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Fruit and Vegetable Consumption Behavior in Sri Lankan Households

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Abstract

Fruits and vegetables (F&V) are widely accepted as important components of a healthy diet. Depending on the diverse nature of socio-economic status, F&V consumption patterns and decisions vary. This study determines the consumption patterns of F&V across sectors. Employing the Multistage Random sampling method and a structured questionnaire, 443 households (HHs) were surveyed. The study found that urban HHs spending on F&V is more than twice high than that of rural and estate residents. Quality, freshness and price were the three key determinants of F&V purchases. The Simpson Index analysis revealed that the diversity of F&V intake varies among sectors, with urban dwellers reporting the highest diversity (0.65). Consumption of vegetables is more diversified than the consumption of fruits. Using Exploratory Factor Analysis, eight factors on potentials and barriers of F&V consumption were identified. Non-availability, lack of promotion, and unclear declarations of organic status were the major barriers that reduced the purchase of organic F&V.

Keywords: *Diversity, Exploratory Factor Analysis, Organic Fruits and Vegetables, Simpson Index*

1. Introduction

Fruits and vegetable (F&V) consumption is widely accepted for healthy diets, and adequate consumption of F&V is one of the best methods to alleviate micronutrient deficiencies. Therefore, F&V consumption is encouraged as part of a healthy diet, leading to lower personal and social health costs. The important role of F&V consumption has been affirmed on several occasions. The United Nations declared 2021 as the International Year of F&V with the aim of raising awareness of nutritional and health

benefits of increased F&V consumption as part of a diversified, balanced, and healthy diet.

Contrary to the standard recommendation, a minimum of 400 grams of F&V of a person per day as set out by The Food and Agriculture Organization (FAO) and World Health Organization (WHO), Sri Lanka's per capita consumption of F&V remains far below. Hence, national level action is required to raise the consumption levels by making F&V more economically accessible, given a host of economic, social, and environmental benefits accrued by such action.

Hence, effective programmes and policies are urgently needed to influence consumption behaviour and increase F&V intake. However, many developing countries lack data on the F&V consumption patterns of their populations. Moreover, due to the diverse nature of socio-economic conditions, it is possible that different sub-populations in a single country also show different dietary patterns on some occasions (Popkin, 1999). This poses a challenge to policymakers in coming up with a set of food and nutrition policies to address diet-related issues in a country. Therefore, knowledge of the actual intake, consumption patterns, potentials, and barriers to upgrading consumption levels is needed for the strategies to be set up properly and to assess what changes need to be made if the recommendations are to be met. Hence, this study focused on identifying consumption patterns of F&V and potentials and barriers in increasing F&V intake at HH level in Sri Lanka, with special attention on urban, rural and estate sectors.

2. Methodology

2.1 Data Collection, Sample Size and Study Locations

Primary data required to perform qualitative and quantitative analysis of the study was gathered through a structured questionnaire. The secondary data was collected from the Department of Census and Statistics and the Ministry of Health in Sri Lanka. Multistage Random sampling method was employed. Districts representing the highest number of HHs in each sector were selected in the preliminary stage. In the second stage, Divisional Secretariats with the highest number of HHs in each district were selected. Grama Niladari Divisions (GNDs) were selected as the third stage, based on the number of residents. Randomly selected HHs from each GNDs were the final stage. Field survey was conducted in August to December, 2019.

Individual household (HH) was selected as sampling unit. The sample was selected from HHs representing the urban, rural, and estate sectors and the sample size of the survey was decided considering the margin of error (5%) and confidence interval (95%). Households representing urban and rural sectors are proportionately very high in comparison to the estate sector. Therefore, the total sample comprised of both urban and rural sectors. Sixty HHs in the Nuwara-Eliya district were surveyed to represent the estate sector. A sample size of 443 HHs were surveyed, representing 309 HHs from the rural sector, 74 HHs from the urban sector, and 60 HHs from the estate sector. Households in Municipal Council or Urban Council areas of Colombo and Gampaha were surveyed to represent the urban sector. Households in plantation areas, which are more than 20 acres of extent and having not less than 10 residential labourers, in the Nuwara-Eliya district were selected for the estate sector. Households that do not belong to the above classification were considered as the rural sector. They were surveyed in Kurunagala, Kandy, Kalutara, Galle, Anuradhapura, Jaffna, and Kegalle districts which constitutes 60 percent of the rural population in the country.

Data on F&V purchases was collected from HHs based on a recall period of one month. Data on individual dietary intakes was collected using a structured questionnaire, and a 24-hour dietary recall method was used. It consisted of reporting all F&V consumed within the 24 hours prior to interview. Consumption on weekdays and weekends was investigated separately as diets can vary between weekends and weekdays (Bingham, 1987; Appleton *et al.,* 2009). As a result, individual dietary intakes of F&V were also recorded on weekends. Subsequently the data was combined ([weekday*5 +weekend day *2]/7) to provide an average consumption of F&V per day per individual. Fruit and vegetable consumption through home gardens and any kind of transfer were considered as monetary purchases. Data collection was completed during the period of August-December, 2019.

3. Data Analysis

Objective 1: To describe patterns and buying behaviour of F&V

The data was analyzed using descriptive methods which included tables, graphs and charts. Attributes which concern during the F&V purchasing were analyzed using a Likert Scale.

Objective 2: To estimate per capita F&V consumption and its diversity across HHs

Per capita F&V Consumption

A single self-administered 24 hour recall survey data was used to obtain quantitative information for fruits (g/day) and vegetables (tablespoons/day) on F&V intake. The intake was measured in accordance with the National Food Guidelines of the Ministry of Health, Sri Lanka (Ministry of Health, 2011) as well as with FAO and WHO guidelines (FAO/WHO, 2004).

Diversity of F&V Consumption

Simpson Index analysis was used to calculate diversity of F&V intake. It has been widely used as a measure of diversity in economic and ecological studies and adopted in recent studies for evaluating dietary diversity (Katanoda *et al*., 2006; Drescher *et al*., 2007; De Oliveira *et al*., 2015).

The Simpson Index describes the distribution of quantity shares over the n fruit and/or vegetable categories. If we denote by W_{ij} the share of fruit j of the household i, then,

$$\boldsymbol{W}\mathbf{ij} = \frac{\boldsymbol{qij}}{\sum_{j=1}^{n} \boldsymbol{qij}}$$

Where *qij* is the quantity of *j* fruit and/or vegetable category purchased by household *i*, then, the Simpson index $\mathbf{S}_i$ is defined as,

$$\boldsymbol{Si} = \mathbf{1} - \sum_{j=1}^{n} \boldsymbol{W2ij}$$

It is obvious that if a HH concentrates all of its purchases in only one fruit/vegetable category, then S*i*=0. The more a HH diversifies the quantities of fruit/vegetable purchases, the closer S_i is to 1.

