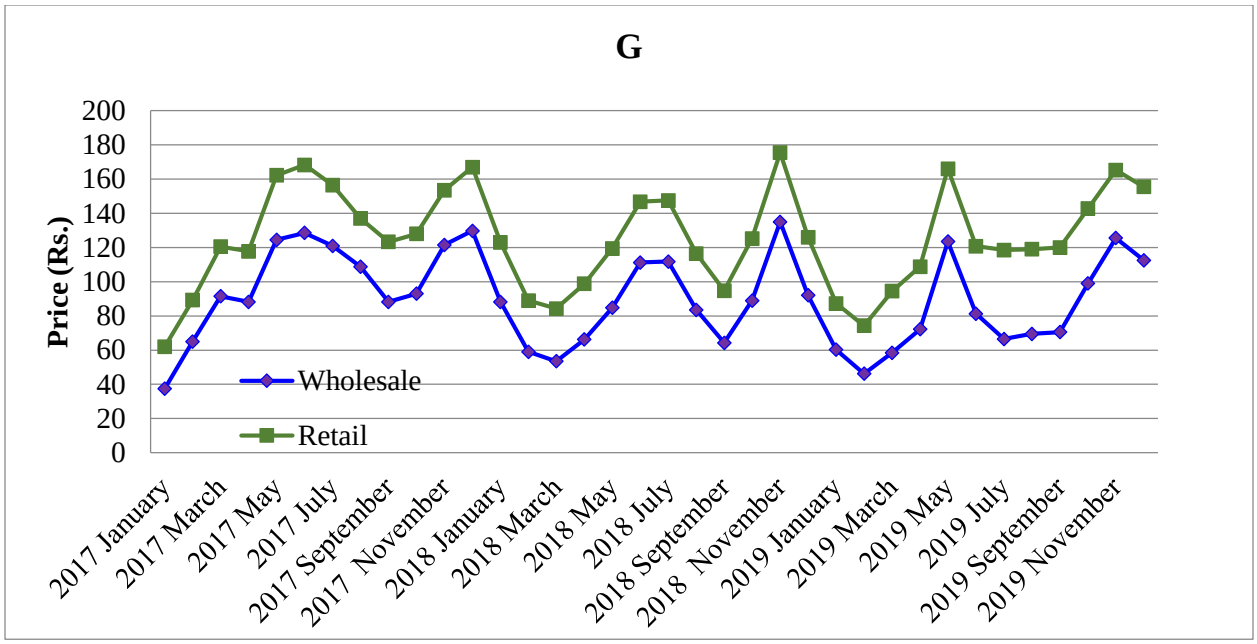
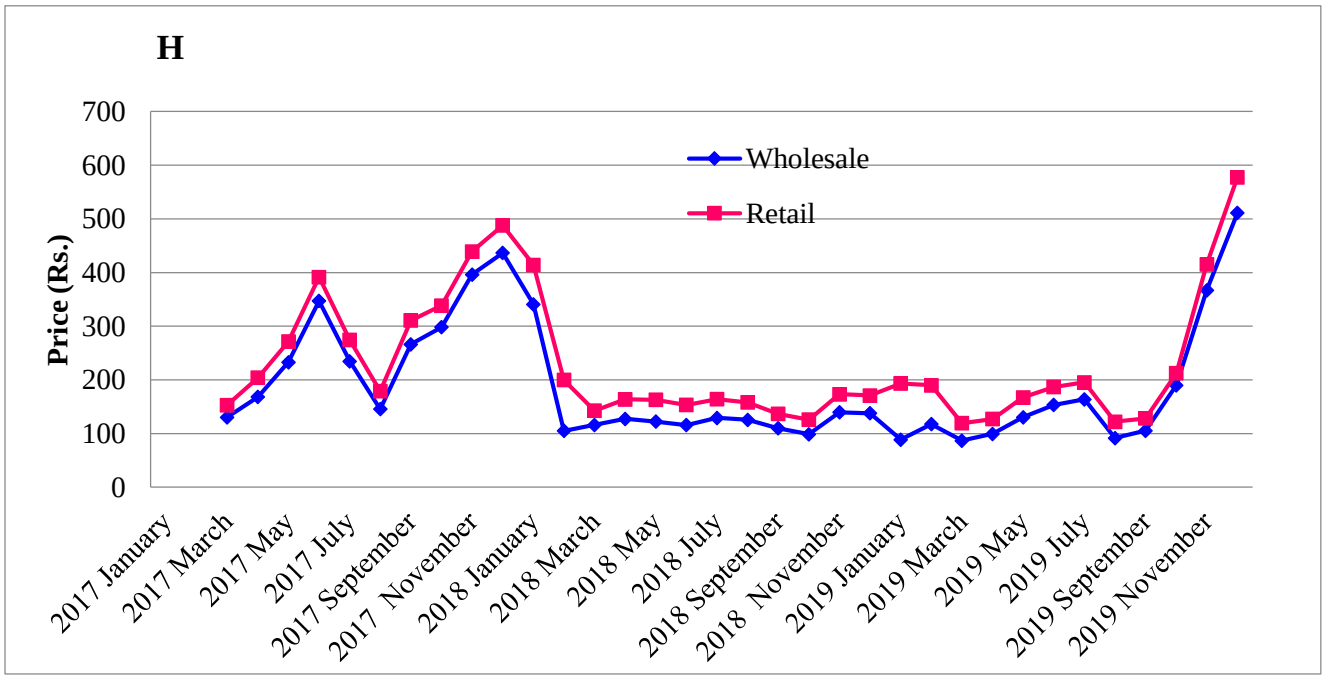
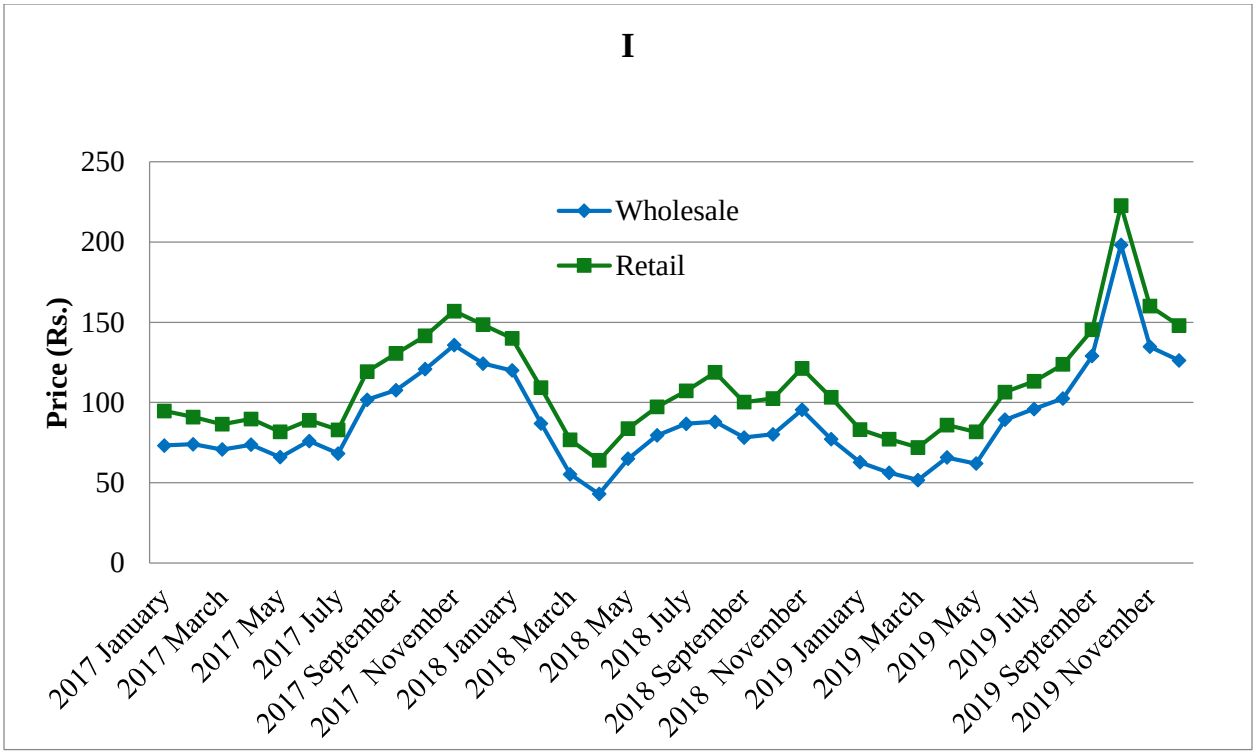


Figure 4: Price fluctuations of snake gourds (G) in Pettah market



(Data source: Central Bank Sri Lanka)

Figure 7: Price fluctuations of red onions (local) (H) in Pettah market



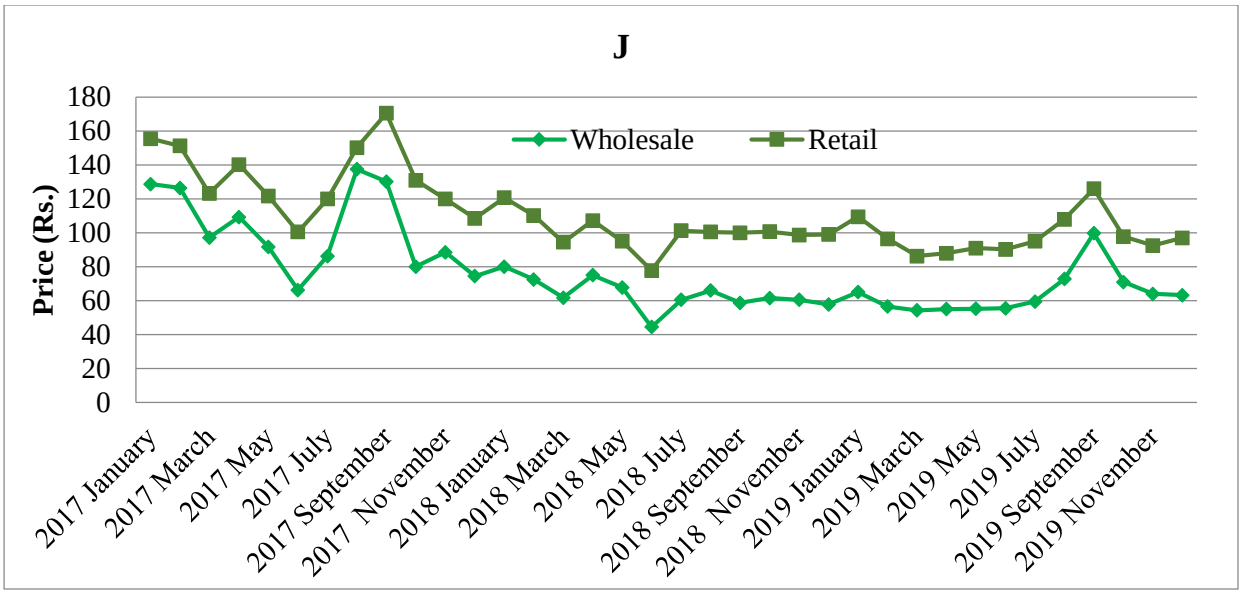
(Data source: Central Bank Sri Lanka)

Figure 8: Price fluctuations of big onions (I) imported in Pettah market

4.3 Price fluctuations of selected fruits

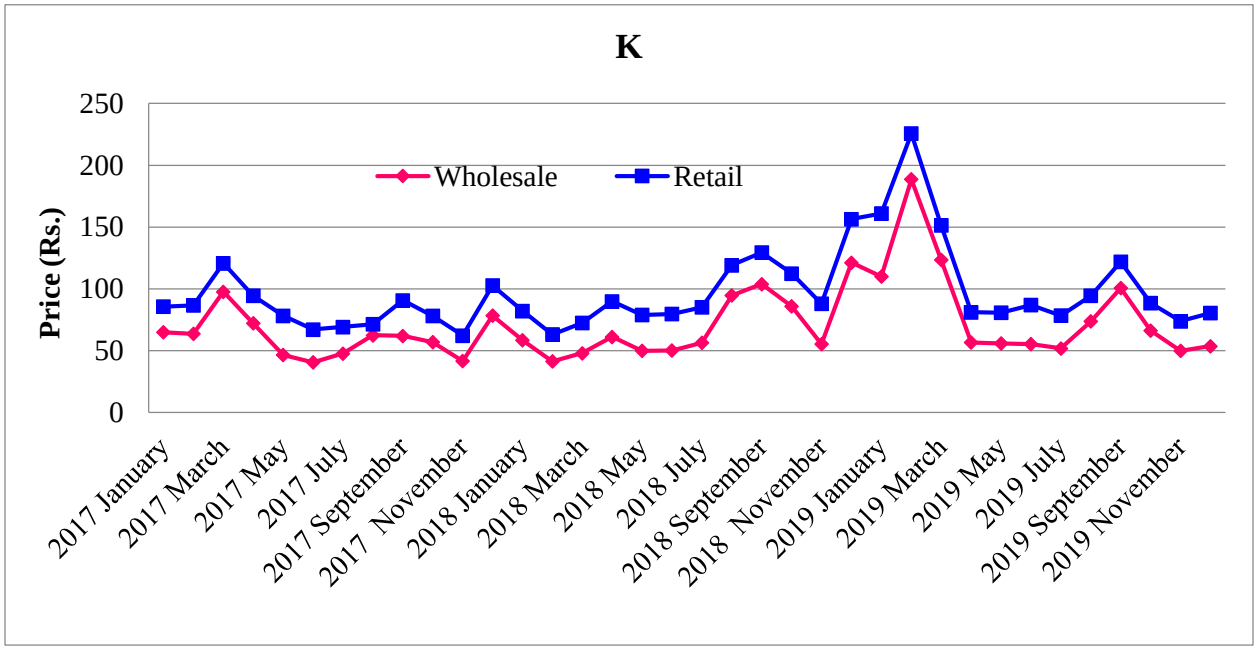
Similarly to vegetables selected fruits showed a considerable gap between whole and retail sale prices (Figures-9-11).

The price analysis show that the retail price of the selected fruits and vegetables is higher than wholesale price and wholesale/retail prices fluctuate throughout the year in similar pattern. However, the retail price is higher than the wholesale price for all fruit and vegetables due to the market margin created by the involvement of middlemen and the postharvest losses at several stages in the value chain.



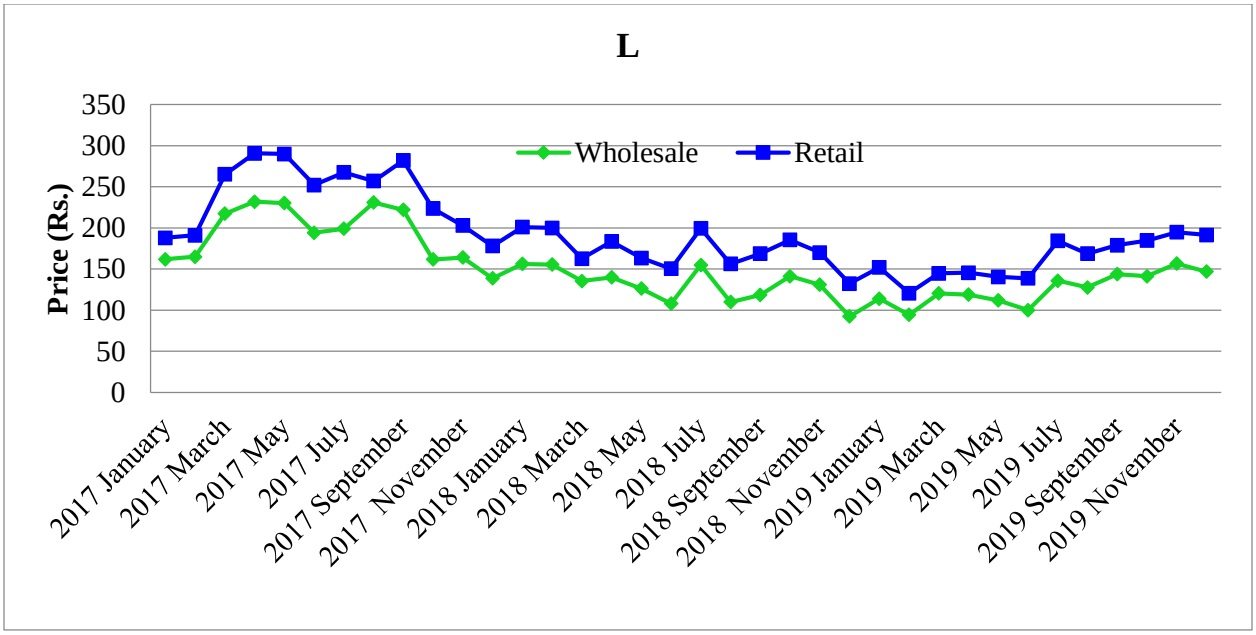
(Data source: Central Bank Sri Lanka)

Figure 9: Price fluctuations of banana (J) in Pettah market



(Data source: Central Bank Sri Lanka)

Figure 10: Price fluctuations of papaya(K) in Pettah market



(Data source: Central Bank Sri Lanka)

Figure 11: Price fluctuations of pineapple (L) in Pettah market

4.4 Postharvest losses of fruits and vegetables

Managing fruit and vegetable supply chain is complicated due to the perishable nature and sensitivity to weather changes of the produce. The food quality of fruits and vegetables degrades depending upon environmental conditions of storage and transportation mode. Post-harvest Food Loss (PHL) is the measurable qualitative and quantitative food loss along the supply chain, starting from the time of harvest to the consumption or other end uses (De Lucia and Assennato, 1994;). Losses are taken place along the chain in the handling, storage, transportation and processing, thereby resulting in a reduction in the quantity, quality and market value of agricultural commodities (Emana et al., 2017). The postharvest losses reduce the availability of food and increase per unit cost of transport and marketing making an impact on the country's economy. This affects both producers and the consumers.

