ABSTRACT

Realizing the gravity of COVID-19 pandemic, the governments around the world have been putting in place a range of policies and strategies to resume their food security level. Among varies of agricultural productions, most affected sectors are livestock farming, horticulture production. In this line, understanding the impact of COVID-19 on horticulture system is likely to become more widely and deeply felt in agricultural sectors and national economies. This study aims to highlight potential risks faced by; outlines the overall functioning of Sri Lankan horticulture sector during the COVID-19 pandemic and discuss policies need to change going forward to safeguard Sri Lankan horticulture sector from similar shocks in the future. The production and market data gathered from Agricultural Statistics, Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI), Department of Census and Statistics and Export Development Board which were gathered over years between 2016 and 2020. The data contain production quantity, average cultivated extent, retail and wholesale price per Kg, export quantity and value of fruit and vegetable products. Descriptive analysis methods used as the primary analysis techniques. The results imply that there is no declining pattern of all vegetables and fruits production volume. From the retail prices and wholesale prices, we can materialize that the supply chains in the agricultural products have
stranded to keep up, first with panic buying, followed by forced changes in food consumption patterns and immediate decline with the dropdown in purchasing power. The agricultural export sector is deemed to experience smaller trade impacts, most agricultural exports have continued to reach consumers in international markets. The pandemic is driving some changes that will likely remain part of the future agricultural practices. These include encouraging home garden practices, shifts in online marketing and selling platform, having higher demand for stable and safe food, a greater awareness of supply chain risks, increasing use of digital trade systems and the risk of creeping protectionism. Accordingly, agriculture policies need to change to safeguard of Sri Lankan horticulture sector from similar shocks in the future.

Keywords: Covid-19; horticulture; production; prices; exports; descriptive analysis.

1. INTRODUCTION

COVID-19 pandemic has caused an irreversible loss of mankind all over the world. Realizing the gravity of COVID-19 pandemic, every country has commenced special steps to limit the spread of the virus and fight against the pandemic; mostly with involving social distancing, self-isolation and restriction in travel and trade. All these fights against the pandemic have infinitely affected the major economic sectors such as agriculture, tourism, education, hospitality and so on. In national level crisis management, the decisions made will change with continuously emerging scenario, agriculture is not an exception. Agriculture sector serves as the most important economic sector endorsing food security and human development; specifically, it mainly involves the sustainability of human life and secondarily involves the economy.

The Food and Agriculture Organization of the United Nations (UNFAO) has estimated that more than 60% of the world population relies on agriculture for survival [1] Out of total employer population in 2019, 26.85% of employers are in agricultural sector [2]. According to the World Farmers’ Organization [3] there is a global food and nutrition security challenges. The more than 820 million people across the globe are suffering from hunger. In line with observations of the COVID-19 pandemic combat, the UNFAO, WHO and World Trade Organization (WTO) issued a joint statement that uncertainty about food availability could spark a wave of export restrictions, creating shortages on the global market [4] A similar conclusion has been reached by the WTO by publishing three scenarios for a global recovery in world trade, termed: V-shaped, with a short-term recovery of only 3 months, U-shaped, with slightly longer recovery of 6 months, and L-shaped, mapping potential impacts from a longer recovery timeline of over 12 months [5].

If the COVID-19 pandemic continues into the critical spring planting period, the production of staple food crops such as wheat, rice and vegetables and fruits are affected. The pandemic has brought significant effects on the stages of agriculture value chains due to shortage of agri-inputs, labourers are unable to move from one place to another, lack of strong food storage infrastructure and facing challenges to sell products [6] The agricultural sector is badly hampered by the availability of the labour who works on a daily basis. In such a crisis, it is utmost that an individual develops a resilient power to adapt to the changing context and conserve the existing food system during prolonged lockdown and disruptions of the food system. Most recently, the global food supply system has stumble upon one of the most vital pressure tests. If agriculture value chains are affected, the impact on food security could be grave. This will be led to a direct effect on peoples’ day to day activities with disruption of consumption of nutritious and sufficient food.