Objective 3: To identify potentials and barriers to increase F&V consumption at HH level

Potentials and barriers to increase F&V intake was analyzed using descriptive methods and Exploratory Factor Analysis.

4. Results and Discussion

Results showed that a majority of the respondents who participated in the survey were females in urban (52%), rural (53%), and estate (51%) HHs as they are the key decision makers with regard to F&V intake in HHs. Average HH size of the sample was recorded as four in urban and rural HHs. While in the estate sector it was five, with a minimum of two members and a maximum of 13 members. Most of the respondents who participated in this survey were middle aged with average education and belonged to different income groups. The average monthly income of urban HHs was 119, 992.00 LKR and the average monthly income of rural sector HHs was 57,368.00 LKR. The mean monthly income of the estate sector HHs was recorded as 36,062.00 LKR with 89 percent of the HHs falling under the income category of <50,000.00 LKR. The average income in the urban sector is more than three times higher than in the estate sector.

According to the survey results, the average food expenditure for urban HHs was recorded as 30,857.00 LKR. It was 19,949.00 LKR and 18,171.00 LKR for the rural and estate sectors respectively. However, in the estate sector HHs, a half of the monthly average income was allocated to food expenditure, while in the rural sector it was 35 percent. Though the urban sector had a higher average monthly income, their share of total food expenditure is around 26 percent from the average monthly income which depicts the highest amount of non-food expenditure.

The results show that HHs spent on vegetables than on fruits indicating that a relatively high vegetable consumption. However, urban HHs spend more than two fold for F&V with respect to rural and estate sectors. Budget share (percentage of expenditure on fruits and/or vegetable as a proportion of food consumption expenditure) of both F&V varies across three sectors and the highest value (0.42) is recorded in urban sector HHs. It was 0.32, and 0.29 in rural and estate sectors respectively. Most of the urban (69%) estate (69%) and rural (56%) HHs obtain F&V totally from outside sources while rest of the HHs depend on both outsource and home gardens.

Most of the urban HHs preferred buying from supermarkets (61%), followed by roadside vendors. Mostly urban HHs had limited access to local markets (*pola*) and limited space for home gardening. However, HHs in the rural sector frequently use home gardens and local markets for

obtaining F&V. Estate sector HHs mostly prefer local markets and roadside vendors. Most of the HHs (55%) preferred buying F&V once a week in the evening or morning. However, majority of the HHs (82%) had keen interest in buying fresh F&V rather than packed or processed ones.

According to the Likert Scale, majority of the HHs (70%) confirmed that they are more concerned about the quality with the mean score of 3.15. Freshness and price were important attributes which turn them to purchasing of fresh F&V. Similar results were reported in the studies of Mahaliyanaarachchi (2007) and Dimech *et al*., (2011). Majority of the urban and rural HHs have refrigerator for storing F&V. It was 94 percent and 75 percent respectively. However, majority (59%) of the estate HHs do not have facilities to store F&V. This is one of the limiting factors which affect F&V consumption and purchasing as they have limited access to storing facilities.

The per capita F&V consumption was estimated across the HHs (Table 01). The highest value was recorded in urban HHs. Per capita F&V consumption in urban HHs is at a satisfactory level as it is about to reach the recommended level. This was further confirmed, as urban HHs show the highest budget share for F&V. The study results of Weerahewa, *et al*., (2013) also demonstrates similar results, showing that fruit consumption in urban areas is relatively higher regardless of the income level.

Table 1: Per capita Fruit and Vegetable Consumption across Sectors

Sector	Fruit Consumption (g/day/person)	Vegetable Consumption (g/day/person)
Urban	187.78	180.55
Rural	151.51	165.89
Estate	43.34	108.38

Source: Authors' own calculation based on field survey (2019)

Simpson Index Analysis revealed that diversity of F&V intake varies among sectors and highest diversity is among urban dwellers (0.65), followed by rural (0.58) and estate (0.32) dwellers (Table 02). Further, consumption of vegetables is more diversified than consumption of fruits when comparing three residential sectors.

Table 2: Diversity of F&V Intake by Households based on Simpson Index

Sector	Mean	Minimum	Maximum	Standard Deviation
Diversity of Fruits				
Urban	0.310	0	0.855	0.244
Rural	0.196	0	0.799	0.232
Estate	0.026	0	0.376	0.097
Diversity of Vegetables				
Urban	0.626	0	0.840	0.204
Rural	0.556	0	0.830	0.237
Estate	0.280	0	0.670	0.269
Diversity of Both F&V				
Urban	0.645	0.130	0.890	0.160
Rural	0.579	0	0.880	0.207
Estate	0.319	0	0.720	0.269

Source: Authors' own calculation based on HARTI field survey (2019)

Majority of the respondents (64%) were aware of nutritional benefits of F&V. However, most of the HHs (75%) in the survey was not aware of the recommended quantity and variety of intake and terms like serving and serving sizes in the National Food-based Dietary Guidelines. Hence, most of the respondents perceive that their current diet as being healthy and sufficient, despite being less consistent with recommendations like dietary guidelines. Perception of chemical usage in fruit ripening (63%) and high prices were the most important factors which hindered purchasing of fruits. Awareness on nutritional value of F&V, quality of the products, reasonable price and seasonal availability are the motives for F&V purchase.

An Exploratory Factor Analysis was used to reduce the variables for identifying the effective factors on potentials and barriers of F&V consumption in Sri Lankan HHs. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy in this research is 0.582 (0.5 is considered as the acceptable value) showing that the data is adequate for factor analysis. On the other hand, the value of Bartlett's Test of sphericity was significant at the 95% confidence level ($X_2^2 = 2950.624, p = 0.000$). Further, the variable reliability gained by Cronbach Alpha was 0.7.

Table 3: The Extracted Factors with Eigenvalues, Percentage of Variance and Cumulative Percent Variance

Factor Name	Eigenvalue	Percent of Variance of Eigenvalue	Cumulative Percent Variance
1. Willingness to Change	2.692	13.459	13.459
2. Choice of F&V in the Shop	2.421	12.105	25.564
3. Awareness	2.191	10.956	36.520
4. Liking	1.757	8.787	45.307
5. Health Consciousness	1.485	7.426	52.733
6. Difficulties	1.261	6.306	59.039
7. Easiness	1.138	5.689	64.729
8. Perception of Quality	1.020	5.100	69.829

Source: Authors' own calculation based on field survey (2019)

The results of factor loadings, eigenvalues, and percentages of variance are summarized in Table 03. Eight components with eigenvalues greater than 1 were extracted, which collectively all together accounted for 70 percent of the total explained variation.