Dassanayake and Jayasinghe (2019) showed post harvest losses of twelve vegetables and five fruits conducted at the Dambulla Economic Centre (DEC) where 65-75% of fruit and vegetable transactions of the country is taken place. Fruits and vegetables reach to consumers primarily through collection agents, wholesalers and retailers.

The results showed that the daily waste generation at DEC was 10.8 t and 10.7 t were derived from fruits and vegetable waste. Among the selected fruits and vegetables, cucumber, pumpkin, leeks, watermelon and banana were shown maximum postharvest losses at the DEC. Among the selected vegetables the highest losses was recorded for leeks and those were accounted as 2.%

from farm to DEC, 14% at the wholesale, 26% retail and 38% at consumer level. However, cucumber showed the highest losses (5%) from at the stalls of DEC (Figure 12)..

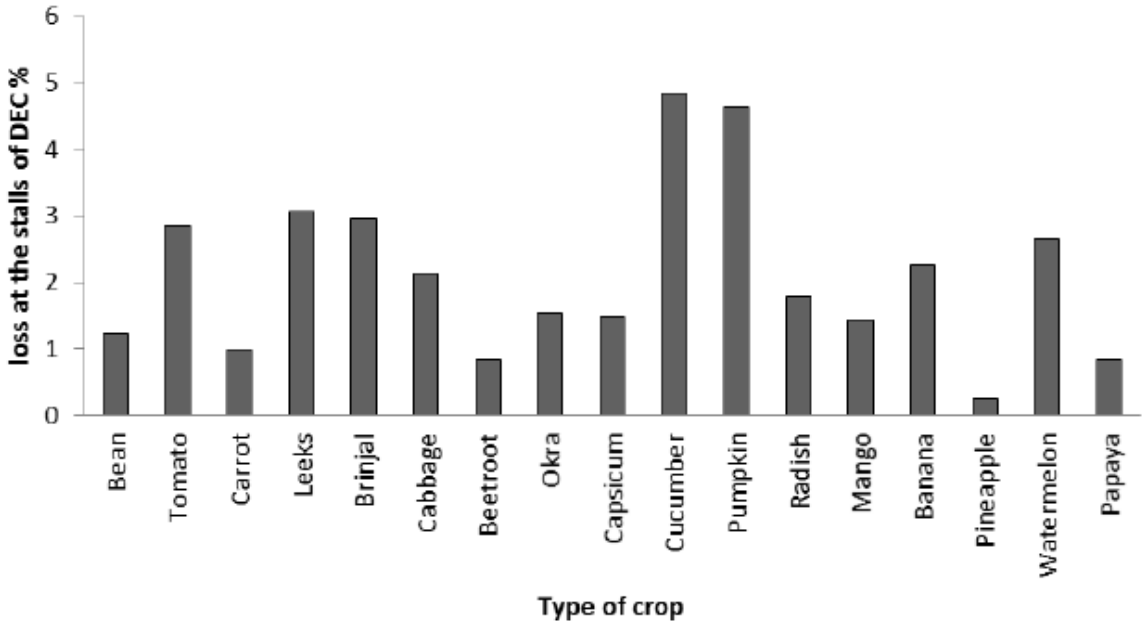


Figure 12 Estimated post harvest losses of selected vegetables and fruits at Dambulla Economic Centre (Dassanayake and Jayasinghe , 2019)

Among the selected vegetables the maximum postharvest loss at the DEC was estimated in cucumber (4.8%) followed by pumpkin (4.6%), leeks (3.0%), brinjal (2.9%), tomato (2.8%) and cabbage (2.%) (Dassanayake and Jayasinghe , 2019).

The vegetables with highest amount of losses in the waste were identified as yellow pumpkin (10.2%), leafy vegetables (10.1%) and cucumber (7.8%). Here leafy vegetable represents leeks, kankun (*Ipomoea aquatica*), onion leaves (*Allium cepa)*, salad leaves (*Lactuca sativa)*, Mukunuwenna (*Alternanthera bettzickiana*) and Niwithi (*Spinacia oleracea*) (Dassanayake and Jayasinghe , 2019) (Figure 13).

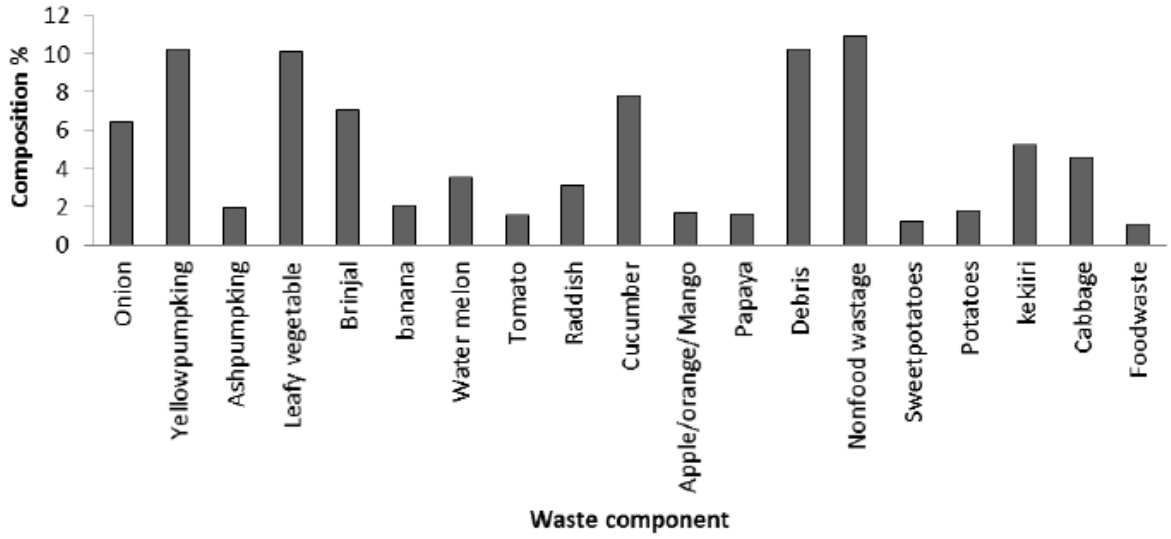


Figure 13: Composition of the waste components at DEC

(Dassanayake and Jayasinghe , 2019)

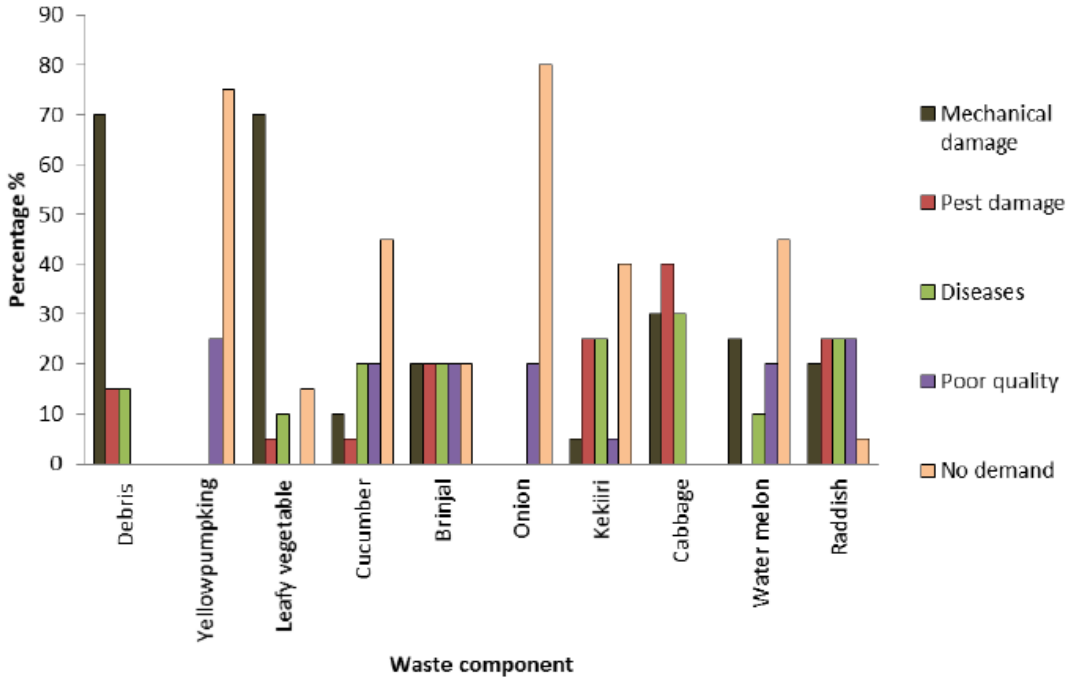


Figure 14: Cause for the loss of fruits and vegetables in the waste

(Dassanayake and Jayasinghe , 2019)

Figure 14 show the causes for the losses of different fruits and vegetables at DEC. Fruits and vegetables at the DEC mainly waste due to lack of demand , pest damages , diseases , mechanical damages and poor quality. Cucumber has been thrown in to the waste dumps mainly due to lack of demand (45%). The main reasons for the losses of yellow pumpkin are lack of demand (75%) and poor quality; un-matured, small in size (25%). Leafy vegetables mainly waste due to mechanical damages (70%), pest damages (5%), diseases (10%) and lack of demand (15%). Cabbage at DEC mainly waste due to mechanical damages (40%) while radish mainly waste due to mechanical damages (20%), diseases (25%) and poor quality (25%).

The majority of the fruits and vegetables waste due to the poor predictions between the supply and demand (Dassanayake and Jayasinghe , 2019). Sorting of vegetables at DEC was not done but fruits were sorted out in order to remove unfit fruits to pass over the value chains. For vegetables, the losses are mostly occurred due to mechanical damages during transportation. Poor handling and poor packaging causes a significant loss of vegetables. Furthermore, when the produce has less/ no demand in the market, farmers threw their products into the waste bins without attempting to sell.

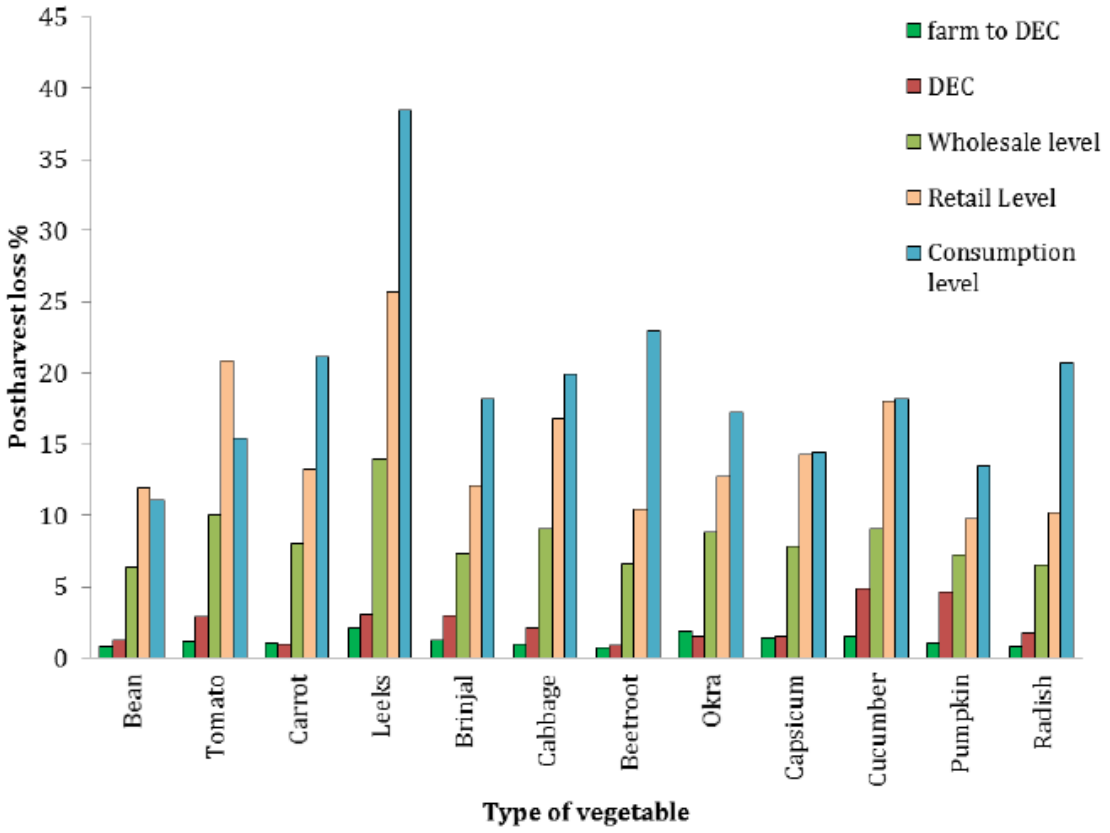


Figure 15: Postharvest losses through the value chain (Dassanayake and Jayasinghe , 2019)

For fruits, the losses are found due to mechanical damages during transportation and the ripened fruits are also dumped in to bins. Loading/unloading processes, causes the fruits are damaged due to the poor handling. The hooks that are used by the *Natamai* or the daily paid (temporary) worker causes damage to the products and the packaging (Dassanayake and Jayasinghe , 2019).

Figure 15 show that the amount of the losses of the selected vegetables has been increased progressively through the value chain.

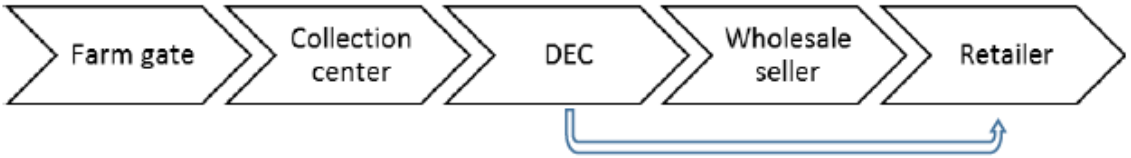


Figure 16 Generic flow of fruit and vegetable value chain through DEC

(Dassanayake and Jayasinghe , 2019)

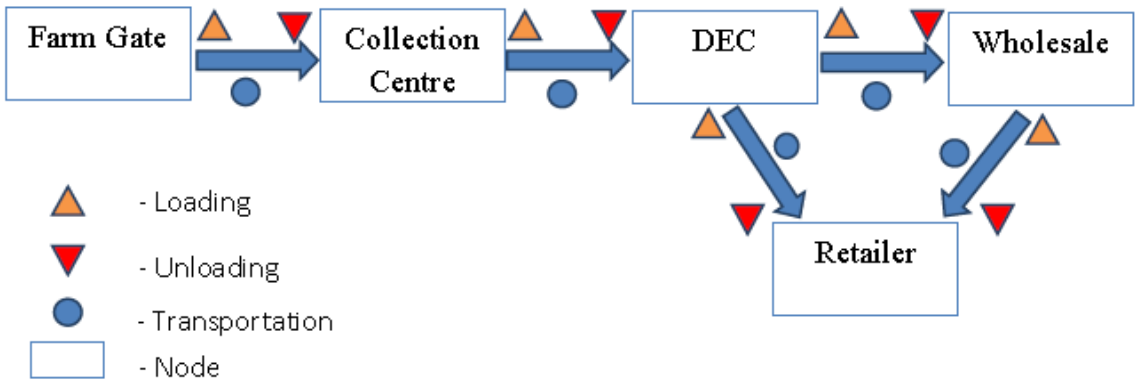


Figure 17: Sub activities along the food value chain

Poor handling during loading unloading and transportation damage the produce unless extra care is taken..