Governments around the world have been putting in place a range of policies to ensure that economic actors have the wherewithal to resume their food security level. As a remedy, the governments imposed quantitative restrictions on agriculture product exports (examples; Kyrgyzstan, North Macedonia, Ukraine, Thailand, and Egypt notified export prohibitions on agricultural products and Russia and Vietnam introduced temporary export-restrictive measures on wheat and rice respectively) and assorted vegetable seeds and seedlings were provided in cities and rural areas to encourage home gardening [7] Export bans have been introduced to curb food inflation and establish reserves of staple foods. Moreover, the governments seek to make their countries self-sufficient in food by protecting domestic food producers [8]. As far we can see that every tier of government should align more the activities in agriculture so that it will be able to sustain self-sufficiency.
A Trilemma: lockdowns, export restrictions, and quarantine; measures currently affect around 5% of globally traded food and agricultural products [9]. Developing and least developing nations are particularly vulnerable to such distortions. In line with that, the UNFAO insists, among populations who are already malnourished, weak and vulnerable to disease, a ‘crisis within a crisis’ could emerge, in which the current health crisis will be compounded by a hunger crisis [10].

Among the United Nations Sustainable Development Goals [UNSDG] to be achieved by 2030, ending hunger and establishing food security hold an important place. A sustainable food system needs to be developed to deliver food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised [11]. This lies at the heart of SDGs. However, due to the regency of the COVID-19 problem, the impacts of macroeconomic fluctuations on food insecurity have remained scantily explored.

Among varies of agricultural productions, most affected have been dairy farming, floriculture, horticulture (fruit and vegetable) production, fisheries, and poultry farms. Horticulture producers were in for a rude awakening when COVID hit. Horticulture products have faced bigger problems than have other agriculture products in harvesting and selling their crops. Since these commodities are highly perishable and important for agricultural diversification and nutrition, understanding the impact of COVID-19 on horticulture system is likely to become more widely and deeply felt in agricultural sectors and national economies.

1.1 Sri Lanka Agriculture Sector

Historically, Sri Lanka had been a self-sufficient economy comprising a peasant agriculture economy. The food system in Sri Lanka comprises of several food supply chains that involve a large number of intermediaries, handling a number of agricultural commodities that are seasonal, bulky and in some instances are highly perishable. After several transformations in agriculture and trade regimes over time, the present food system in Sri Lanka comprises both locally produced food (79%) as well as imported food (21%). Domestic production of major food categories like rice, meat, eggs, fish, vegetables and fruits exceeds 87% of total supply. Traditionally, agricultural market in Sri Lanka is not readily available to absorb the produce at the time of harvest. The purchase of agriculture products is left to those who function as organized traders, and these traders typically purchase at relatively low prices [12].

Enforcing the necessary social distancing measures and subsequent curfews hindered the economy of Sri Lanka, including its important rural sector mainly based on agriculture and tourism. However, in order to prevent agriculture sector activities being curtailed by an island-wide curfew imposed on 20th March 2020, the sector was released early from curfew and mobility restrictions starting from 25th March. Farmers were allowed to continue with their usual farming operations, while traders too were permitted to transport essential agricultural inputs like fertilizer without any restrictions. Nevertheless, movement restrictions of consumers have disrupted normal market practices, so prices for commodities have swung both high and low in search of equilibrium between supply and intermittent demand. The decision on April 7, 2020 to lock down for health reasons the major economic centers, which are collection and distribution centers of fruits and vegetables, was impact both farmers and consumers.

Despite huge losses in mankind affecting various sectors worldwide, an individual can also see the silver lining that can come over with the upliftment of lockdown due to COVID-19. In early April 2020, a new system was initiated to distribute essential food items (vegetable and fruit) at Divisional Secretariat level. Apart from this, online retail platform for farmers, markets and the public to purchase/sell agriculture products was required. E-commerce companies and leading supermarket chains were facilitated to procure agricultural products from farmers and markets. When, these online platforms were overwhelmed with delivery orders, supermarkets partnered with delivery businesses like PickMe to ease food accessibility issues.