The results of the Table 04, show the eight factors and their consisted items. For example, Factor 1 consisted of three items of the variable list and explained 11.45 percent of the total variance, with an eigenvalue 2.692. Based on the sub-items of the criteria list, factor 1 was termed 'Willingness to Change'.

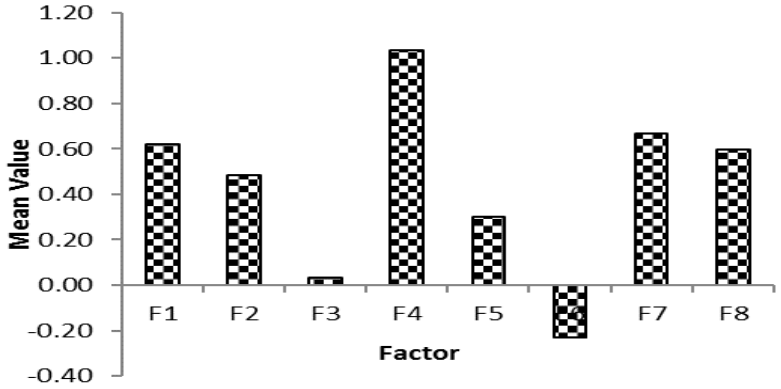
Table 4: Factor Analysis for Grouping Potentials and Barriers for Fruit and Vegetable Consumption in Households

Factor	Variable Description	Factor Loading
1. Willingness to Change	I would consider cutting out foods I normally eat in order to eat more fruit and/or vegetables	0.582
	I would eat more F&V in order to improve my health	0.932
	I would eat more F&V in order to increase the number of nutrients I eat	0.919
2. Choice of F&V in the Shop	The shop where I usually buy food has a wide choice of F&V	0.861
	Buying more F&V than I already do would be difficult for me due to the limited choice in the shop	-0.641
	I am satisfied with the choice of fruit and /or vegetables at the shop where I usually buy my food	0.848

3. Awareness	I am aware of current food guideline recommendation of eat 3-5 potions of F&V per day	0.909
	I am aware to eat 5 varieties or five colour of F&V each day	0.918
4. Liking	I like eating F&V	0.924
	I like the taste of F&V	0.935
5.Health Consciousness	I eat enough F&V for my health	0.839
	I eat the recommended amount of F&V for my health	0.876
6. Difficulties	Buying more F&V than I already do would be difficult for me due to the total food cost	0.629
	Buying more F&V than I already do would be difficult for me due to the effort in getting them home	0.727
	Buying more F&V than I already do would be difficult for due to the effort in preparing them	0.597
	I find F&V tasteless and dull to eat	0.450
7. Easiness	I find F&V easy to store so that they keep well at home	0.786
	I find F&V easy to prepare and cook for eating	0.797
8. Perception on Quality of F&V	I do not prefer to buy more F&V as perceived that contamination of pesticides residues	0.621
	I do not prefer to buy more F&V as they have short shelf life	0.832

Source: Authors' own calculation based on field survey (2019)

The mean values for the eight factors were calculated and presented in Figure 01, to classify potentials and barriers of F&V consumption.



Source: Authors' own calculation based on field survey (2019)

Figure: 1: Mean Values of Factors for Grouping Potentials and Barriers for Fruit and Vegetable Consumption in Households

According to Figure 01, of the eight factors only the sixth shows a negative mean value. F1 (Willingness to Change), F2 (Choice of F&V in the shop), F3 (Awareness), F4 (Liking), F5 (Health Consciousness), F7 (Easiness), and F8 (Perception on quality of F&V) show a positive perception towards F&V consumption while F6 (Difficulties) shows a negative perception of respondents. Consequently, factors of F1, F2, F3, F4, F5, F7 and F8 can be grouped as potentials and factor F6 named as a barrier in F&V consumption in HHs.

Majority of the respondents (97%) highly perceive that the F&V available at the market are not very safe and believe that they are contaminated with pesticide residues. This belief negatively affected the majority of HHs (74%) F&V consumption and purchasing decision. Majority of the respondents (60%) were aware of organic F&V and willing to purchase if they were available at their regular stores. However, almost more than half of the respondents (53%) doubt about the organic status of the product and 57 percent of the respondents believe that non-availability is the major barrier for reducing purchase of organic F&V. Moreover, 46 percent of the respondents do not believe that organic F&V are without chemicals. Therefore, non-availability, a lack of promotion and unclear declarations of the organic status were the major barriers that discouraged purchasing of organic F&V.

5. Conclusions and Recommendations

The proportion of HH income spent on food is higher for low-income HHs than for high-income HHs. In the same way, socio-economic status and the buying behaviour of HHs towards F&V vary according to the residence sector, and actors in the supply chain should find the most suitable markets to sell their produce across the three sectors. The act of consumption influences the consumer's purchasing decisions. Hence, directing research towards the consumer's F&V purchasing and consumption is an effective approach to modifying individuals' dietary habits. Further, promotion of F&V consumption requires a better understanding of how the food environment, availability, safety, and affordability influence F&V intake.

The greatest barrier to increased F&V intake is the perception that current individual consumption is already sufficient, despite being less consistent with recommendations like food dietary guidelines of Sri Lanka. Hence, public health and nutrition interventions should promote F&V consumption by increasing people's awareness of a diversified F&V intake and changing their attitudes towards healthy diets. Moreover, HHs in the estate sector should be specifically targeted in such strategies as they have comparatively low F&V intakes and less diversity.

There is a potentially viable market for safer F&V if production is scaled up. Fruit and vegetable research aimed at reducing production costs and enhancing food safety could greatly benefit population health. It will help lower the price of F&V and make them more accessible to the deserving populations. Assurance of the quality and safety of F&V available on the market is essential, and market inspections and legislation procedures are strengthened to assure the safety and quality of F&V. It is recommended that scientific research be conducted to assess the residual effects of pesticide use on F&V, as well as to raise public awareness to prevent misconceptions from being formed and spread. It is critical to develop national legislation for reputable organic certification, which could lead to increased trust in the organic food and beverages available in the local market. Home gardens are one potential way to increase the production and consumption of F&V. Therefore, home gardening programmes should be promoted to produce fresh F&V by addressing their limitations. Due to seasonal variations in F&V dietary intakes, the interventions and future studies should consider seasonality.

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Agriculture Development in Different Provinces of Sri Lanka Considering Selected Sector-Specific Factors

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Abstract

Agricultural development is widely recognized as a pre-condition for sustainable growth in developing countries as well as an effective approach to ending extreme poverty, unemployment, and food insecurity in developing nations. Sri Lanka, being an agriculture-based country, a study of recent developments in the sector would be vital. This study aims at comprehending the existing agricultural development of the provinces by taking into account the chosen sector-specific elements and to develop each province's agricultural status. Secondary data and the variability related level of agricultural development was examined using composite Z score technique with 14 indicators. Mapping was done according to the computed agricultural status z score value. The highest Z score value (0.348) was given to North Central Province and the Lowest Z score value (-0.558) to Northern Province. It found that agriculture development in provinces of Sri Lanka can be increased by prioritizing selected sector-specific factors. Moreover, an increase or decrease in the measures in these indicators has a direct correlation to the improvement or deterioration of the provincial partial agricultural development.