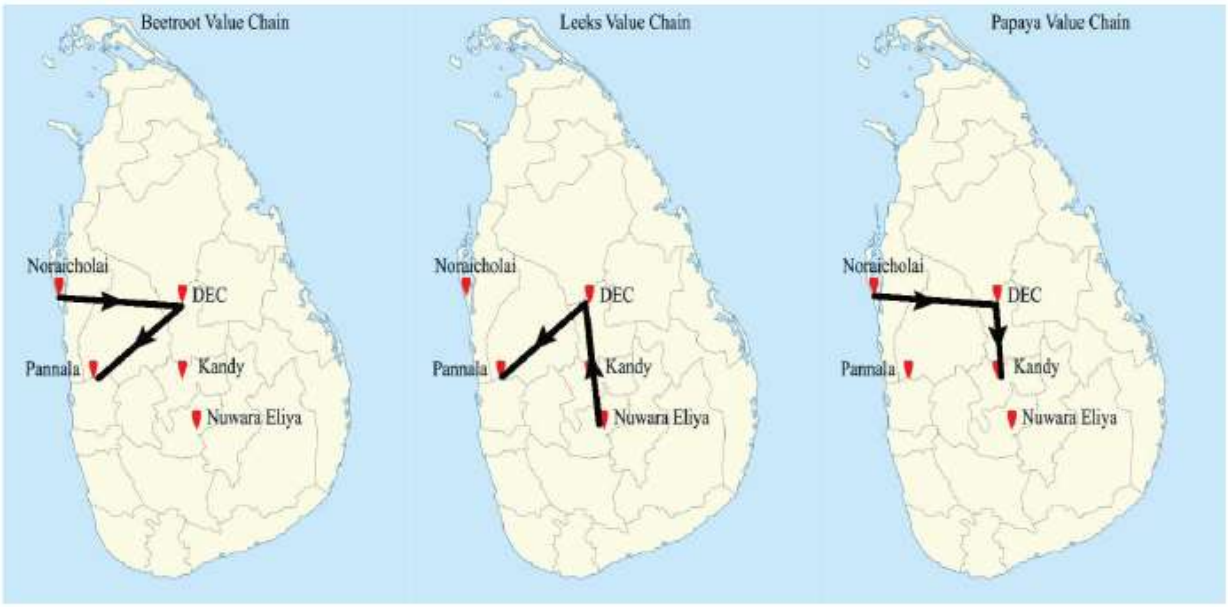


Figure 18 Selected value chains for beetroot, leeks and papaya

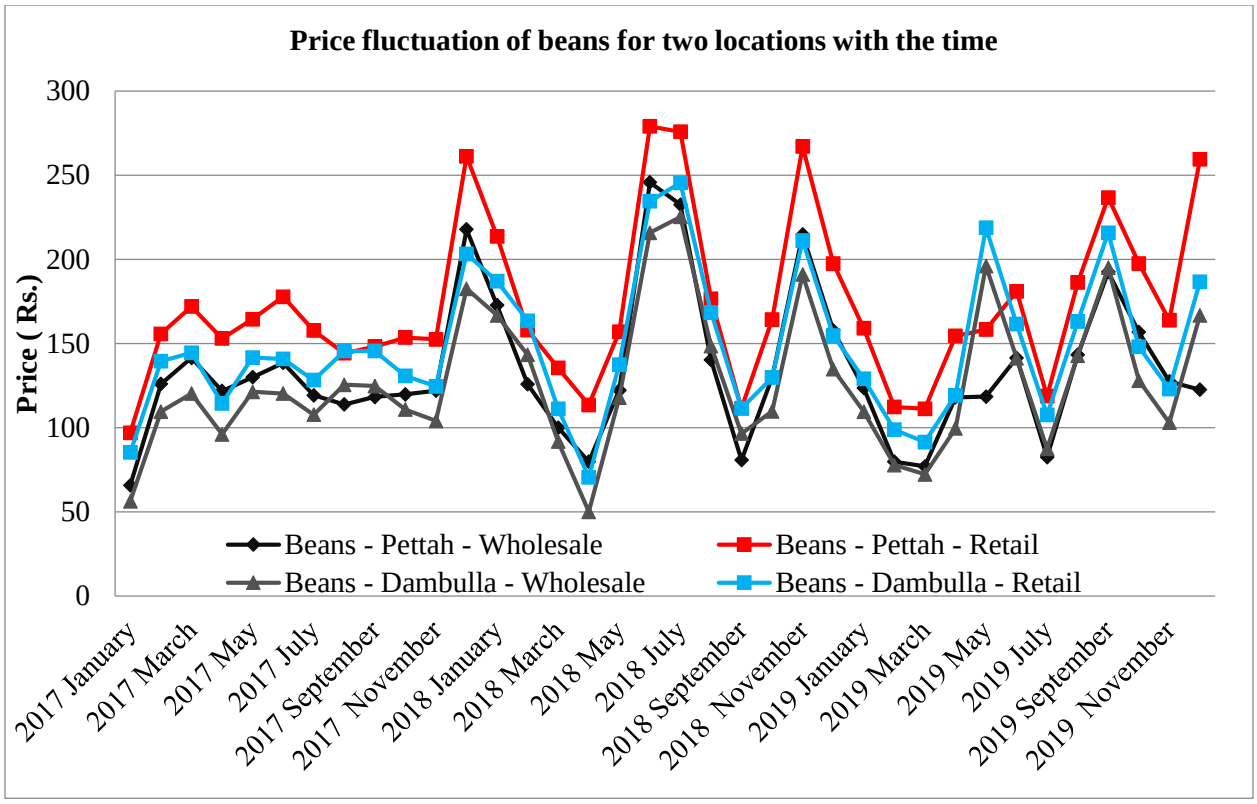
(Dassanayake and Jayasinghe , 2019)

4.5 Causes of Fruits and vegetable losses throughout food value chain (Dassanayake and Jayasinghe , 2019)

1. Poor management of high production quantities in Maha season
2. Lack of management for poor environmental conditions in Maha season (High atmospheric humidity)
3. Lack of sorting process of the produce at the field level
4. Lack of opportunities for value addition when there is surplus of produce/lack of demand
5. Mechanical damages during harvesting and transportation
6. Use of unsuitable packaging materials; mechanical damages/spilling over
7. Overload of produce in vehicles
8. Poor handling during loading/unloading

4.6 Price fluctuations of food commodities at different locations

It is noteworthy that depending on the place of economic center food commodities are transferred for distribution prices are fluctuated. Pettah prices showed generally higher compared to Dambulla Economic Centre.



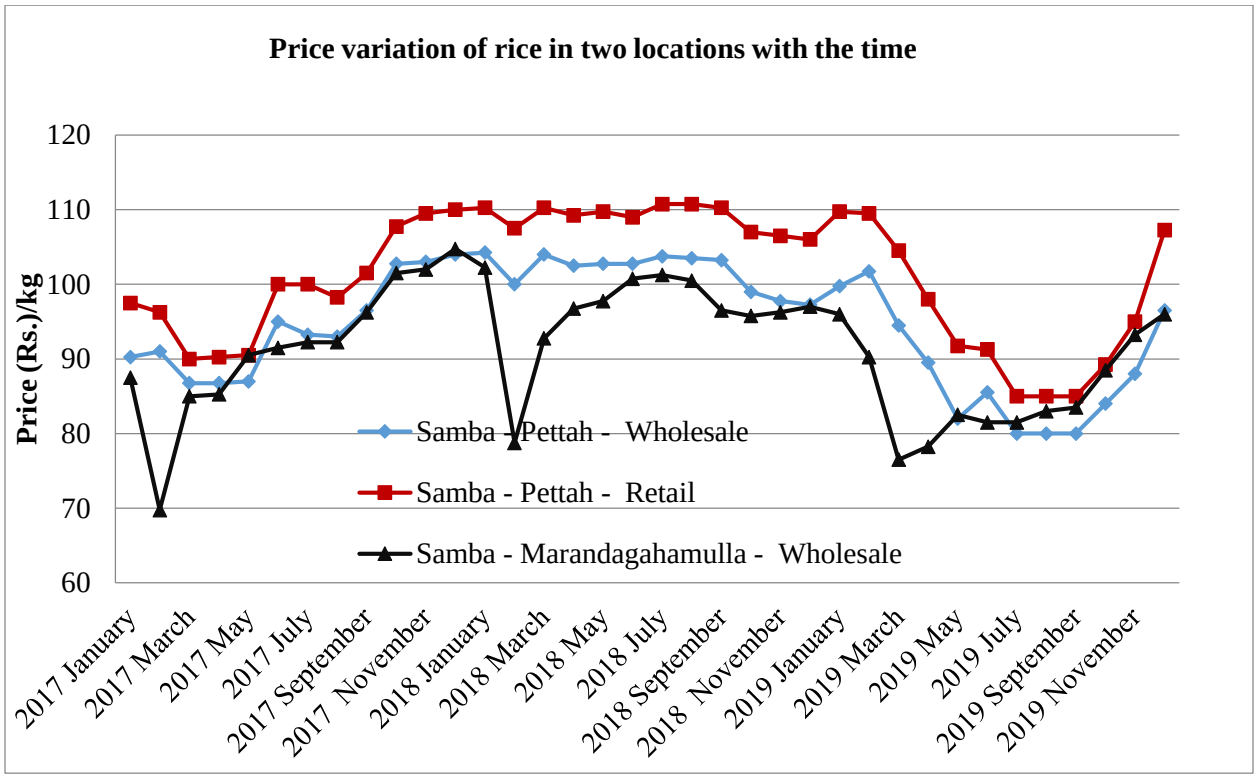


Figure 19: Price fluctuations of beans and rice **(Data source: Central Bank Sri Lanka)**

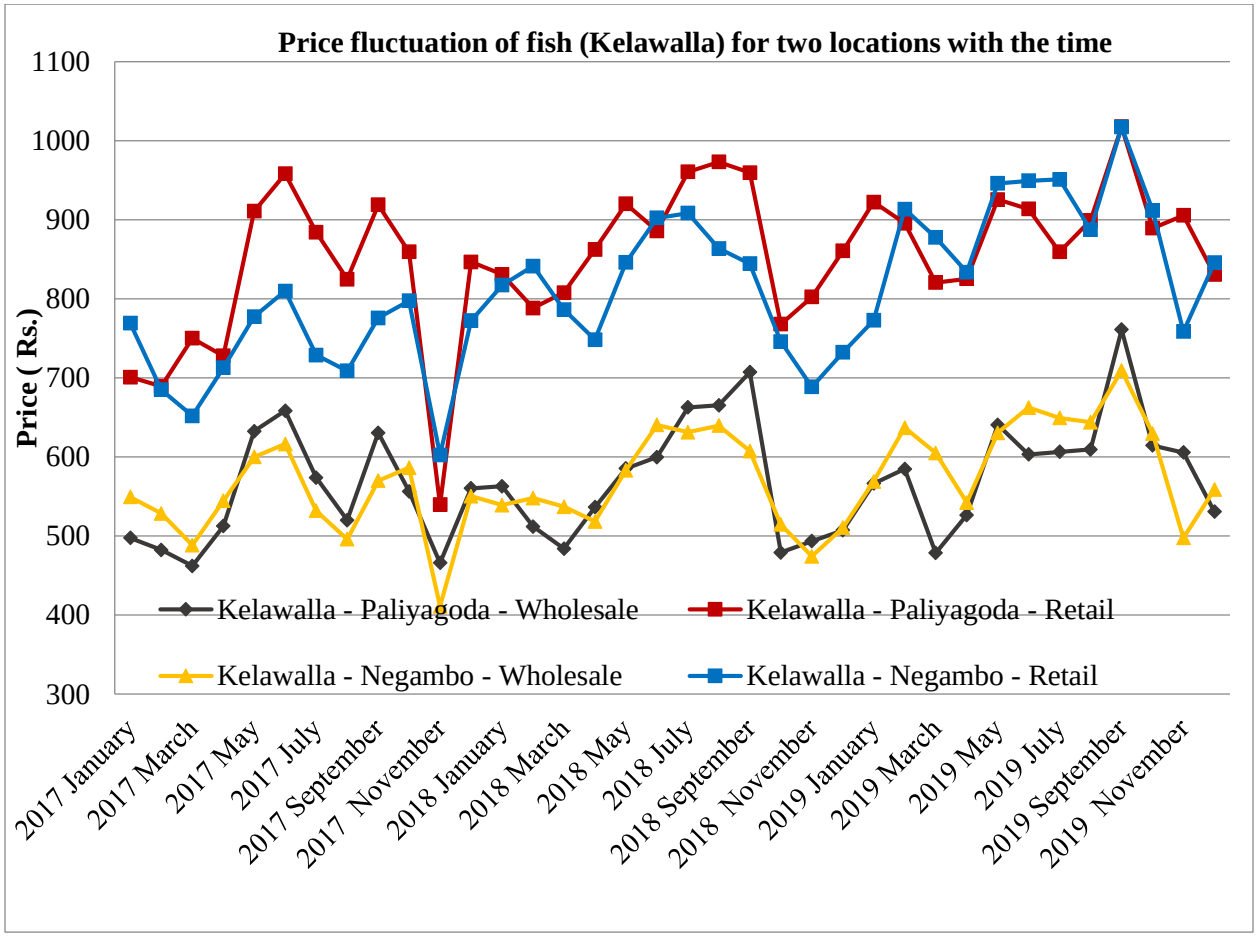


Figure 20: Price fluctuations of Fish (Kelawalla) **(Data source: Central Bank Sri Lanka)**