To address the future demand for fruit and vegetables, the Sri Lankan Ministry of Agriculture introduced a home gardening programme called Saubhagya Gewatta (Prosperous Home Gardens) to develop 1 million home gardens. It will encourage rural seed farm projects, popularise organic fertiliser use, encourage production of home crops and promote home gardens for self-consumption. However, the success of this programme depends on the availability of quality seeds and planting material.
and the perception of family members to continue the home gardening practices.

In addition, the Department of Agriculture is drafting a cropping plan for the minor season, with more emphasis on import-substituting crops. This is a precautionary measure to face possible export restrictions of other countries and to release the pressure on the rupee exchange rate by reducing imports.

This study highlights potential risks faced by Sri Lankan horticulture sector due to the COVID-19 pandemic and outlines the overall functioning of Sri Lankan horticulture sector from similar shocks in the future. On these notes, the study aims to answer the research questions: What does the COVID-19 pandemic reveal about the overall functioning of our horticultural systems? How can we reorient our horticultural systems to function optimally in a post-COVID-19 world? Do our policies need to change going forward or are we already well equipped to safeguard our horticultural systems from similar shocks in the future?

2. MATERIALS AND METHODS

2.1 Data Sources

The data used come from Agricultural Statistics, Socio Economics and Planning Centre, Department of Agriculture, Peradeniya; Marketing Food Policy and Agri-business Division, Hector Kobbedakudwa Agrarian Research and Training Institute (HARTI); Department of Census and Statistics and Export Development Board which were gathered over years between 2016 and 2020. The data contain production quantity, average cultivated extent, retail price per Kg, wholesale price per Kg, export quantity and export value of fruit and vegetable products in Sri Lanka. Vegetable products categorized as Up-country vegetable and Low-country vegetable. Up-country vegetables contain Green beans; Carrot; Leeks; Beetroot; Knol-khol; Raddish; Cabbage and Tomatoes, whereas Low-country vegetables consist with Ladies fingers; Brinjals; Capsicum; Pumpkin; Cucumber; Bitter gourd; Snake gourd; Luffa; Ash plantains; Green chilies and Lime. Fruits contain with Papaw; Passion; Orange; Avocado; Mango; Pineapple and Banana. It should be noted that the varieties of Mango, Pineapple and Banana were standardized as specific category by considering average values of the varieties. These production and market data allow for the effective analysis of Sri Lankan horticulture sector functioning patterns and reactions during the COVID-19 pandemic. Finally, consider the exports (volume and quantity) of fruits and vegetables.

We use descriptive methods as our primary analysis techniques. Following descriptive analysis, visual data analysis technique was performed.

3. ANALYSIS RESULTS

3.1 Analysis of Production

The production volume in key vegetables and fruits were figured in the Figs. 1-3, from 2016 to 2020. Among up-country vegetables, Beans recorded the highest production expansion, followed by Cabbage and Carrot. However, Knol-khol was upheld with lowest reduction. As seen in Fig. 2, Capsicum, Brinjals and Pumpkin productions had increased sharply as the economic fallout of the pandemic spread globally. With the interest of home gardening concept, for the cultivation of crops, people have started giving priority to the local seeds available in their area. With regard to the fruits (Fig. 3), banana production increased exceptionally, whereas other fruits follow the same production tendency. As we can see, up-country and low country vegetables and fruits recorded the high production during 2020.

3.2 Analysis of Cultivated Extent

Figs.4-6 illustrate the cultivated extent of vegetables and fruits during the year 2016 to 2020. The cultivated extent of key up-country vegetable items too followed a similar path over the same period (Fig. 4). The cultivation area of Beans deteriorated tremendously, followed by Tomatoes and Cabbage. We can further see that the sharp production declining in Ash plantain and Brinjals was the outcome of shrinking cultivated extent. Interestingly, there is no colossal changes in the cultivated extent of fruits. It is worthwhile to investigate why banana production deteriorated tremendously though cultivated extends are not changed such.
The restricted access to agricultural inputs such as fertilizer and seeds, and lack of support services and infrastructure affected the production of vegetables and fruits in Sri Lanka. It is worth to note that there were climatic pressures that often aggravate supply-side food shocks in Asia [13]. However, continuous declining in cultivate extent (we can see from the year 2016), shed a red light on the food security in Sri Lanka, threatening that the food system in Sri Lanka has proven to be vulnerable and inefficient to cope with future shocks, even much smaller shocks than COVID-19.