Key Words: *Agricultural development, Composite Z score, Correlation, Mapping, Sector specific*

1. Introduction

With an illustrious history in the agriculture industry Sri Lanka was among the leading agrarian societies in the world in the ancient times. Initially, people were engaged in agricultural activities to fulfil consumption needs. During the colonial era, the agriculture sector underwent massive changes at provincial wise. In effect, at commercial scale, coffee, rubber, coconut, and tea became new additions to the sector (Wickramasinghe, 2006).

The bedrock of all civilizations was agriculture. The countries with fertile landmass further grew with agriculture at industrial level providing food to many countries and some countries lagged behind due to a lack of labour, advanced technology, capital to develop agriculture at the industrial level and due to adverse natural disasters (Ritchie, 2022).

Agriculture in the 21st Century played multiple roles and fulfilled many purposes; producing more food for a growing population, supplying raw materials for expanding industrial and bio-energy sectors, conserving the natural environment and biodiversity and particularly in many agriculture-dependent developing countries, contributing meaningfully to rural employment, livelihoods and economic development. The agriculture sector in Sri Lanka always acts as a major economic strength to the national economy as it ensures food security, employment, and poverty alleviation of rural communities (IISD, 2017).

Hence, the agricultural sector contributes about seven percent to the national GDP (Gross Domestic Product) out of which the fisheries sector contributes around 1.2% and the livestock sector accounts for 0.6%. Analyses in 2016 found that 65% of poor working adults made a living through agriculture (World Bank, 2022). Agriculture continues to play a central role in addressing food insecurity. Hence, it is the primary means of generating income for the poor and ensuring their food accessibility (UK essays, 2018).

Sri Lanka's agricultural sector is related to food crops, plantation crops (38%), ornamental crops, livestock, fisheries, and forestry. Main plantation crops are determined as tea, coconut, and rubber. Tea is the major export plantation crop in Sri Lanka and coconut, rubber, and cinnamon are the other major export crops. Sri Lanka’s primary food crop is rice and it is cultivated in two seasons (Central Bank of Sri Lanka, 2020).

Agricultural development symbolizes the quality of an agriculture system in a country and it is unquestionably a multi-dimensional concept, of which crop production, crop diversification, and commercialization of agriculture are the main components (Lawrence, 2022). All provinces have contributed fairly in terms of agricultural activities. Sri Lanka is divided into nine provinces which are further subdivided into 25 districts. Districts are further subdivided into 331 Divisional Secretary's Divisions. Each Divisional Secretariat Division is divided into 14,022 Grama Niladhari Divisions (Abeykoon, 2013).

The provincial agricultural status shows how it contributes to agricultural development in the entire country. Most studies have not highlighted the inter-district or inter-provincial variation in agricultural development. Therefore, it is important to study and investigate how agricultural development occurred on a provincial base in recent years. The present study aimed to identify appropriate variables and bridge the gap in the literature about the comprehensive treatment of agricultural disparity. Each province has sector-specific agricultural development variables when deciding its position in the sector. The research aims to study and investigate the provincial-wise agricultural development in recent years (2005-2018) by selecting some key parameters which directly linked to the development in the sector.

2. Methodology

Data for this study was collected by considering some selected variables from 2005 to 2018 as available with the Central Bank data, the study consisted of secondary sources collected from reports of the Census and Statistics Department of Sri Lanka and various other published and non-published sources. To reach standardization, the raw data for each indicators which are (Household income, household expenditure, estimated tea production, number of tea factories, estimated rubber production, estimated coconut production, paddy production, paddy net extent harvested, paddy yield kilogram per hectare, motor vehicles by province, goods transport vehicles, road kilometrage total) have been computed into Z scores. Initially, a provincial-wise z-score for each indicator was computed. The values obtained were added block wise and standardized scores were taken out from the analysis known as composite z-score (Cs) for each block and each set of indicators. Then these results have been transformed into z-score and unity (+ or -) representing one standard deviation in either indicates high or low values respectively. Thus,

the regional patterns of agricultural development have been examined with the help of the composite z-score technique, as given as follows:

$$Z = \frac{X - \overline{X}}{\delta} \text{ ---------- (1)}$$

Where, Z = Standard score, X= Original values of the variables $\overline{X}$ = Mean of variables, and δ = Standard deviation of variables, the obtained Z-core of each indicator is added provincial-wise to be known as composite Z=score(s) for each spatial unit of the study area.

$$Cs = \frac{\sum zij}{N} \text{ ---------- (2)}$$

Where Cs are composite Z-scores, Zij indicates the sum of Z-scores of indicators j in blocks i and N symbolizing the number of variables. The correlation coefficient is worked out among dependent variables and independent variables (selected variables of the factors affecting agricultural development) and the correlation coefficient was computed based on Karl Pearson's correlation coefficient (r) method which is as follows,

$$r = \frac{\sum XY - \sum x \sum y / n}{\sqrt{\sum x^2 - \frac{(\sum x)^2}{N}} \sqrt{\sum y^2 - \frac{(\sum y)^2}{N}}} \text{ -------- (3)}$$

Where, r is the coefficient of correlation, x, and y are the two given variables and n is the number of observations. The level of significance was tested using the Student t-test significance level of 5 percent using statistical software called Minitab software (Alma, 2018).

Household income, household expenditure, estimated tea production, number of tea factories, estimated rubber production, estimated coconut production, paddy production, paddy net extent harvested, paddy yield kilogram per hectare, motor vehicles by province, goods transport vehicles, road kilometrage total. Secondary source data was collected from central bank data and statistics between 2005 and 2018. Results for each indicator for each province were calculated as methodology and the final Z score values explained how each indicator influences the development of agriculture in a particular province. The levels of agricultural development have been examined with the help of the composite Z-score technique (14 indicators) (Central bank, 2020).

To understand the level of agricultural development in detail in the study area, each indicator was analyzed in spatial distribution. Each province has been categorized into 4 divisions: very high (Above + 0.3), medium (0-0.3), Low (0-(-0.3)), and Very low (Below -0.3) in terms of composite Z-score and mapping was done according to the mean z score values; based on slandered interval relative variation of agricultural development among provinces of Sri Lanka.