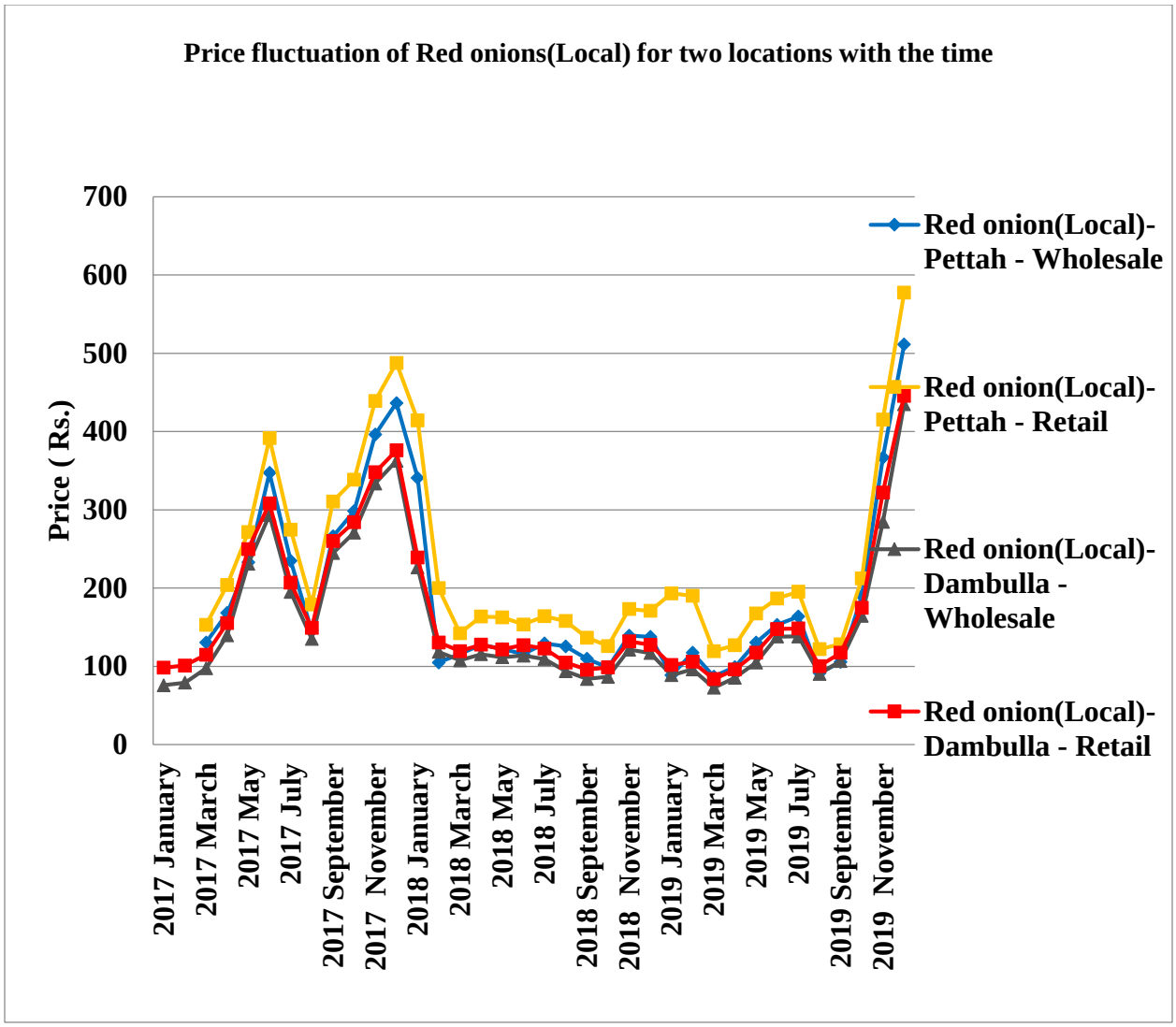


Figure 21: Price fluctuations of red onions (local) (Data source: Central Bank Sri Lanka)

4.7 Price fluctuations of other different common food commodities

The prices of food commodities such as potatoes, coconut oil, eggs and dried fish at the Pettah market showed up and down variations throughout the time course. It is noted that slight rise in Prices for all commodities in general noted during 2019 (Figure 22 and 23)

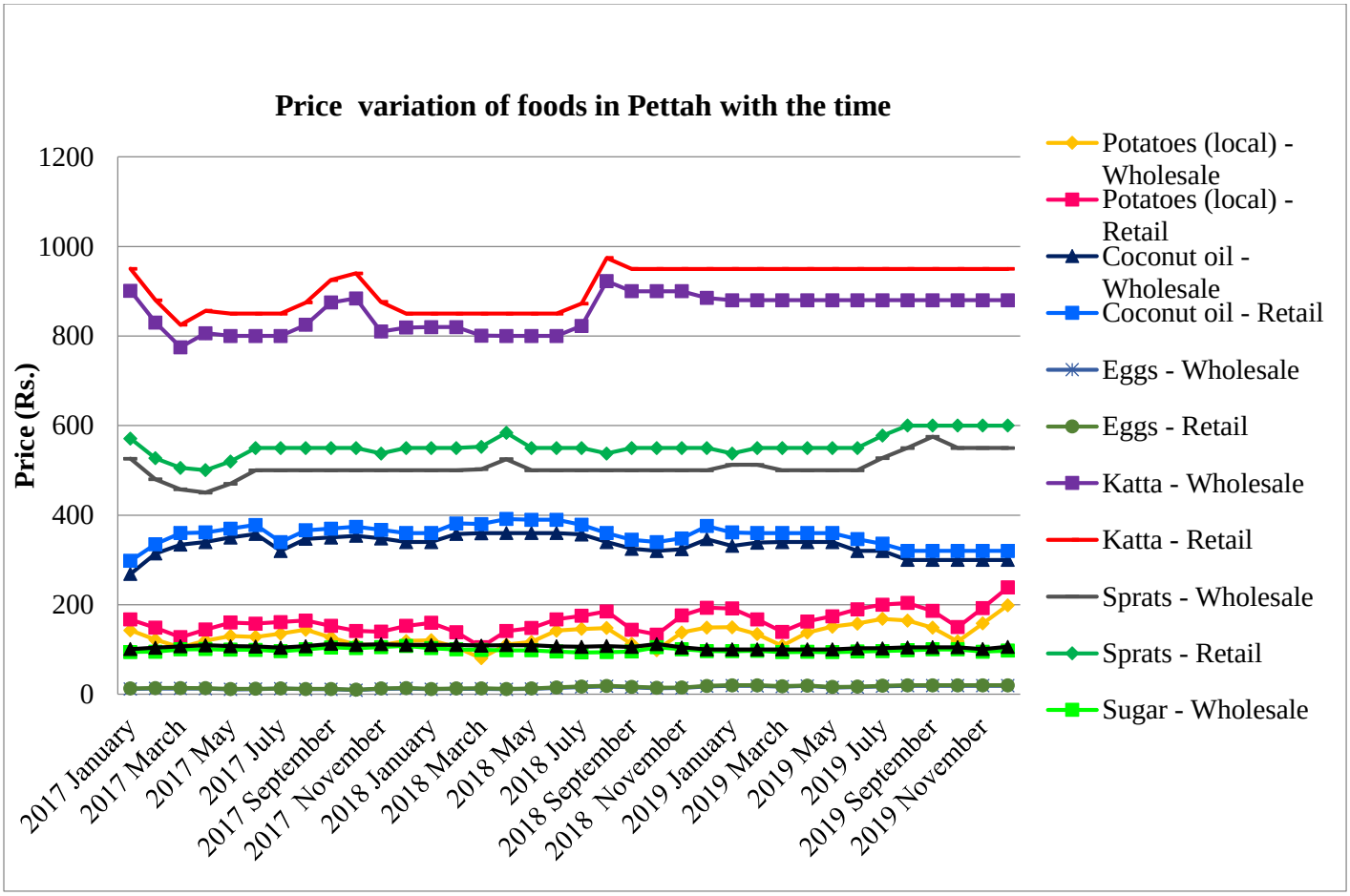


Figure 22: Price fluctuations of other food commodities

(Data source: Central Bank Sri Lanka)

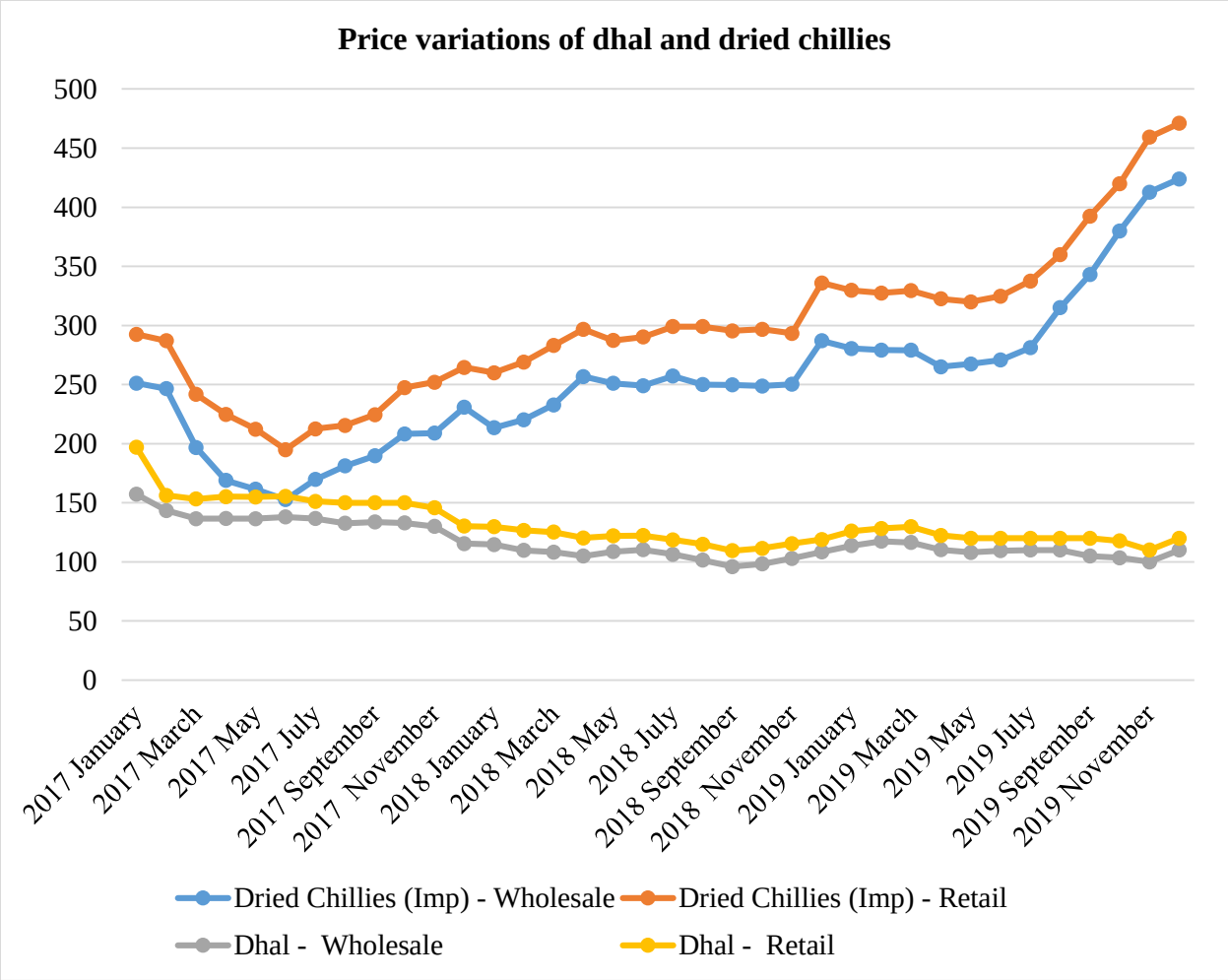


Figure 23: Price fluctuations of dhal and dried chilies

(Data source: Central Bank Sri Lanka)

4.8 Rice Food value chain

Rice is the staple food of Sri Lankans and rice sector is one of the largest food sectors in Sri Lanka. There are many players, activities and resources are involved in the food value chain (Figure 24). It is established that the value chains, provide opportunities for the players to improve their competitiveness. Large scale producers as well as small scale producers are integrated in the value chains. It is obvious that the small producers get together within value chains to work together and form producer groups. Large scale firms take a leading role for such integration (Senanayake and Premaratne, 2016). Figure 25 shows the price variations of different rice.

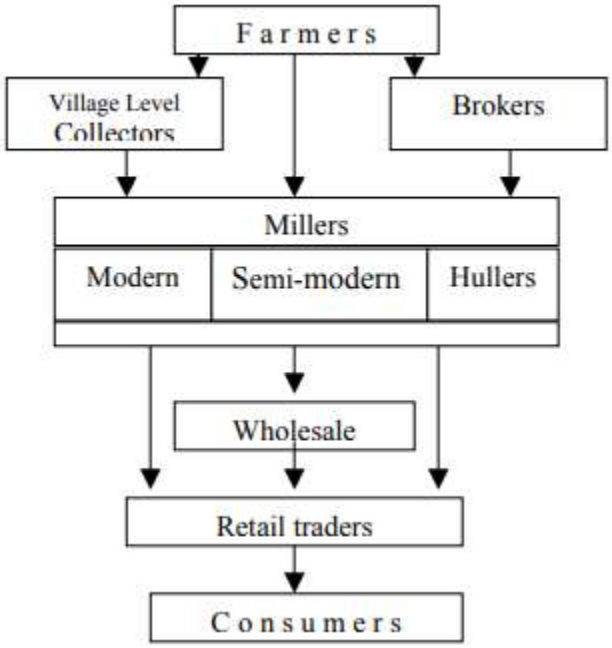


Figure 24: Rice food value chain

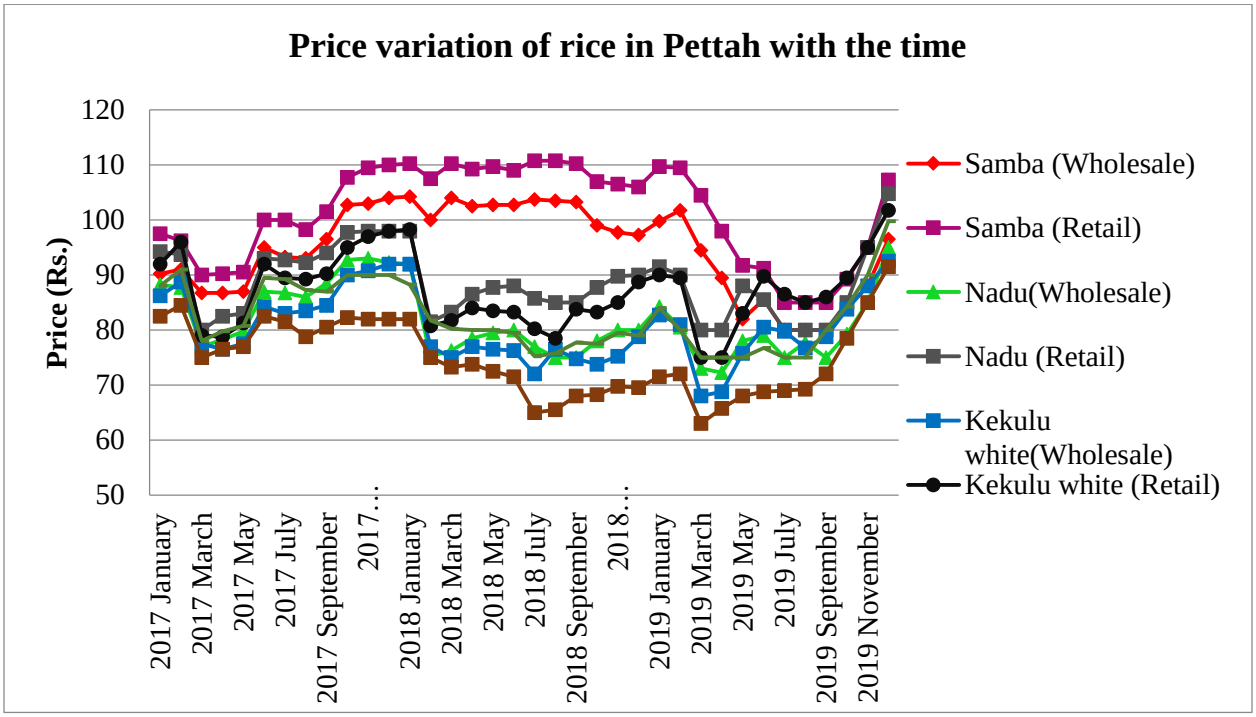
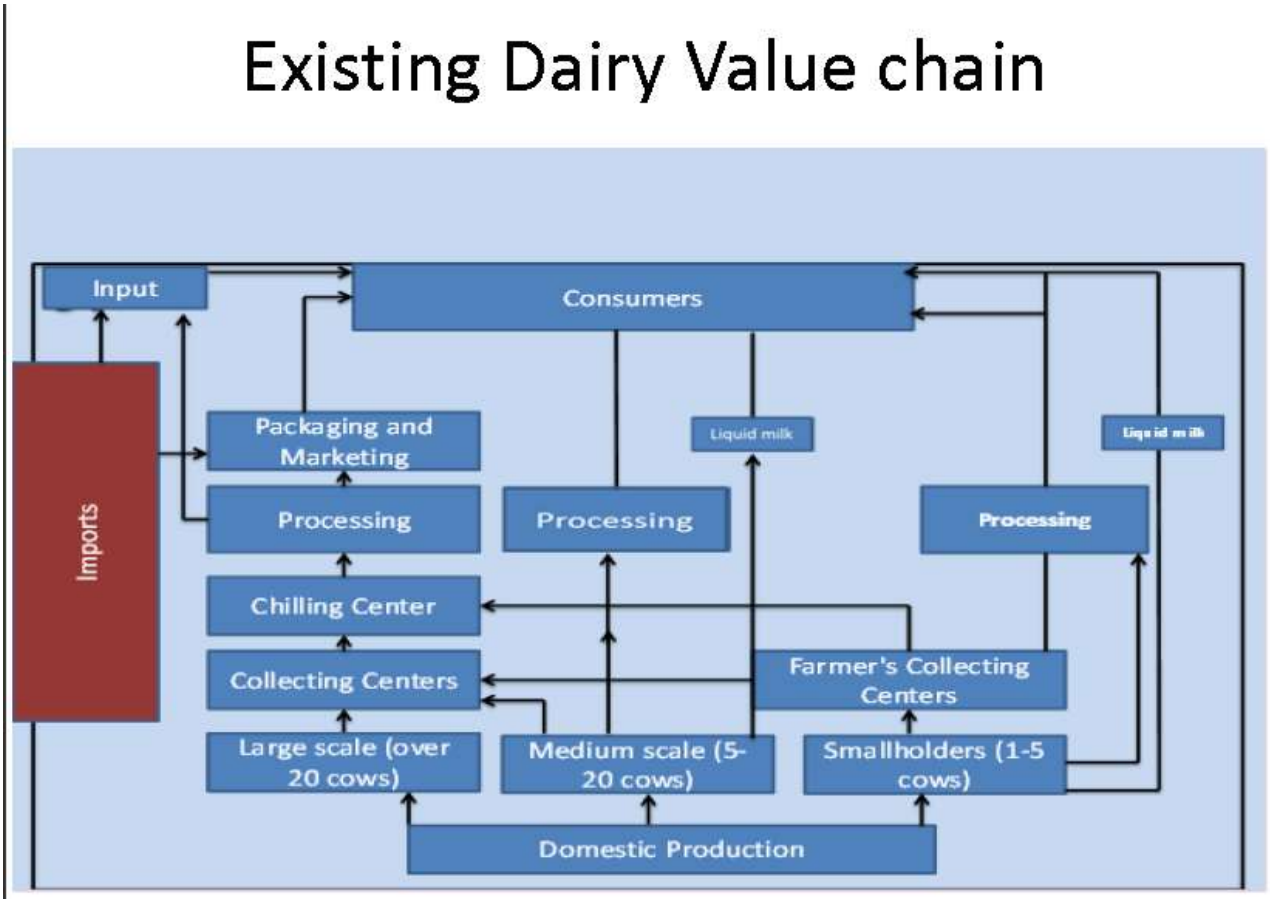