### 3.3 Analysis of Retail Price Fluctuation

Figs. 7-9 show the fluctuations in retail prices of vegetables and fruits. The retail prices were on the rise during the first few months of the pandemic exposed, while the situation...
exacerbated with panic-buying of food and other essential items. However, the demand of food has affected due to reduction in income and purchasing capacity.

As shown in Fig. 7, up-country vegetable inflation was fueled by higher demand due to panic buying, while most cases of panic buying have been evidenced specifically Beans, Carrot, Leeks, Knol-khol and Tomatoes. Relative to up-country vegetables, low-country vegetables and fruits did not show panic buying behavior. However, retail prices of Capsicum, Pumpking, Bitter gourd and Ash plantain recorded increasing tendency after passing six months from the start of the COVID-19 spread. This might happen due to the lack of availability of the products, people have felt the importance of foods available in their residential areas. Instead of struggling to search for up-country products, consumers are interested in consuming local foods as they are more nutritious. Though fruit retail prices did not show substantial effect of the pandemic, prices remain in place as the previous years mostly.

As Welsh [14] opined, the pandemic is affecting food systems directly by distorting supply and demand locally as well as globally, and indirectly by degrading the purchasing power of the population and by undermining the capacity to produce and distribute food. The link between retail price increase and access to food has been primarily considered in terms of supply disruptions and shortages along the retail food supply chain [15]. Together with climate-change driven disruptions of food systems and the pressure of COVID-19 outbreaks intensified by lower harvests and higher food prices in developing economies [8].
3.4 Analysis of Wholesale Price Fluctuation

We are already witnessing the effects of the pandemic on retail prices fluctuation of vegetables and fruits, similar pattern could be observed with wholesale prices. Interestingly, as seen in Figs. 10-12, wholesale-retail prices spread widened, and price peaks at times in favour of food retailers. The situation aggravated with a decline in wholesale prices in the months of May and June.

3.5 Analysis of Export

The agri-food sector is highly connected internationally. Some nations are exploring more domestic food security in order to address emerging domestic food security concerns due to COVID-19. These actions have serious implications for our current globalized agri-food trading system and is potentially one of the most important impacts on the current food system. Fig. 13 illustrates the quantity of vegetable exports in years 2016 to 2020.

Gherkins and Tamarinds recorded high demand in foreign market compared with year 2019 demands. However slender declined has been observed in the other vegetable crop exports. Interestingly, we can observe that the vegetable export value (Fig. 14), rather than other vegetable category, exported vegetables follow the similar trading values in years 2016 to 2019.
In line with our observations, the agricultural export sector is seemed to experience smaller trade impacts. This official trade data indicates that, despite the pandemic, most agricultural exports have continued to reach consumers in international markets.

Figs. 15 and 16 illustrate the quantity and value of fruits exports in years 2016 to 2020 respectively. Relative to year 2018, Bananas, Melon and Papaws recorded the higher export quantity. However, export earnings were relatively low in 2020 (Fig. 16). Eventhough Banana showed panic export demand behavior, its export price was significantly getting lower due to Covid-19. There have also been declines in the export of Pineapple and Mango since the start of 2020. Declining other fruits category exports is also a watch point as the pandemic continues to evolve. Interestingly, Pineapple export has continued to reach consumers in international markets.
Fig. 10. Analysis of Wholesale price fluctuation: Up-country Vegetables (Rs./Kg.)

Fig. 11. Analysis of Wholesale price fluctuation: Low-country Vegetables (Rs./Kg.)