3. Results and Discussion

According to Table 1, the highest Z score was received by the North Central Province regarding agricultural development, and this province has a higher amount as a percentage of land area and inland water. These two parameters were directly involved in agricultural development when looking at the development of the paddy sector in the province. North Central Province has maximum land area and enough irrigation systems so paddy sector can be further developed with the use of those resources, therefore it can be concluded that if the province has specific factors considering the crop going to be cultivated can get full efficiency of the productivity. Then the overall agricultural development of the province also can succeed with time. Another major key finding was determined by correlating two important parameters (total tea production and total tea factories in a region) as shown in Table 1. The province (Central) which has the highest z score value (1.65) for tea production has given a lower z score value (0.01) for agricultural development compared to the province (Southern) which has a lower z score value (1.3) for tea production while having higher z score value (0.2) for total agricultural development. Therefore, it can be concluded that productivity is not the only important factor that is contributing to the overall agricultural development in a particular province but also other sectors such as marketing channels, household income, and expenditure, the number of industries and factories, good transport and storage facilities which important when contributing to the development of agriculture in a particular region. For household income, the highest z score value was given as 2.57 for the Western Province and the lowest value was given as -0.99 for the Eastern Province, there for mean agricultural development z score value was given as 0.23 in the Western Province, and the mean z score value for agricultural development in Eastern Province given as -0.09 and it can be determined that the importance of socio-economic factors such as household income and related factors to the well-being of human life in the region. Furthermore, for household expenditure, the highest Z score

value was 2.59 in the Western Province and the lowest Z score value was -0.88 for the Northern Province, therefore the mean Z score value of the Western Province for agricultural development was higher than the Northern Province.

Table 1. Mean Final Composite Z score Values for All Provinces with Selected Parameters

Indi.	WP	CP	SP	NP	EP	NWP	NCP	UV	*SG*
Pop.	2.60	0.24	0.15	-0.86	-0.51	0.07	-0.73	-0.71	-0.24
TP	-0.43	1.64	1.34	-0.88	-0.88	-0.88	-0.88	-0.11	1.08
NTF	-0.44	1.70	1.63	-0.85	-0.85	-0.85	-0.85	-0.05	0.56
RP	1.28	-0.49	-0.15	-0.64	-0.64	-0.51	-0.64	-0.49	2.31
CP	0.44	-0.53	0.10	-0.71	-0.67	2.63	-0.36	-0.60	-0.28
PDY	-0.97	-0.80	-0.13	-0.67	1.58	0.25	1.90	-0.42	-0.73
PNE	-0.93	-0.834	-0.214	-0.646	1.756	0.498	1.659	-0.464	-0.820
PYK	-1.96	-0.270	0.832	-0.724	0.401	-0.713	1.704	0.417	0.318
VGT	2.687	-0.061	-0.081	-0.773	-0.653	0.279	-0.495	-0.539	-0.364
RKT	0.583	1.456	-0.152	-0.952	-1.981	0.933	-0.320	-0.340	0.774
HI	2.573	-0.138	0.045	-0.750	-0.985	0.456	-0.185	-0.324	-0.692
HE	2.590	0.081	0.161	-0.876	-0.656	0.298	-0.252	-0.710	-0.636
LA	-1.65	-0.683	-0.778	0.649	1	0.264	1.361	0.671	-1.004
IW	-0.91	-0.888	-0.642	1.076	1.238	0.235	1.619	-0.626	-1.094
AVG.	0.228	0.009	0.197	-0.558	-0.087	0.160	0.348	-0.261	-0.036

Indi- Indicators, Pop- Population, TP- Estimated Tea Production, NTF-Number of Tea Factories, RP- Estimated Rubber Production, CP- Estimated Coconut Production, PDY-Paddy Production, PNE- Paddy Net Extent Harvested, , PYK- Paddy Yield kilogram per Hectare, VGT- Goods Transport Vehicles, RKT- Road Kilometerage Total, HI- Household Income, HE- Household Expenditure, LA- Land Area, IW- Inland Water (sq./km), AVG- Average (mean z score value for all indicators for each province), WP-Western Province, CP- Central Province, SP- Southern Province, NP- Northern Province, EP- Eastern Province, NWP- North Western Province, NCP- North Central Province, UV- Uva Province, SG- Sabaragamuwa Province

Correlation Results

All selected variables were considered as agricultural development indicators and the correlation between each indicator was computed. These correlation values for each indicator was helped determine the relative contribution to agricultural development Table 2 shows that population is significantly and positively correlated with household income (r = 0.9) and household expenditure (r = 0.9) at one percent level of significance on the other hand household income and household

expenditure are significantly positively correlated with goods transport vehicles (r = 0.9) at one percent level of significance. This means that when a farmer's income increases their level of spending also increases, consequently the rate of good transport vehicles also increases because they are willing to spend more money to transport goods since it generates more income. Moreover, farmers are willing to pay more for extra materials, facilities, new equipment as well as new technologies also. After all farmers' main task is to increase the yield. Towards that end their household income and household expenditure are highly correlated to agricultural development. Tea production is significantly positively correlated with the number of tea factories (r = 0.9) at one percent level of significance because tea production requires labour force and machinery which is provided by tea factories. Here it can be concluded that the most correlated factors have a positive sign on agricultural development in a selected sector, and focusing on the most specific factors which highly correlated to each other is an important process when considering the development of agriculture in the region.

Table 2. Correlation Coefficient Values of Indicators

Indi	**Po**	**TP**	**NT**	**RP**	**CP**	**PY**	**PN**	**PK**	**VT**	**RT**	**HI**	**HE**	**lA**
TP	0.1												
NT	0.1	1											
RP	0.5	.3	.2										
CP	0.3	-.2	-.2	.0									
PY	-.4	-.5	-.5	-.5	0								
PN	0.4	-.6	-.5	-.5	.1	1.*							
PK	-.7	.1	.2	.3	-.4	0.6	0.6						
VT	1.0	0.0	0.0	0.4	0.4	-.4	-.4	0.7					
RKT	0.5	0.5	0.5	0.4	0.5	-.6	-.6	0.3	0.4				
HI	.9*	-.1	0.0	0.3	0.5	-.3	-.3	0.6	1.*	0.4			
HE	1.0*	0.0	0.0	0.3	0.4	-0.3	-0.3	-0.6	1.0*	0.4	1.0		
LA	-.8	-.6	0.6	-.7	0.2	.8*	.8*	0.5	-.7	-.7	-.6	-.7	
IW	-.5	-0.7	-0.7	-0.6	-0.1	0.8*	0.8*	0.4	-0.4	-0.7	-0.4	-0.4	0.8

* Denotes significance at 0.001 level

Indi- Indicators, Pop- Population, TP- Estimated Tea Production, NTF- Number of Tea Factories, RP- Estimated Rubber Production, CP- Estimated Coconut Production, PY- Paddy Production, PN- Paddy Net Extent Harvested, , PK- Paddy Yield kilogram per Hectare, VT- Goods Transport Vehicles, RKT- Road Kilometerage Total, HI- Household Income, HE- Household Expenditure, LA- Land Area, IW- Inland Water (sq./km)

Paddy production is positively correlated with the paddy net extent harvested (r= -0.9), land area (r= -0.8), and inland water (r=0.8) province-wise. Similarly, paddy net extent harvested is positively related to the land area (r=0.8) and inland water (r=0.8). Furthermore, paddy yield bushels per acre is positively correlated with paddy yield kilogram per hectare. Household income is also positively correlated with household expenditure and also the land area is positively related to inland water. With these correlation results, it can be concluded that agricultural development can be enhanced while focusing on the most correlated factors.