Figure 25: Price fluctuations of rice

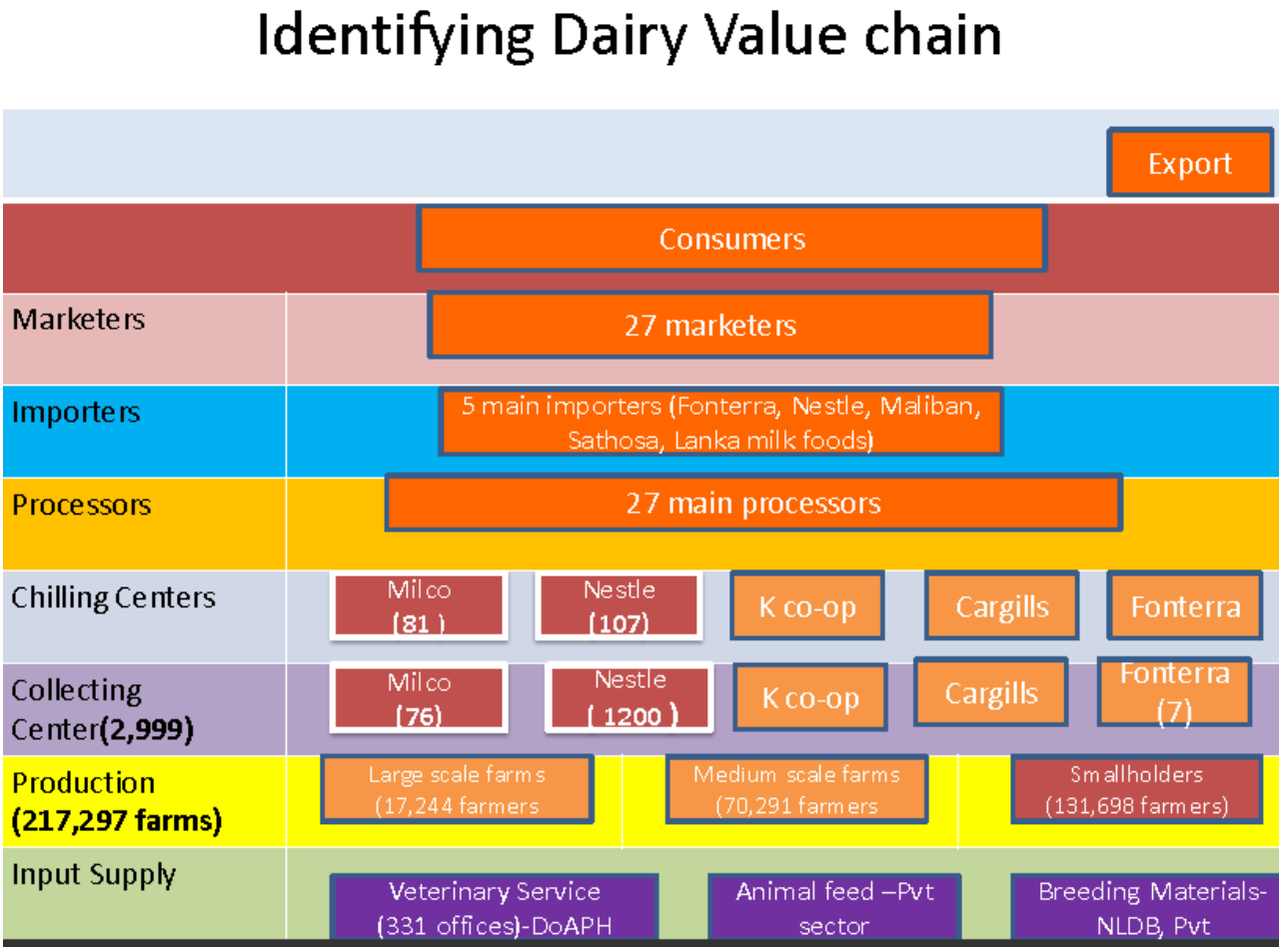
(Data source: Central Bank Sri Lanka)

4.9 Dairy value Chain



(Source: Hirrimuthugoda, 2016)

Figure 26 Dairy value chain

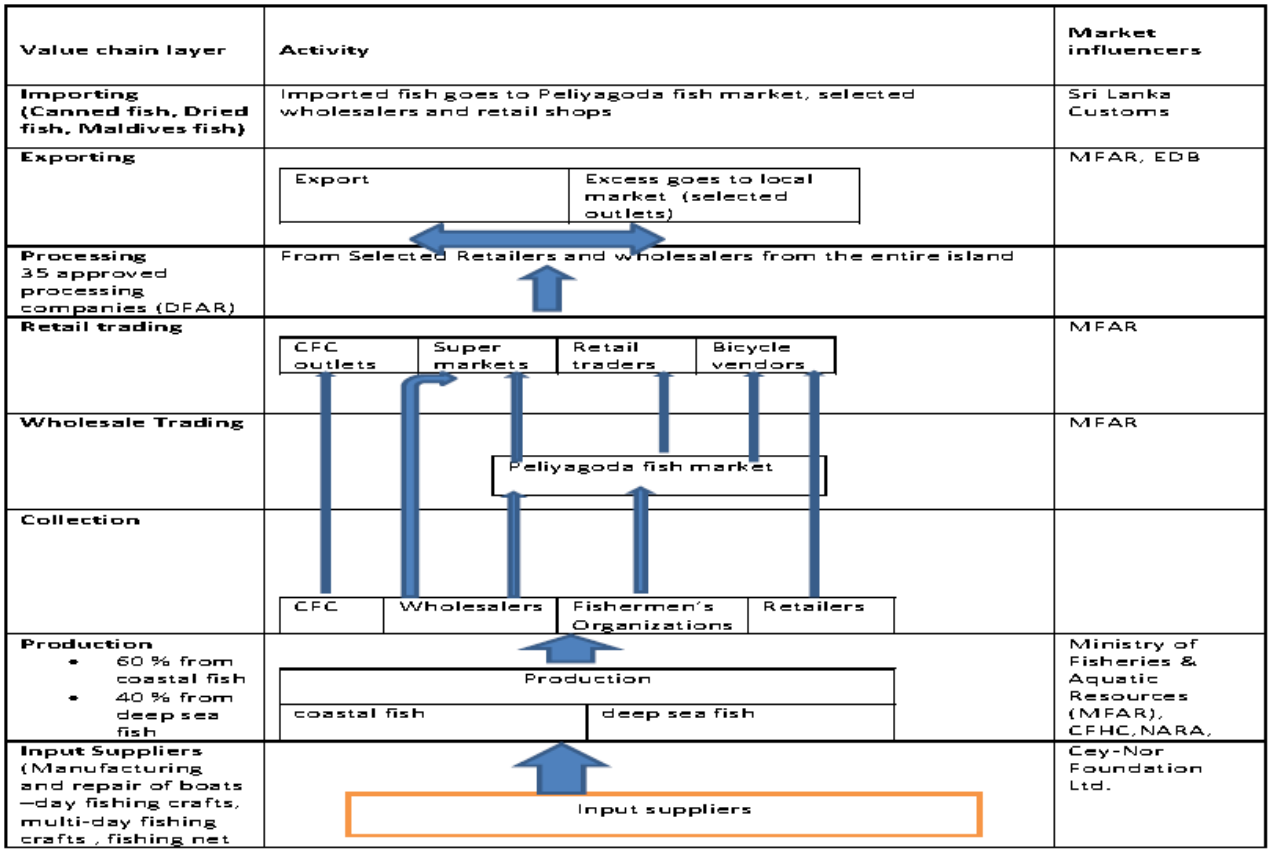


(Source: Hirrimuthugoda, 2016)

Figure 27 Dairy value chain including large scale producers

4.10 Fisheries value chain

A number of middlemen participated in fisheries value chains.



(Source: Hirrimuthugoda, 2016)

Figure 28 Fisheries value chain

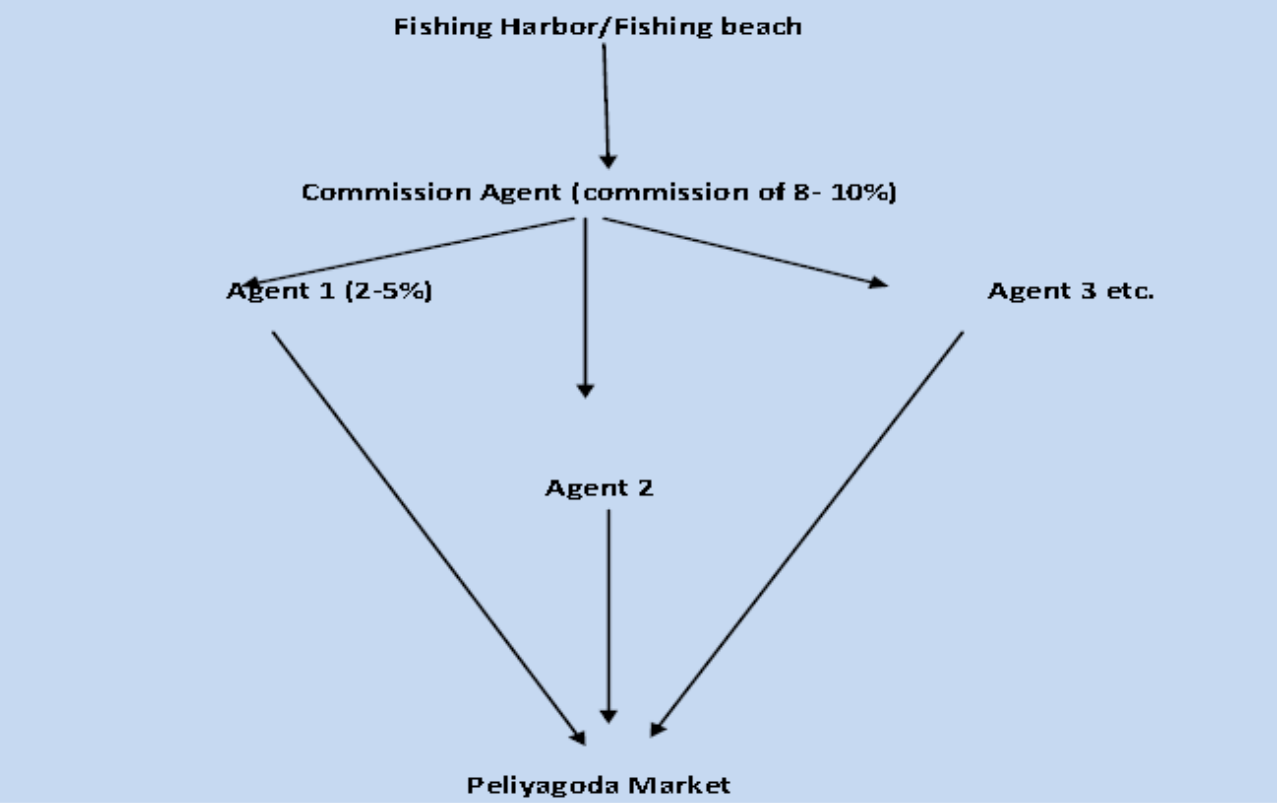


Figure 29 Involvement of middlemen in fisheries value chain

(Source: Hirrimuthugoda, 2016)

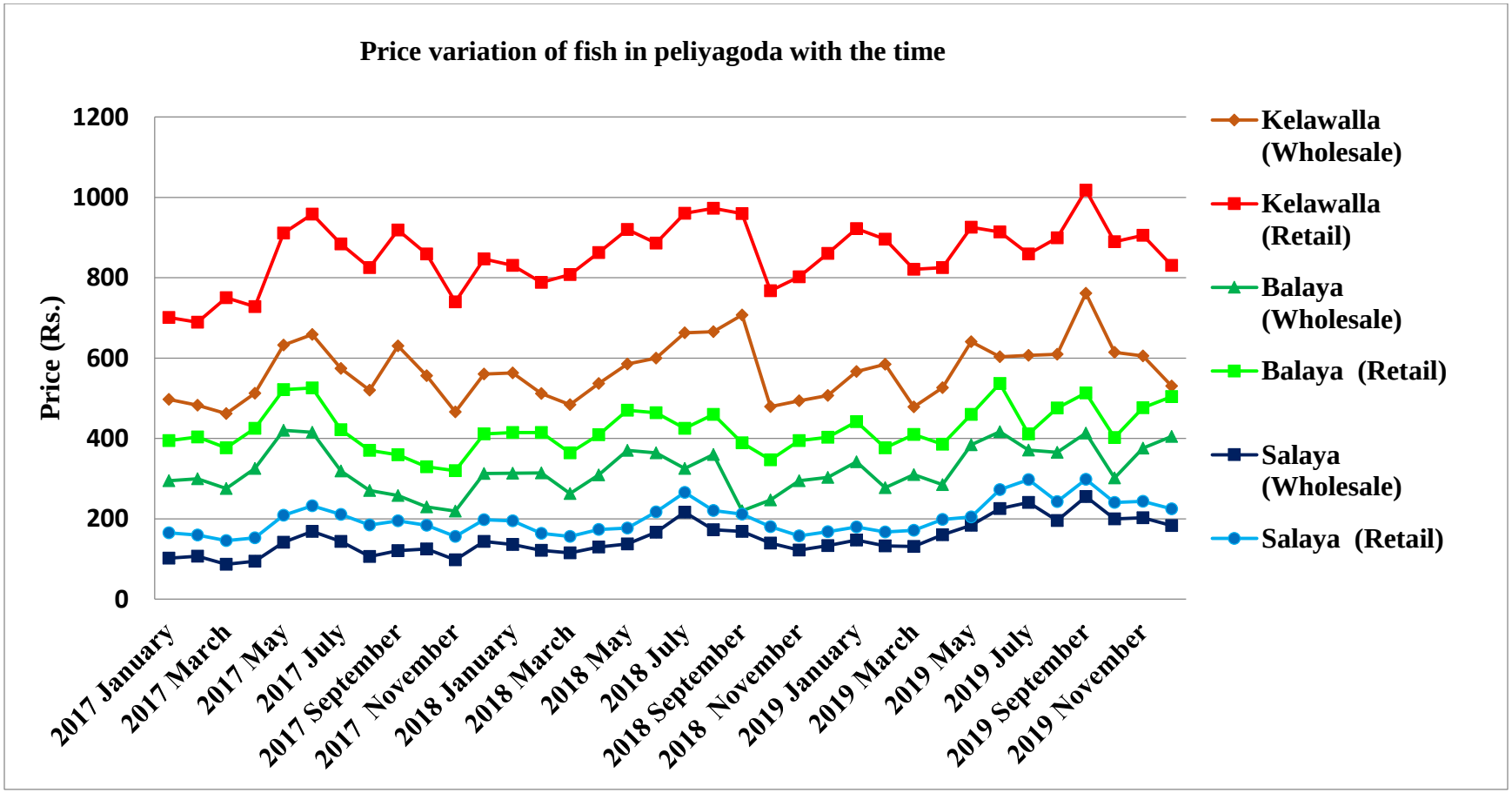


Figure 30a Price fluctuation of fisheries at Paliyagoda center

(Data source: Central Bank Sri Lanka)