Fig. 12. Analysis of Wholesale price fluctuation: Fruits (Rs./Kg.)
Fig. 13. Analysis of Vegetable Export (Quantity in Kg.)

Fig. 14. Analysis of Vegetable Export (Value in US$ million)

Fig. 15. Analysis of Fruits Export (Quantity in Kg.)
4. DISCUSSION AND CONCLUSION

In the scenario of ongoing global COVID-19 pandemic, it is important and of immense necessity to investigate the impact of COVID-19 on agriculture sector. In line with our observations, the agricultural export sector is seemed to experience smaller trade impacts. This official trade data indicates that, despite the pandemic, most agricultural exports have continued to reach consumers in international markets. Export levels have been on par with what would have otherwise been experienced in 2019. The ability to expand agriculture export market is a strong determinant of Sri Lanka's ability to trade. Thus, the risks associated with crawling protection linked to the COVID-19 pandemic should be carefully considered. As [16] highlighted, vastly reduced freight capacity on commercial flights for agricultural goods and other broad global supply chain disruptions critically limited the access to agricultural inputs and markets. In these notes, precisely, Sri Lanka has been able to minimize the trade impact of agriculture. This will shed positive sign as well as serious challenge for policymakers to continue the same trading tendency. Thus, there is a clear challenge for policymakers to both mitigate the impact of COVID in the short and medium term and strengthen the resilience of the food system in the long term.

What we observed from the retail prices and wholesale prices, we can materialized that the supply chains in the agricultural products have strained to keep up, first with panic buying, followed by forced changes in food consumption patterns and immediate declined with the dropdown in purchasing power. The results of cultivated extent and production volume (Fig. 1-6) imply that there is a tremendous declining pattern of all vegetables and fruits. Thus, there is a serious issue in productivity of vegetable and fruit farming, which can be improved via a change in operation functions of farms. In global agriculture is now going through ‘Smart Farming’. The skills in scientific farm management, online marketing and post-harvesting management are key necessities for smart farming. Unfortunately, Sri Lankan farmers have mostly taken the skills either from their elders or from peers of from marketers of weedicides and pesticides. As a result, there is no tendency for adopting smart farming practices in all manner. With due respect, the food security in Sri Lanka is having serious trouble, threatening that the food system in Sri Lanka has proven to be vulnerable and inefficient to cope with future shocks, even much smaller shocks than COVID-19.

As we can see, making use of internet, email and telephone is an essential part of smart farming. In this regard, it is vital to look at the country’s readiness to adopt telecommuting. According to the Network Readiness Index (NRI) in 2019, the country's computer and digital literacy rates are not at a satisfactory level (Computer literacy – 29%; Digital literacy – 42.4%; Household population using internet – 26.8%; Household population using email – 10.2%) (IPS Report 2020). Thus, as a country, which is agriculture-driven, we must adopt strategic plans and programmes to enhance smart farming practices. Thus, computer and digital literacy and IT infrastructure facilities could play an indispensable role to maintain the status in the agricultural sector.
The pandemic is driving some changes that will likely remain part of the future trade landscape such as shifts in consumer buying towards more online sales, higher demand for stable and safe food, a greater awareness of supply chain risks, increased use of digital trade systems and the risk of creeping protectionism [17]. The ways that government and authorize parties address these challenges will lead Sri Lankan agriculture in a good position to maintain its overall export profile during the pandemic and to take advantage of a global economic recovery quickly. However, in truth, there is no proper forecasting on the future shape of economic activity, including international trade relationships for agriculture, is pure speculation [18].

New technologies could facilitate the supply-demand interface, which would be especially valuable for supply chains of highly perishable goods. The Information and Communication Technology (ICT) tools are getting popular in crisis. The crisis has shown how digital technologies can help make supply chains function better and more efficiently. Various mediums (Uber, Pick-me, Door-to-door delivery) have been used to inform people about the products of the farmers. In addition, ICT tools service to connect with the agricultural experts and farmers would be good to bring transformational change in agriculture.