Considering some important selected correlation factors specific to each sector development of agriculture in the province can be done through some activities such as decentralization of power, technology, infrastructure, knowledge, and required resources for agricultural industries which are specific to each province and local level administration with people's participation in creating a more coordinated, conductive, as well as cooperative effort to the development of agriculture in the province.

Figure 1 shows that the North Central Province has the highest agricultural development position and most correlation factors related to the paddy sector were inland water and land area, so correlation factors play a major role in the development of a specific region when taking them together.

According to Figure 1 agricultural position and its distribution is varying with the sector-specific factors for each region and it is denoted that North Central Province has higher potential for agricultural development compared to other provinces, which because there are most arable land area and inland water for paddy cultivation and also most of the people who live in the North Western Province are farmers, in that case, agricultural development is mainly based on human resources, and other associated factors. There are four provinces including the North Western Province, Western Province, Central and Southern Province which have moderate agricultural development as Figure 1, reason behind that results is although there were limited land area and inland water, more infrastructures, roads, good transport vehicles, and new technologies are centralized in Colombo compared to other provinces. Northern Province and Eastern Province indicate minimum agricultural development because those valuable lands and resources were not efficiently used for agriculture, due to lack of proper management facilities, lack of inland

water, extreme weather conditions, etc., in that case, it should be the most prominent aspect to focus on agricultural development for those areas too.

Development of agriculture of the province can be developed with some major activities such as decentralization of power, technology, infrastructure, knowledge and required resources for agricultural industries which are specific to each province and local level administration with people's participation in creating a more coordinated, conductive, as well as cooperative effort to the development of agriculture in the province.

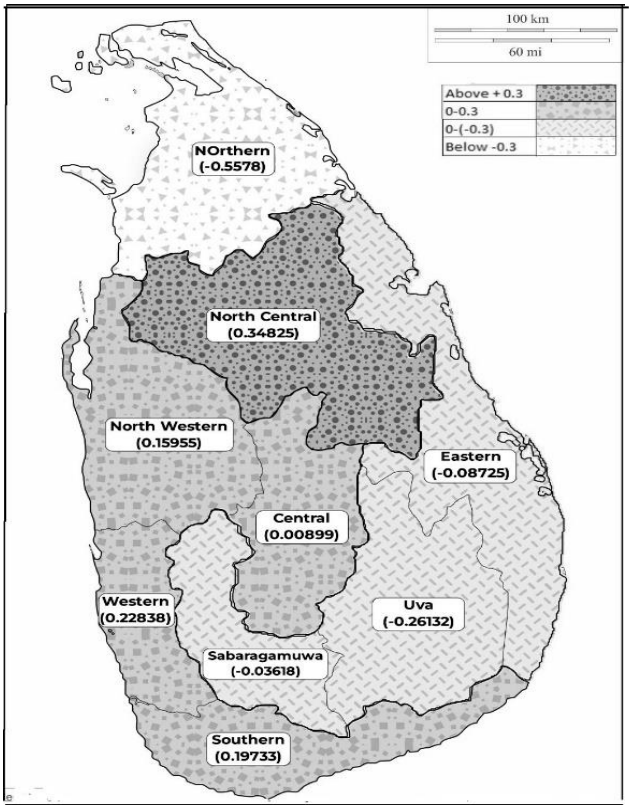

Figure 1. Agriculture Position in Provinces of Sri Lanka

4. Conclusion

The area of land dedicated to agriculture plays a central role in determining a country's agriculture production. However, if the population growth rates continue, increasing urbanization will potentially threaten agricultural production. Agricultural development in each province presents different z scores according to the culture and cultivation systems. Moreover, agricultural development in a region is not only about increasing crop yield, but it is also more about efficient use of resources, management of current manpower, facilities and basic welfare of human beings, otherwise, it is hard to achieve sustainable development of the agricultural system in a country. In this study, it can be explained that the current status of agricultural development is not enough to contribute efficiently to the national GDP when it is taken province-wise. This study covers only the statistical analysis of the last decade and, there is less literature available on the agriculture industry on a provincial base, therefore it is essential to give more focus on regional and sustainable agriculture development. One limitation of the study is that it cannot be generalized to the entire agriculture industry since some factors are focused only on one category, limited only to a specific geographical extension without considering overall agricultural development in the region. However, this study helps determine how agricultural development varied between provinces considering some major factors to a certain extent.

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Export Growth, Competitiveness and Potential of Major Fruits in Sri Lanka

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Abstract

Tropical fruits from Sri Lanka are in high demand worldwide due to characteristics such as flavour, aroma, and colour. Sri Lanka has not tapped its full potential in the fresh and processed fruit export industry but only a speck of the total production reaches off-shore markets. Despite significant evidence available on the fruit export industry in Sri Lanka, scant attention has been paid to its growth patterns, competitiveness, and potential. The overall objective of the study is to analyze the export growth, competitiveness, and potential to suggest policy measures to enhance the fruit export industry in Sri Lanka. Secondary data was used in this study. Avocado exhibited the highest growth rate in terms of different export indicators. Results revealed that papaya and pineapple have retained the comparative advantage while papaya remained at the top. American region was the preferred destination for Sri Lanka's major fruit exports followed by the Middle East and South Asia.

Keywords: *Augmented Gravity Model, Export Competitiveness, Export Growth, Export Potential, Major Fruits, Revealed Comparative Advantage*

1. Introduction

In Sri Lanka, there is a high potential for cultivating fruit crops for domestic and export markets (Dahanayake, 2015). Compared to certain other countries in the region, given the favourable climatic and soil conditions, Sri Lanka has great prospects for fruits (Dahanayake, 2015). Moreover, specialties associated with Sri Lankan products such as superior flavours and vicinity and organic yield have elevated the industry's prospects (Export Development Board, 2019). For instance, tropical fruits in Sri Lanka

such as pineapple, rambutan, mangosteen and passion fruit are very popular around the world for their unique flavour, aroma and colour (Export Development Board, 2019).