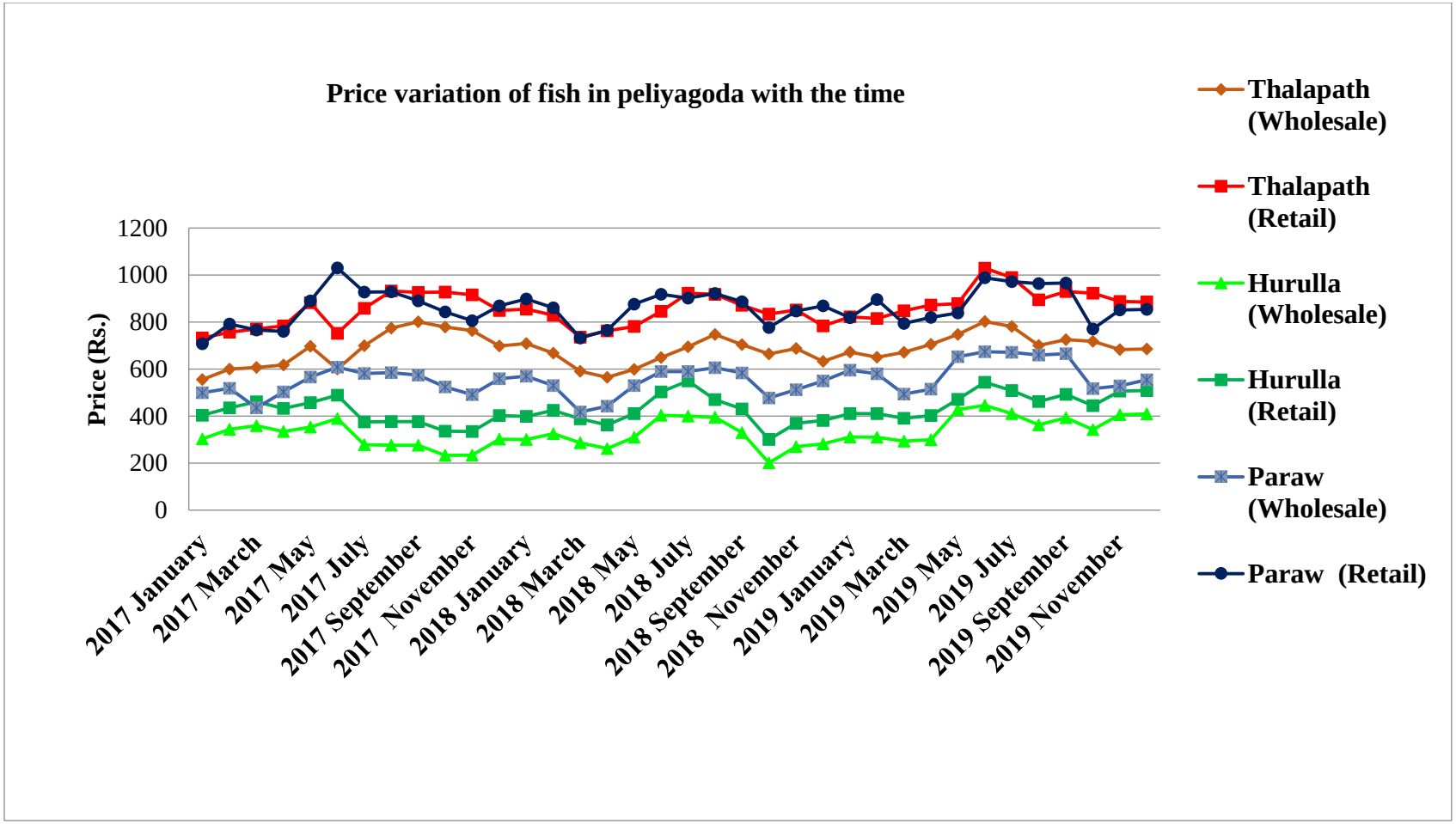


Figure 30b Price fluctuation of fisheries at Paliyagoda center

(Data source: Central Bank Sri Lanka)

5. Summary

There are limited studies in Sri Lanka assessing the different aspects of nutritious food value chains. Available studies on fruits and vegetable show that involvement of the middle man, poor management practices at different nodes of the value chain affect the availability of food produce from farm to consumer. Limited published studies available on other food value chains demonstrate heavy involvement of middlemen and seasonal price fluctuations with a wider gap between retail and wholesale prices. This affects the consumption leading to variable nutritional outcomes of the population.

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Hirimuthugodaage D (2016) IPS https://www.ips.lk/wp-content/uploads/2017/03/IPS_IFPRI_FoodValueChainWorkshop_AgriFoodValueChainSL_April2016.pdf

Section 6 –b

Women empowerment in agriculture sector in Sri Lanka

1. Introduction

Gender equality is essential for human development. Despite the similar situations such as educational equality and income generation in many societies women yet enjoy lesser the same opportunities as men. It is noteworthy they work longer hours and they are paid less. Furthermore, the choices on how they spend time, in both work and leisure, are limited compared to men. Due to these constrains there are substantial gaps between how much women and men can contribute to society, modality of work and how they share benefits.
Objective of the review of this section (6b) was to provide situational analysis of women status in Sri Lanka to understand the linkages between nutrition, and the women contribution to agriculture sector in the food system.

2. Methodology

The review was based on secondary data gathered from literature survey which were directly related to the women involvement in agriculture nutrition issues in women and children.

3. Inclusion & exclusion criteria of evidences

Information related to agriculture sector for women involvement in Sri Lanka was included.

4. Findings and Analysis

4.1 Gender empowerment

In Sri Lanka, both men and women have access relatively high standards in health and education, compared to other developing countries. Women in Sri Lanka are generally well cared by the health system. It is noteworthy that services for the early detection of pregnancies, the monitoring of expectant mothers and the provision of supplements during pregnancy are taking place systematically. All deliveries are taking place in hospitals. The maternal mortality ratio and adolescent birth rate is lower in Sri Lanka than in other countries in the region, such as India, Nepal, and Bangladesh. The low maternal mortality ratio indicates the good position of women as it reflects a combination of sociocultural factors that affect women's health and access to healthcare, including availability of the health services (ADB, 2016). The adolescent fertility rate is an indicator that shows opportunities for skill development and higher education for girls and lower risk for health complication due to early pregnancy.
However, despite these positive social development indicators, the overall level of women gender empowerment is yet to be improved among the average level of developing countries, due to the extremely low involvement of women in politics and low female participation in the labour force (Figure 1and Figure 2). Furthermore the problems lies in the poor female

representation in the national parliament (5.8%) and in the labour force (35%) (Jayaweera, 2008). These figures indicate that women's capabilities are grossly undervalued and underutilized in Sri Lanka. The main reasons for poor participation in the labour market is lack of quality child care facility and flexible working hours (Central Bank, 2016).

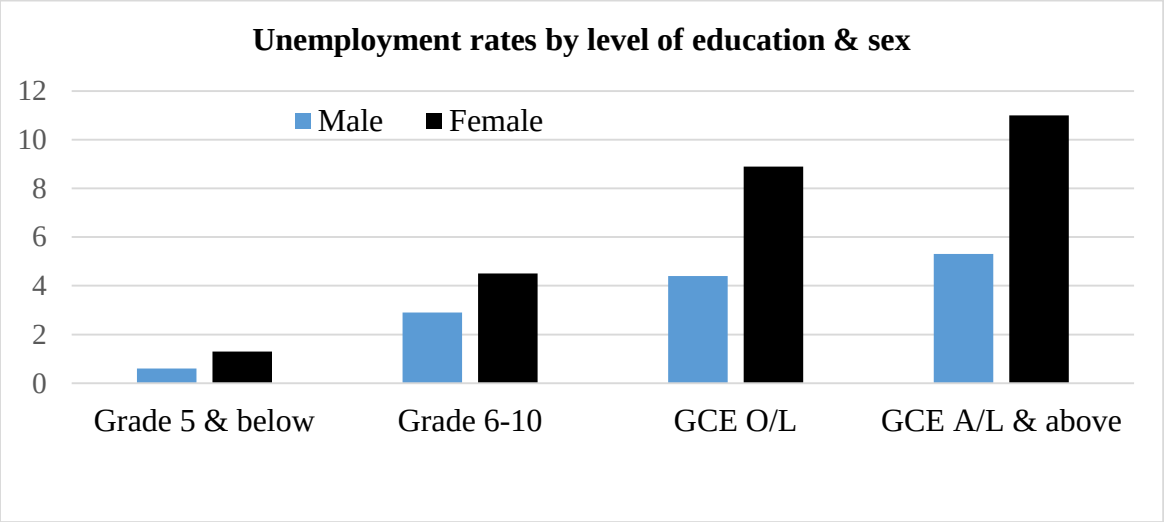

Figure 1: Unemployment rates by level of education and sex
(Data source Department of Census and Statistics 2014)

Figure 2: Labour force participation

Women participation in development process is important. Though, the women percentage is 51.4 of total population, labour force participation rate is only about 35%, and contributing as family worker is around 77%, economically inactive population of women out of total, women population is 75% while the young female unemployment rate is around 26% as a percentage of labour force in 2016 (DCS, 2017). Furthermore, benefits between men and women in a number of sector allocations such as agriculture, higher education and, government and private sector employments have serious gender imbalances and inequalities (Figure 3).

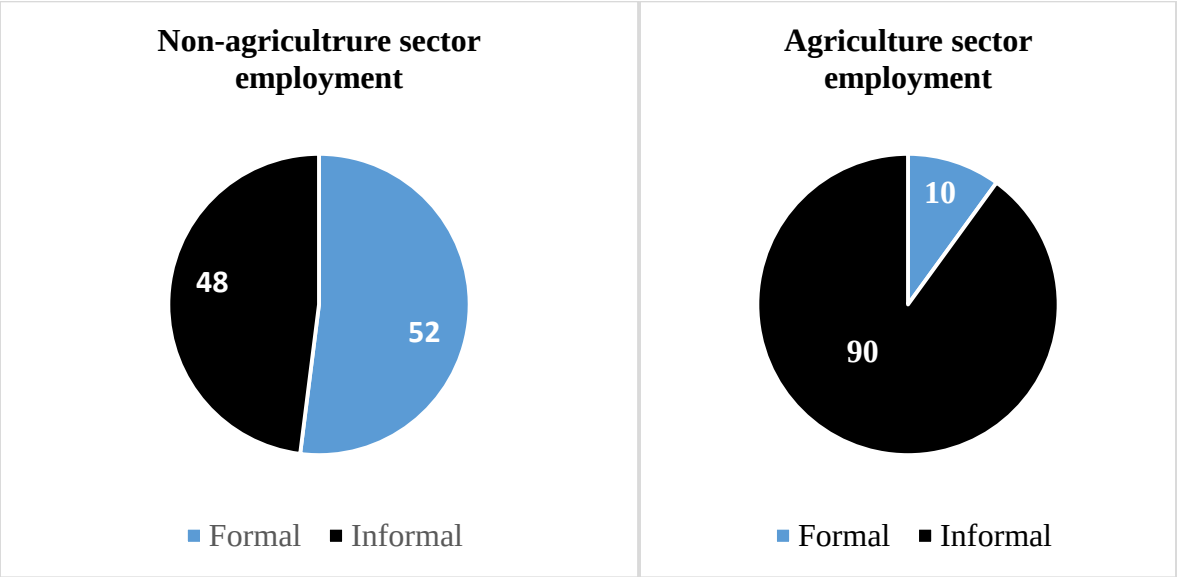

Figure 3: Type of employment by women

(Data source Department of Census and Statistics 2015)

There is gender equality in education, for enrolment and attendance for boys and girls in Sri Lanka. In addition, girls remain in school a longer period of time than boys. However, gender inequality exists in decision-making, development planning and political participation. Women hold few management positions in the workplace, do not receive equal pay for similar work, and have higher rates of unemployment. There is also a notable gender gap in terms of access to and control over resources, such as land, credit and technology.

Sri Lanka has received low scores in the global indexes measuring women's empowerment (table 1). For Sri Lanka, interpreting the low scores in these indexes at the national level is made more complicated by the inter-regional disparities such as having urban population in some provinces while having more rural percentage of population in others. It is clear that even in Sri Lanka, similar to other developing countries, rural women who involve in agriculture sector are at a greater disadvantage than urban women.

Table 1: Global development and gender empowerment Indices

INDEX	VALUE	RANK
Human Development Index (HDI) 2016	0.766	73rd/168 countries
Gender Development Index (GDI) 2016	0.934	Gp 3 (Medium equality in HDI achievements between men and women)
Gender inequality Index (GII) 2016	0.386	87th /159 countries
Global Gender Gap Index (GGGI) 2017	0.669	109th/144 countries
Women's Economic Opportunity Index (WEOI) 2012	47.6	84th /128 countries

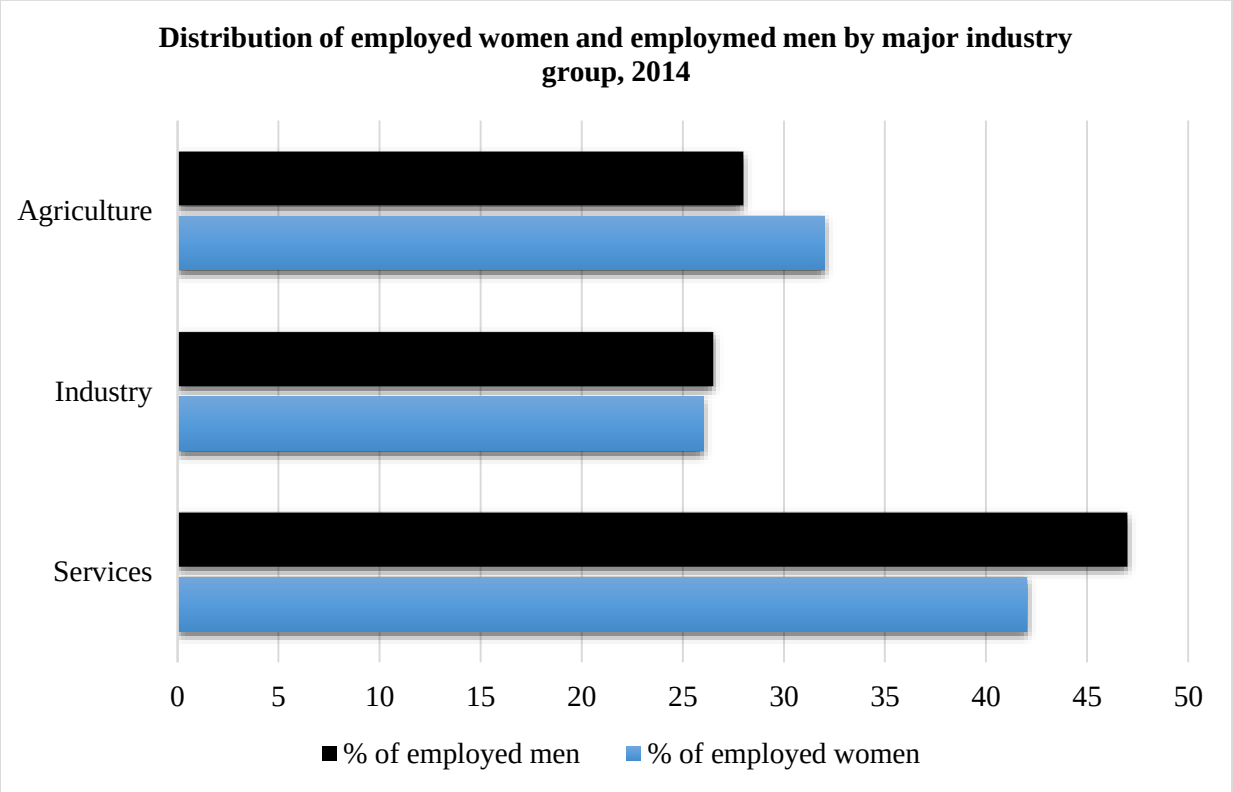

Figure 4: Distribution of employed women and employmed men by major industry group, 2014