Once we look at the positive side, as a global pandemic, COVID-19 creates few prospects that arise from the crisis in the field of agriculture. The concepts of home garden and rooftop farming have been emerging due to the lack of excess nutritious vegetables and fruits. The farming practices of gardening of vegetables and fruits gained much importance where all the family members are actively engaged. Likewise, the importance of subsistence farming has been emerged and re-cultivating abandoned paddy fields in urban areas also emerged. These would add to dietary diversity and make available safe vegetables and fruits with a smaller environmental footprint. Ministry of Agriculture and agricultural research institutions are required to develop a suitable package of agronomic practices to facilitate urban farming, including tank farming. For instance, the buzzword is that as a country we should not import anything that it could produce here locally. Now, this has been elevated to a mass drive in which everyone is having a home garden in the backyard to make the family self-sufficient in food items and re-cultivating abandoned paddy fields in urban areas to assure food security to Sri Lankan people. These are admirable aims, and no one can have complaints to them. But if it is done on old lines, its ability to rescue the country as planned is limited. Present food system has undergone several transformations to generate mixed and modern food system. That may be the reason for the Central Bank to talk about the need for introducing new technology to develop the country’s agriculture on modern lines.

During the lockdown period, small scale farmers were penalized; the wholesaler resisted loading the smaller amount of produce. As the results, the group approach of farming has been emerged among small scale farmers in order to produce a large amount of vegetables or fruits, to arrange flexible transportation methods and to obtain a good price in the market. Furthermore, producing the dried vegetables and mushrooms become one of the options during the crisis to avoid the loss of the vegetables in the past-harvesting period.

The country largely depends on imported farm inputs like pesticides and fertilisers, as well as high-quality seeds. Due to global trade disturbance, farmers are facing the shortage of agricultural inputs like seed, fertilizer and pesticides. As a result, farmers were encouraged to practice rural seed farm projects and use organic fertilizers. These will lead to increased calls for greater self-sufficiency, protectionist measures, and less international engagement. There are already encouraging signs that these strong starting points, will put Sri Lankan agricultural sector in a good position to maintain its overall production profile during the pandemic and to take advantage of a global economic recovery quickly.

We are already witnessing the direct and indirect effects of the pandemic on agricultural sector in Sri Lanka. The pandemic is driving some changes that will likely remain part of the future agricultural practices. These include encouraging home garden practices, shifts in online marketing and selling platform, having higher demand for stable and safe food, a greater awareness of supply chain risks, increasing use of digital trade systems and the risk of creeping protectionism. These changes force Sri Lankan agriculture sector to introduce new technology to develop the country’s agriculture on a modern system. Such a system would encourage an efficient resource allocation and finally come up with a long-term sustainable agricultural development.
strategy. Even with reformed agricultural system, real-time price information needs to be formed to disseminate everyday prices of major agricultural commodities from major regional markets.

It is critical that policies and initiatives target the vegetable and fruits producers to support essential businesses and local, regional, national and international supply chains. Without a modern technological driven system coordinated, there is no doubt that potential risks associated with food insecurity during and after COVID-19 will arise, which could in turn derive to a ‘crisis within a crisis’. Hence, taking initiatives to develop Sri Lanka’s agriculture, specifically vegetable and fruits, is a laudable goal. But it should be done not on old lines but on modern lines.

Despite the challenges and hardships caused by COVID-19, the crisis has also shed light on weaknesses in Sri Lanka’s agriculture sector. This knowledge can help guide reforms to make the agri-system more resilient. Key among the needed changes are Smart Farming and digital trade system. The emerging new normal in various aspects of life must be learned and embraced, including that in the food production sector, to make society sturdy and resilient in confronting COVID-19 and other potential crises in the future.

Obviously, the estimations provided in this paper are rather rough. The study is built on a short array of data covering only twelve months that have passed from the start of the COVID-19 spread. Over time, seeding of new data on the number of new COVID-19 cases, dynamics of food trade balances, food inflation rates, and currency exchange volatilities will allow one to use the established methodology framework to obtain more well-grounded quantitative assessments of the pandemic’s impacts on food security.

**DISCLAIMER**

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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