Although Sri Lanka is blessed with a wide range of delicious fruits only a small share of the total production is exported. Sri Lanka exported 38,725 metric tons of fresh fruit worth US $ 33.1 million during 2020. Meanwhile, Sri Lanka imported 52,778 metric tons of fresh fruit amounting to US $ 58.1 million in the same year. In the preceding year as well as in 2020, apples, mandarins, oranges and grapes were the main varieties that were imported (Central Bank Annual Report, 2020). Consequently, the percentage of fruit contribution to total merchandise exports in 2020 was around 0.36 (Export Development Board, 2021). The Export Development Board reveals that Sri Lanka exports both fresh and processed fruits and vegetables with 65 percent of the fresh products targeting the Middle East and the Maldivian market. The destination of almost 90 percent of the processed products is the European market. United Arab Emirates, Saudi Arabia, Qatar, Maldives, Kuwait, Germany, Pakistan, Japan, Oman are Sri Lanka's leading fresh fruit markets.

At present, the government of Sri Lanka hails export promotion as a key strategy to capture the international market. Further, the current local agricultural policy framework is aimed at modernizing the Sri Lankan agriculture to draw a lucrative income from export crops. To harness the full potential, it is essential to analyze the export growth of fresh and processed fruits, evaluate the potential end markets and export competitiveness of Sri Lankan fruits. As opposed to the little evidence available in respect of export trends in agricultural and horticultural commodities information on the export competitiveness of major Sri Lankan fresh and processed fruits, and the direction and magnitude of change in fruit exports is scarce. Further, only a limited number of studies have been conducted on the export performance of the fruit industry in Sri Lanka. Perera *et al.,* (2015) also recommended further research into processed fruit export products and the market situation. In a similar vein, Shand (2002) underscores the need to study export crops' potential in international markets.

With the recognition of proper niche markets, Sri Lanka may have the potential to develop exports of fresh and processed fruits (Department of National Planning, 2019). Hence, this study will analyze the export growth of Sri Lankan major fruits, the competitiveness of fruit exports in foreign

markets, and the potential for major fruit exports in order to suggest policy measures to enhance the fruit export industry in Sri Lanka.

2. Materials and Methods

Methods of Data Collection

This study was mainly based on secondary data regarding the fruit export sector in Sri Lanka. The secondary data was mostly collected from sources such as databases at the Department of Customs, Export Development Board, Department of Census and Statistics, Central Bank of Sri Lanka, FAO, CEPII (Centre d'Etudes Prospectives et d'Informations Internationales), World Development Indicators (WDI), and publications of the Department of Agriculture and its affiliated institutions. In addition, secondary data was gathered from research reports and journals.

Data Analysis

Objective 1: To Analyze the Growth Pattern of Major Sri Lankan Fruit Exports.

In order to estimate the growth pattern of Sri Lankan fruit exports, Compound Growth Rate Analysis was employed.

Compound Growth Rate Analysis

The compound growth function was used to analyze the trend and growth pattern in exports of selected fruits. The growth rates of production and export indicators for selected major fresh and processed fruits arrived by using the compound growth function of the form Bhowmick and Ahmed, (1993). The secondary data pertaining to export quantity (Kg) and value (LKR) for selected fruits for the period 2010-2020 were collected from databases of the Department of Customs Sri Lanka.

(1) $Y = ab^t e_t$

Where, Y = Dependent variable for which growth rate is to be estimated (Quantity exported/ total export earnings / unit value)

a = Intercept

b = Regression Coefficient = (1+g), where g is the compound growth rate

t = Time variable (Years which takes values, 1,2…n)
e_t = error term

The equation (1) was estimated after transforming it to logarithmic form as follows:
(2) Log Y = log a + t log b + log e_t
The percent compound growth rate (g) was computed using the following relationship
(3) g = ((antilog of b)-1) x 100
The standard error of the growth rate was estimated and tested for its significance with 't' statistics.

Objective 2: To Assess the Export Competitiveness of Sri Lankan Major Fruits in the Global Region.

In order to estimate and analyze the competitiveness of major fruit exports of Sri Lanka, the Revealed Comparative Advantage (RCA) index was employed.

Revealed Comparative Advantage (RCA) Indices

To examine the dynamics of the comparative advantage of Sri Lankan major fruits in the global scenario, the Revealed Comparative Advantage Method was employed. According to Ricardian Trade Theory, comparative advantage determines the pattern of trade (Ahmad *et al.,* 2021). In this study, Balassa Index was used (Balassa, 1965).

(1) RCAij = (Xij / Xi) / (Xwj / Xw) = (Xij / Xwj) / (Xi / Xw)

Where, *i* stands for Sri Lanka, *j* for selected fruit and *w* for world. *RCAij* represents the revealed comparative advantage of Sri Lanka for j^{th} fruit in equation (1) whereas Xij and Xi represent the exports of selected 'j' fruit and total merchandise exports of Sri Lanka respectively. Total World exports of individual, 'j' fruit and world's total merchandise exports are denoted by Xwj and Xw respectively in equation (1). A value of RCA > 1 indicates the existence of revealed comparative advantage which is a sector in which the country is relatively more specialized while a value of RCA < 1 reveals comparative disadvantage which is the sector in which the country is less specialized.

Objective 3: To Identify the Potential for Sri Lankan Major Fruits Exports.

Gravity Model Estimation

In the present study Augmented gravity model with a stochastic frontier approach (SFA) was used to estimate the potential fruit exports for 2010-2020 and investigate the determinants of fruit exports in Sri Lanka. Major fresh and processed fruit exports such as banana, pineapple, mangoes, papaw, avocado, and lemon were taken into account. The major importing countries were selected for the sample on the basis of Sri Lanka's fruit export value as well as the data availability. Fruit exports with 19 major destinations in terms of the export value from the year 2010 to 2020 can be modelled as:

$\log(Xijt) = \beta_0 + \beta_1\log(GDPit) + \beta_2\log(GDPjt) + \beta_3\log(POPit) + \beta_4\log(POPjt) + \beta_5\log(PCGDPDijt) + \beta_6\log(DISTij) + \beta_7\log(REERjt) + \beta_9(COLij) + \beta_{10}(TAijt)$

Where;

Xijt = Value of exports from Sri Lanka to country *j* in year *t*,

GDPit (GDPjt) = Sri Lanka's GDP (country *j*'s GDP) in year *t*,

POPit (POPjt) = Sri Lanka's population (country *j*'s population) in year *t*,

PCGDPDijt = Absolute value of per capita differential of Sri Lanka and country *j* in year *t*,

DISTij = Distance between Sri Lanka and country *j*,

REERijt = Bilateral Real Exchange Rate between Sri Lanka and country *j*,

COLij = Colonial link or relationship of Sri Lanka with country j (dummy variable),