(Data source Department of Census and Statistics 2015)

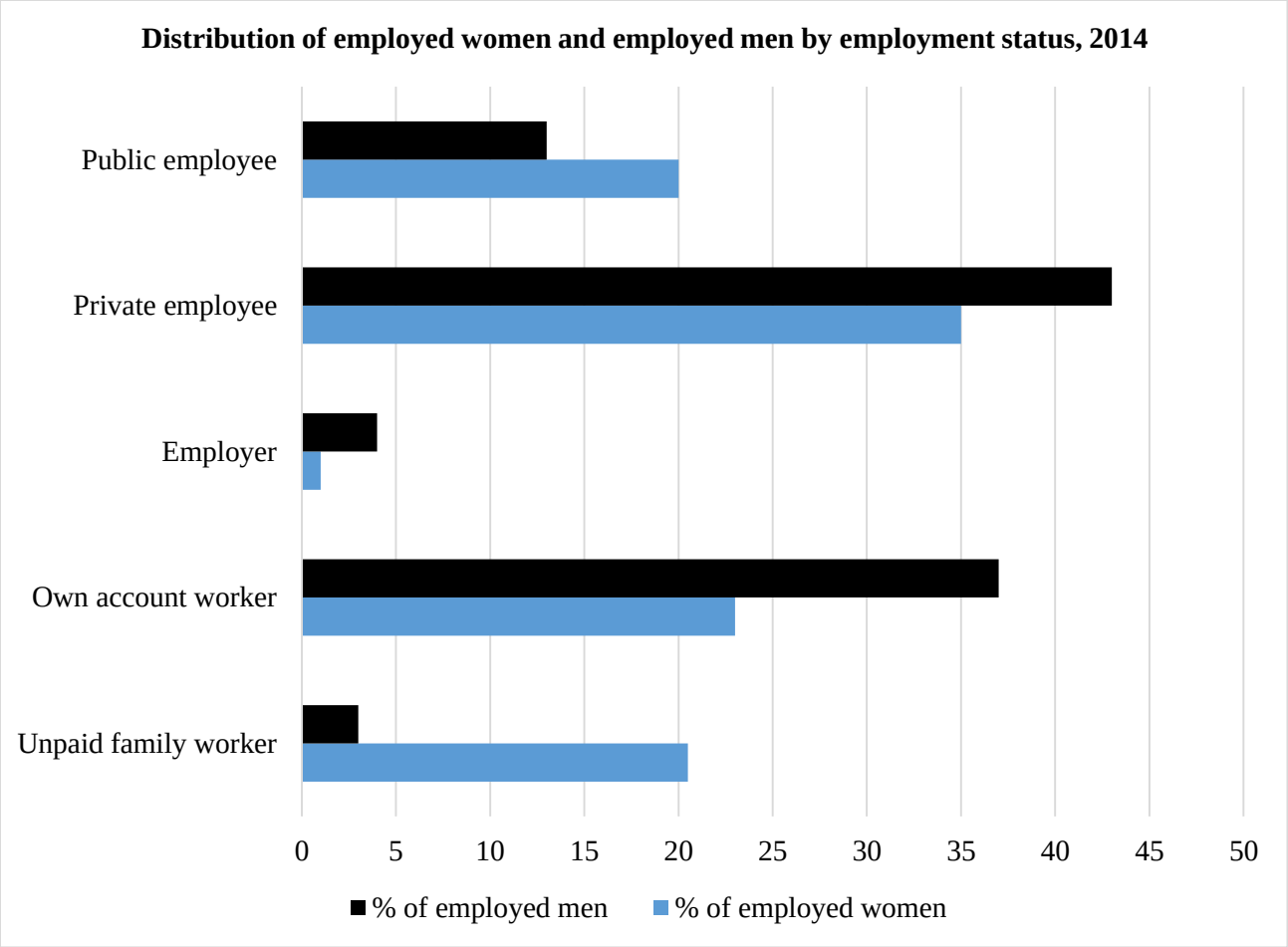

Figure 5: Employment status of men and women

(Data source Department of Census and Statistics 2015)

The service sector provides more jobs for both women and men . However women are found more in the agricultural work than men (Figure 4). Furthermore, the proportion of informal sector employment is very high (90%) (Figure 3). Women are much more likely than men to be unpaid family workers (Figure 5), which is common in agriculture. The agriculture remains an important sector for family livelihoods, the economy of the country and the food supply. However productivity and earnings are low in agriculture sector (ADB, 2016).

Though women contribute to many activities in agriculture sector women have been disadvantaged by perceptions of men as breadwinners, producers and community leaders. They are cornered to their reproductive role, to dependency on man and subordination. This affect their visibility and actual contribution made and ignored their decision making power especially in agriculture. Technology and mechanization have not only hindered women's traditional roles in agricultural production but also impacted on postharvest activities such as crop drying milling etc that were traditional important activities handled by women.

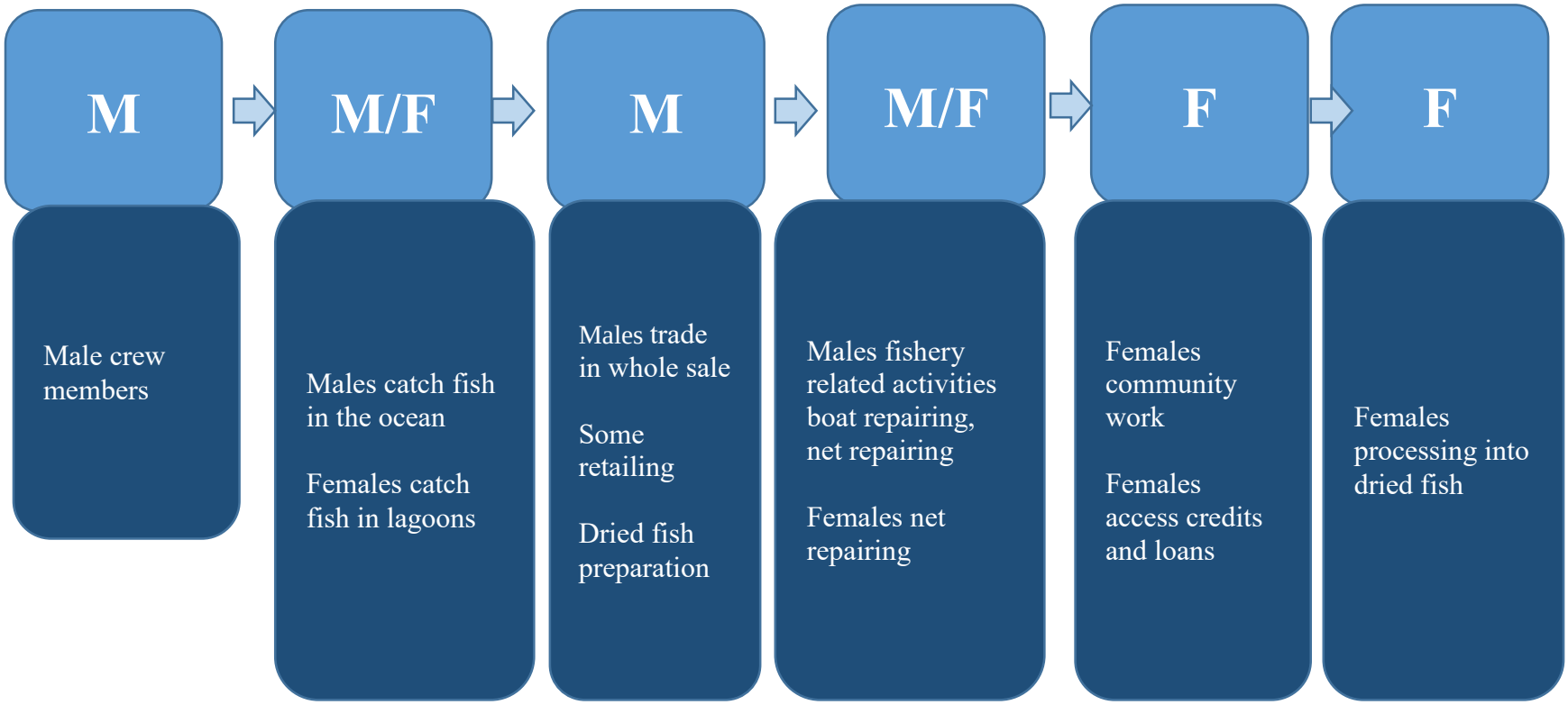

Figure 6: Male and Female participation in fisheries value chain

(Source: Hirrimuthugoda, 2016)

4.2 Role of women in fisheries value chain

Marine fisheries are carried out all around the island in coastal areas and more than one-third of the
population that live in these areas are dependent on it either as producers or consumers. Women actively participate in the small scale fishery industry and on the Southern coast they play a major role as managers of income. In migrant fishing communities women play an important role in fish sorting, processing, drying and even dragging boats ashore. About 75% of women in Mannar (North-West), Trincomalee and Batticoloa (East) and about 25% of Women the west coast areas of Negombo, Chilaw and Kalpitiya are estimated to be engaged in fishing related activity (Figure 6). In some areas of the west coast women involve in fishing, marketing both retail and wholesale and and post harvest activities of small fisheries such as sorting, drying and marketing.

4.3 Livestock sector involvement of women

In Sri Lanka women play a major role in raising livestock and poultry. The reduction of grazing livestock and moving to stall feeding has resulted in women driven livestock programmes with improved stock that add to family income. Cattle and goat raising projects have proved to be successful income generating activities for poor rural women. While women attend to rearing and milking of animals, the men handle supply to milk collection centers. With regard to milk production there are several female headed family groups actively pursuing this for livelihood.

5. Summary

Women empowerment in food value chains is essential to translate household income for better social and nutritional outcomes of the family. It is needed to improve necessary skills in decision making, logistic arrangements and entrepreneur skills. Facilitating child care during training, and offering flexible working hours is essential to improve labour force participation of women.

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Section 7

Recommendations

Nutrition related recommendations reached based on the situational analysis of different sectors are presented in this section Part 1. Part 2 of the section presents the prioritized recommendations.

1. Crop sector

1. Food imports to Sri Lanka to be determined after careful analysis of monthly production of specific commodity and the consumer demand. Further, the nutritional requirements of the Sri Lankan should be taken into account when conducting cultivation planning and food imports.
2. Carry out a comprehensive analysis on national level nutrition and nutrition-related policies to develop a harmonized national policy, strategy and action plan to ensure nutrition security in Sri Lanka.
3. Develop and provide funding to implement a national research plan on nutrition sensitive agriculture.
4. Revise import taxes to ensure healthy food is accessible and affordable to improve nutritional status of people.
5. Conduct scientifically designed studies on the contribution of home garden to the nutritional status of the household especially through crop-animal integration.
6. Analyze availability of nutrients of home garden products in determining appropriate composition of trees, crops and livestock in the system that will be useful in reducing poverty and malnutrition.
7. Conduct well-articulated pilot scale studies to assess the benefits of bio fortified food on improving nutritional status of people in Sri Lanka.
8. Design, develop and implement a continuing capacity building programmes targeting field level officers to educate and build awareness on human nutrition and healthy life.
9. Develop and implement mechanisms to the required agricultural inputs are provided to the farming community in a timely manner to ensure healthy and nutritious food crop production.
10. Conduct a national food and nutrition security drive especially targeting promotion of fruits and vegetables considering the availability, accessibility, affordability and acceptability (quality, taste, safety, type of food, cultural sensitivity).
11. Introduce novel technology packages to improve crop productivity/land productivity and climate resilience.
12. Conduct scientific studies to assess the nutritional quality of traditional and new improved varieties/hybrids of commonly grown crops to facilitate future nutrition security programmes in Sri Lanka.

13. Design, develop, promote and implement urban and peri-urban agriculture systems it appropriate technologies and incentives to increase food and nutrition security among people.

2. Livestock sector

1. The value chain of ASF struggle at the farmer and processing level. Therefore, need to assist in production and processing methods to improve the productivity and sustainability of the ASF.
2. The highest cost in the livestock sector is associated with feeding animals, and some raw material is imported into the country. Therefore, research should be conducted to improve the yield and efficiency of the feed raw materials. Also, research should address the utilization of commonly available feed resources in different climatic zones in the country and the efficient management of those resources. Also, though high yielding animals are provided through various government programs at the farmer level, proper feeding management practices are not implemented. Therefore, farmers should be educated about the importance of proper feeding management practices to obtain high production yield and profit margin.
3. Though various institutes provide statistical data, discrepancies and lack of the latest data are noticeable. Therefore, it is necessary to strengthen and explore the mechanism for monitoring and updating national livestock statistics. According to Sri Lankan legislation, any animal husbandry establishment should be registered, and upgrading this database to an electronic or online system can enable the collection of real-time data.
4. Maintain the status quo on tax and trade policies for imported ASF products. This position should be reviewed regularly and revised if considered necessary to support domestic production with changes in the market. Further, the finances associated with the Sri Lankan ASF production should be assessed and mapped with the bottlenecks. Thereby should modify the supporting policies to improve the production of the sector.
5. Undertake a comprehensive review of all legislation relating to ASF to identify any outdated, overlapping, and not streamlined, update legislation with appropriate consideration for current developments in the ASF and nutritional requirements.
6. With changes in the food systems of low- and middle-income countries, there will be an increasing demand for food and shift can observe towards high protein and/or processed diets. Therefore, we need to conduct a quantitative assessment to identify the adaptiveness, robustness, resilience, and transformability of the food systems. In addition, we need to assess the resilience and adaptiveness of farmers to the current trends and global phenomena such as climate changes, pandemics. This approach can assist in achieving food security in the country.

7. The level of development, quality, and quantity across ASF in Sri Lanka vary, and within the commodity also huge variation is apparent at the farmer, processing, and retail level. Therefore, all sectors of livestock suffer from marketing constrains. Therefore, all the segments should be encouraged to maintain quality standards, and these standards need to be compatible with international standards. Capacities and policies should be developed to monitor the implementation and inspection of food safety standards.
8. The poultry sector performs well with an established network of farms, slaughterhouses, and processing plants. However, with the social and cultural impacts, the other meat industries are not well organized and lack a consistent quality. Therefore, consumers should be enlightened about the importance and necessity of consumption of ASF.
9. Often the indigenous animals used for farming are given the least priority in the existing policy, economic, and social regimes. In addition, there is minimal data available on indigenous animals. Due to the unique features of indigenous animals and their role in the rural economy and household food security, it is highly required to formulate policies to support the conservation and sustainable utilization of indigenous animals.
10. Fourth Industrial Revolution (4IR) technologies, including the Internet of Things (IoT), Artificial Intelligence (AI), drones, and robots, can be used in the animal husbandry sector to increase productivity. In IoT incorporate sensor to the network of devices so that these will have digital intelligence and will be able to communicate real-time data automatically (Ranger, 2020). By fixing these devices to farms can monitor the activities of the farm and later can be analyzed by AI to generate valuable information.
11. Promote linkage of researchers from universities and research institutes with veterinary officers, staff, farmer organizations, and NGOs to improve participatory research and extension efforts in support of the production and development of ASF.
12. Strengthening the institutions catering to livestock farmers, reinforcement of the government veterinary network, and enhancements in the service delivery system for the livestock farming community should be done to enhance the production capacity and efficiency to strengthen the livestock sector. Since the poultry production has reached the sufficiency, to overcome the barriers for low exports need to formulate policies and procedures to the place the products in the international market.

3. Fisheries , inland fisheries and aquaculture

1. Need to consider whether there a way to estimate the economic losses incurred by the fishers and aquaculture sector of Sri Lanka to date due to the COVID outbreak and associated containment measures.
2. It would have been better to get a sense of the impact of the food security of the fisher folk themselves and of consumers in different parts of the country, given the disruption in the supply chain. Also the COVID's impact on fish imports that covers

a significant part of the local fish/protein needs. Any quantification would be suggested.

3. It is high time to reconsider feasibility of aligning the fisheries act and policy with the food and nutritional security.
4. Further attitudes of fishing society need to be gradually changed towards more gender equitable way, providing more opportunities for women to engage in employment in fishing related activities and to hold positions in community organisations such as fisheries cooperatives.
5. Further, provision of empowering women in training and capacity building to take up fish processing and other alternative livelihoods could also be considered.
6. NARA and MFARD should facilitate provision of export market information to fishers and to help them access fish export firms.
7. Establish state fish purchasing centers at landing sites and allow for increased entry into fish marketing
8. Develop infrastructural facilities at landing sites to ensure the provision of electricity, water, facilities for cold storage and waste disposal, wash rooms, drainage system, auction halls, etc.
9. Strengthen the co-management in all perennial reservoirs where this has been properly established. Introduction and established the co-management in reservoirs, where good management practices have not been properly stablished. It would be important to identify the location specifics conflicts and issues to overcome obstacles in establishing co-management in reservoirs, where it had not been successful yet.
10. Increase the use of seasonal reservoirs and optimize the use to enhance the inland fish production in a time bound planning process. Support of provincial authorities, government development schemes other than fisheries and nongovernmental organizations can be potentially mobilize for this purpose. Use of scientific method to select suitable reservoirs and use prioritizing list of reservoirs based on the national plan will be supported to minimize the fingerling shortages for stocking and improve the sustainability.
11. Revisit to the fishing regulations (especially gear regulations) and promote exploitation of minor cyprinids based on scientific approach in perennial reservoirs.
12. Identification of alternative fish culture methods to use reservoirs less than 6 months of water retention. i.e. use of minor cyprinids for shorter period of cultivation, improve value addition techniques or processing techniques for small size tilapia or other suitable species stocked in these reservoirs and promote aquaculture.
13. Diversification of livelihood opportunities for fulltime fishers to overcome difficulties they face in lean periods. Improve the awareness on reliable microfinance opportunities in rural areas.

14. Identify technically and financially feasible activities and promote alternative livelihood practices for women and encourage them to use their time productively. Empower women themselves by improving hard and soft skills. Strengthening the existing women organizations and newly formed organizations by providing trainings under NAQDA's supervision. Skills development and capacity building programmes for small enterprises/businesses, management and marketing development and training on savings mobilization are important aspect to empower fisher's women societies.
15. Encourage of the production of aquaculture feed in the country. As an initiative fish feed required for fingerling production can be promoted based on the locally available raw materials.
16. Research on inland fishing communities, their social and economic aspects should be promoted to understand the unrevealed information of inland fishers. Mostly their social and economic information have been masked by the social information of agricultural societies.
17. Actual contribution of inland fisheries to the national food and nutritional security is still unknown. There should be an urgent need to assess the significance of this sector through proper research intervention.
18. Inland fish production is entirely used for the local consumption. The contribution to the food and nutritional security must be highly significant although data is not available except total production information. Therefore, promoting new markets should not be affected the food and nutrition security of the rural communities. Therefore, managerial authorities should not promote monopoly in any type of inland fish products affecting to the main aspect of food security in the country.

Natural resource management

1. Multifaceted information gap related to nutrition and natural resources and biodiversity need to be filled with suitable approaches. (Develop collective information system for related policies, programs and projects; documentation of nutritional value of traditional food crops, indigenous & traditional knowledge)
2. Improve policy coherence supportive to enhance nutrition and sustainable natural resource use, so that one policy does not work against another policy or program.
3. Incorporate nutrition objectives into sustainable agricultural & biodiversity projects, programs and policies. Traditional agriculture, agro-biodiversity and sustainable utilization of natural resources may have potential to yield nutrition improvements especially with community-level projects.
4. Maximize opportunities for multi-sector and multi-institution coordination in planning and implementation of local level program and project formulated aiming at sustainable utilization of natural resources.

5. Formulate and implement overarching frameworks to improve overall effectiveness of sustainable natural resources management for enhancement of nutrition and food security.
6. Strengthen collaborative mechanisms for linking fragmented local level instructional governance for effective local level implementation of nutrition and natural resources management plans.
7. Strengthen institutional legal arms of existing act related to nutrition, biodiversity conservation and natural resources management.
8. Modern approaches for incorporating notorious food traditions linked with agro-biodiversity into modern life style need to be mainstreamed and promoted.

Food value chains

1. Design and introduce effective food distribution systems with supportive market mechanisms to reduce food miles, minimize post-harvest losses, and fresh, healthy and nutritious products reach the consumers.
2. Accommodation and placement of local ASF products, especially beef, mutton, and pork, are challenging. Therefore, infrastructure facilities for collecting networks, value addition, further processing, packaging, improve quality standards, and assurance of the quality are necessary for the provision of high-quality ASF to the consumers.
3. Value addition to ASF can (e.g., conversion of milk to yogurt or cheese) increase the marketability to the product and provide additional income. Small scale milk processing should be encouraged because the production of such producers is essential to reduce the importation and wastage of milk.
4. Price, income, taste, and preference are key variables that affect the ASF purchasing and consumption patterns. Therefore, necessary to identify the factors that impact the purchasing patterns of ASF products in order to cater to the purchasing behavior of consumers.
5. The operations at production level and post-production value-chain including processing and marketing necessary to be horizontally integrated. Therefore, farmers will receive an economically attractive price for their products and encourage more medium- and large-scale entrepreneurs to enter the animal husbandry sector and make further investments increase production and achieve self-sufficiency.
6. Promote better post-harvest handling practices from the landing site to the end market. Promote the correct use of ice in preservation. Make available the infrastructure facilities such as availability of cool storage facilities or connect the inland fish production to such existing storage facilities of Ceylon Fisheries Cooperation effectively.
7. Promote value addition targeting high end market and promote rural entrepreneurs participation in value chain with special consideration to fishing communities.

8. Improve the quality of existing post-harvest processors in dried fish production and smoked fish production. Transferring technical knowledge to local producers and facilitate required infrastructure to enhance the quality up to the standard levels.

Women empowerment

1. Need to facilitate policy environment, strategy and programme process to support empowering of women providing flexible working hours, equal pay and more decision taking power.
2. Promote equal opportunities and enabling environment for women and men to get training in agricultural production and value addition in terms of technology and machinery, credit, subsidies and office holding positions organizations.
3. Promote to integrate provisions for opportunities to maximize incomes and productivity by empowering women through of farmer, fisheries and dairy organizations.
4. Facilitate formation of women groups/ societies to incorporate value additions of agriculture and wild commodities in the respective food value chains to improve social level of farmers' families
5. Promotion of the empowerment of young women and men equally to increase the participation in production activities
6. Promote gender parity in food value chains for both women and men giving equitable access to programmes for upgrading skills related to technology, management, marketing, transport and developing networks.

Annex 1

Mainstreaming Nutrition into Agriculture Sectors

Questions for situational analysis

This document list possible questions in each sector. **Technical experts can add other questions if they feel these are necessary.**

You can use attached guide to present your analysis.

A. Crop (field crops, , paddy, fruits & vegetables, green leaves, roots and tubers coconut, condiments, under utilized agricultural commodities, home gardening)

1. Crop production statistics/availability for consumption / imports/exports (2015 onwards)
2. Agricultural policies /trade policies, strategies and investments those influence food production , food diversity and consumption and highlight whether nutrition objectives and indicators are included or gaps relating to nutrition objectives
3. Food price and associated policies and highlight their effect on healthy dietary consumption
4. What are agricultural interventions/programmes in Sri Lanka incorporating nutrition objectives and indicators?
5. Explore availability of biofortification programmes for staple foods, what are their progress and impact on nutrition
6. Explore Availability of home gardening programmes and their impact on nutrition/food security
7. Explore the extent of agriculture extension to support overall agriculture process
8. Level of incorporation of nutrition promotion in programmes
9. What is the current status of value chain/ value addition of crops
10. What is the status of inputs for agriculture production such as irrigation programmes, pest and weed control, fertilizer application, organic farming, planting material distribution, and soil protection
11. What is the level of agricultural commercialization/ diversification to cash crops and impact on food consumption at households, and communities

12. What is the level of quality of yield/storage facilities /agro processing and preservation opportunities/food safety and how influence them on nutrition across all agro ecological zones in the country
13. Availability and practice of pre and postharvest losses and impact on food consumption adequacy and diversity
14. Marketing /food prices/ distribution system/effect from nonfood prices /risks and impact on food choices
15. Women empowerment in agriculture/ food choices/cultural and norms
16. Improving farmers income and family social level and their impact on nutrition through access to health care
17. Effect of climatic changes on yield, crop selection and food consumption and choices
18. Availability of climatic resilient agricultural practices for staple crops and their impact on food security
19. Production practices and crop diversity/biodiversity of crops effect on food security/ nutritious foods / traditional foods for consumption and sale
20. Profitability potential from farming and impact on household food security and nutrition
21. Availability of national agricultural market system and its impact on distribution across the country in all sectors
22. Extent of urban and peri urban agriculture and their impact on food security and nutrition promotion
23. Research on improving productivity, and quality of food and value chain
24. Availability and potential adoptability with cross-sectoral (crop, livestock, forestry, fisheries and aquaculture) approaches

(17 questions on nutrition)

B. Livestock (milk & dairy products, poultry and meat, eggs, small ruminants sheep and goat, game meat)

1. Livestock production statistics/ availability for consumption/ imports/exports (2015 onwards)

2. What are the policies, strategies /trade policies and investments those influence the livestock production and whether nutrition objectives and indicators are incorporated
3. What is livestock ownership and impact on consumption and nutrition outcomes
4. Support for home based animal husbandry and their effect on availability and diverse sources of animal proteins (meat, egg, milk, poultry)
5. Extension facilities for milk and dairy production, consumption opportunities at household level by women and children, barriers for production, consumption and marketing
6. Gender issues regarding animal husbandry practices and impact on availability and consumption at household level.
7. Availability of programs to target females as flat form to deliver nutritional benefits to the family
8. Myths, taboos and cultural practices, gender restrictions associated with consumption and their impacts on nutrition
9. Effect of facilities available for storage, processing, preservation, marketing, and distribution on nutritional outcomes
10. What is the status of value chain for livestock commodities?

C. Aquaculture and Fisheries

1. Aquaculture and Fisheries production statistics/ availability for consumption/ imports/exports (2015 onwards)
2. What are the policies, strategies /trade policies and investments those influence the aquaculture and fisheries production and whether nutrition objectives and indicators are incorporated
3. Availability and promotion of sustainable fishing opportunities
4. Level of postharvest losses/management of losses and processing techniques and facilities
5. Promotion of small fish (nutrient densed) consumption
6. Opportunities and barriers of inland fish farming and aquaculture
7. Income and socio economic factors of producers

8. Gender issues and influence on nutrition at households
9. Level of input and extension services availability to increase production and consumption

D. Natural Resources

1. Availability of policies and to what extent they are implemented to sustain the base of natural resources (soil, water , air, biodiversity, climate, forest) in food systems
2. Extent of securing sustainable water sources at households
3. Availability of Promotional programmes for biodiversity and their impacts
4. Extent of access to food sources from natural forests such as bee honey, fruits (wood apple, gooseberry) and green leafy vegetables and impact on nutrition at household level
5. Involvement of different institutions and agencies for the implementation of strategies and policies and their impact on sustainable nutritious food production and consumption
6. What programs are available and their impact to ensure improving nutrition in a sustainable manner

Annex 2

Terms of Reference for Multi stakeholder technical working group for the services to support mainstreaming nutrition in the agriculture sector of Sri Lanka

Situational analysis

1.Introduction

The economy of Sri Lanka is based mainly on agriculture, services and to a lesser extent on light industry. Recent reports show that agriculture earns about 10% GDP and employs 38% percent of the workforce in the country. Further about 77% of the population lives in the rural sector. Though there are improvements in social indicators in Sri Lanka, nutritional status of its people is stagnating for some age groups while non-communicable diseases are aggravating in adults and elderly.

Recent technical review completed by the Nutrition Society of Sri Lanka collaboratively with Nutrition Division of the Ministry of Health in the process of updating Food Based Dietary guidelines in Sri Lanka with the financial assistance from FAO showed several salient points in food and nutrition sector. A clear remarkable calorie gap exists between the poor and non-poor populations and there is a gap between the desirable average calorie intake and the actual calorie intake of underprivileged groups. Population trends show an increase in population of the elderly and the increased dependency ratio of 20% on the younger age. Among people inactive lifestyle is a common place while the prevalence of NCDs are the highest among the age groups beyond 30 years. Further raised blood pressure, blood glucose and cholesterol levels also show significantly increasing trends in the age groups 45 to 59 years.

On the other hand low birth weight is persisting at a higher rate while short stature and thinness of women exist in a considerable rate. Nutritional problems of children (<5y), stunting, wasting, underweight are major health problems. Both children and adults face diet related non communicable diseases and overweight and obesity is leading among others. Micronutrient deficiencies exist considerably among Sri Lankans. One third of vulnerable groups (pregnant, infants, young children etc) are iron deficient.

FAO in Sri Lanka is commencing the programme 'Mainstreaming Nutrition in Agriculture' for implementation in 2019-2020. Under this program initiatives will be taken to mainstream nutrition in to agriculture in Sri Lanka with ultimate objectives of achieving nutritional goals through building strategies and service provision in the agriculture sectors.

2. Objectives

The objective of this assignment is to provide stakeholders with the information to understand linkages between agriculture food systems, nutrition and health in achieving national nutrition goals. This understanding would develop the knowledge and skills to fulfill the requirements of nutritious food to improve the nutrition situation of the population. This support is provided through this situational assessment to identify nutrition related gaps in different sectors, namely crop, livestock, aquaculture and fisheries and natural resources.

3. Terms of Reference

3.1 Outcome of situational analysis

Nutrition related gaps (lack of consideration of nutrition requirements) in the agriculture sector would be identified. This would include the gaps spanning agriculture policies, sector plans, strategies and budgets, institutional mechanisms, service provision and implementation of other activities at national and provincial levels.

3.2 Activities to be completed

3.2.1 Review documentary evidences for nutrition considerations in your assigned area (crop/livestock/aquaculture & Fisheries/Natural resources) for food production (current status/export/impact from imports) processing and value addition, marketing, pre and postharvest losses, biodiversity, farmers income, social factors of farmers, climatic change and influence, gender influence, natural resource management, pricing, trade policies and taxes

3.2.2 Conduct an analysis of nutrition related gaps in policies, sector plans, strategies, budgets, institutional mechanism and service provision at national and decentralized levels (provincial/district/grassroots levels) in your assigned area (crop/livestock/aquaculture & Fisheries/Natural resources)

3.2.3 Compile the situational assessment and prepare a report on findings and recommendations not less than 15 pages and not exceeding 20 pages

3.2.4 During the process assistance can be provided to collect relevant information.

4. Payment

4.1 Payment will be provided for 4 days of review of publications (list of publications reviewed and summary of findings should be compiled and handed over), 2 days of report writing and 2 days of assistance to the writing of the main report.

A sum of Rs 100,000 would be paid for the total assignment per person.

5. **Deliverables**

5.1 List of publications reviewed and summary of findings

5.2 Sector Gap Analysis Report

6. **Date of completion**

30th April 2020