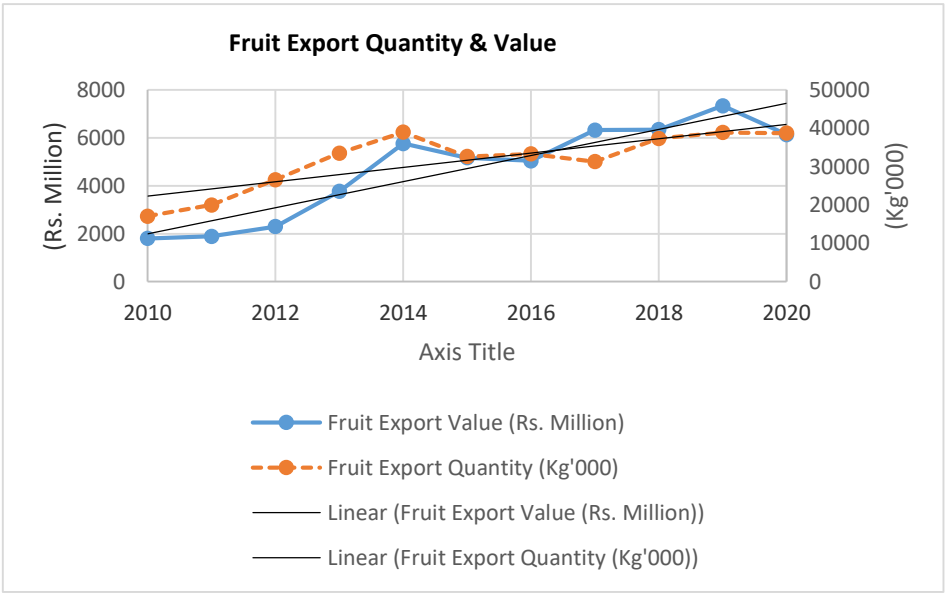
TAijt = Trade agreements of Sri Lanka with country *j* in year *t* (dummy variable)

Maximum Likelihood Estimates of the Gravity Stochastic Frontier Model were used to estimate the destination-wise potential of the fresh and processed fruit exports of Sri Lanka. Further, the ratio of actual export (A) and export potential (P) was obtained by the model. Then, (A/P) was calculated to analyze the export potential of Sri Lankan fruit exports. Sri Lanka has exported potential with countries whose values of (A/P) are less than one (Rahman, 2010). The value of [1- (A/P)] is the unused export potential.

3. Results and Discussion

Export Trends of Major Fruits in Sri Lanka

As shown in Figure 1 except for 2015, 2017 and 2020, an increasing trend for fruit exports was witnessed in terms of quantity. The highest quantity of fruit exports was recorded in the year 2014, perhaps due to increased production. However, the highest value of exports was reported in the year 2019. According to Figure 1, except for the years 2015, 2016 and 2020 in terms of value an upward trend for Sri Lankan fruit exports is seen.

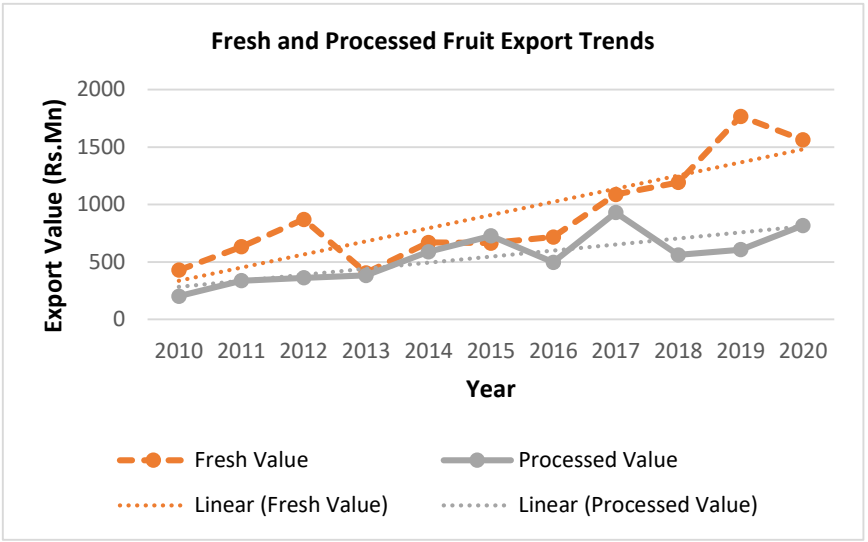


Source: Central Bank Annual Reports Multiple Issues

Figure 1: Total Fruit Export Quantity & Value (2010-2020)

As shown in Figure 2, except for 2013, 2015 and 2020, in terms of value an increasing trend in fresh fruit exports is observed. The highest fresh fruit export value was recorded in 2019 while the lowest was in 2013. As per Figure 2, except for 2016 and 2018, in terms of value an upward trend for processed fruit exports is seen. Further, the highest value of processed fruit exports was recorded in 2017.

Fresh and Processed Fruit Export Trends (2010-2020)



Note: Fruits included in the Figure 2 are Banana, Pineapple, Papaya, Mango, Guava, Mangosteen, Avocado, and Lemon.
Source: Authors' Compilation Based on Customs Data, 2021

Figure 2: Fresh and Processed Fruit Export Value (2010-2020)

Compound Growth Rates for Different Export Indicators of Major Fruit Exports

Table 1: Compound Growth Rates for Export Indicators of Fruits (2010-2020)

Fruit	CGR (% Per annum)		
	Quantity (Kg)	Value (Rs)	Unit Value (Rs/Kg)
Banana	-24.27^{NS}	-6.48^{NS}	29.20*
Pineapple	-2.06^{NS}	8.65*	10.95*
Mango	23.56*	25.62*	4.85^{NS}
Papaya	32.31*	32.44*	-0.75^{NS}
Avocado	44.92*	69.28*	43.85*
Lime	-7.53^{NS}	-3.90^{NS}	7.06^{NS}

Note: Figures in parentheses indicate in percent * denotes significant at 5 % level of probability, NS denotes Non-Significant, CGR (Compound Growth Rate)
Source: Authors' Calculation based on Sri Lanka Customs Statistics, 2021

It is evident from Table 1, avocado exhibited the highest positive growth rates in terms of quantity (44.92%), value (69.28%), and unit value of exports (43.85%) respectively. Consequently, these growth rates were statistically significant at 5 percent. Mango, papaya, and avocado show significant positive export growth of quantity and value over the considered years. Other fruits show a negative growth of export in terms of quantity and value over this period but are not significant.

Export Competitiveness of Major Fruits in Sri Lanka

Competitiveness of Sri Lankan Fruits: Global Context

In 2020 top five exporters of the banana were Ecuador, the Philippines, Costa Rica, Colombia, and Guatemala. According to FAO (2021), the global exports of bananas, excluding plantain was around 21.5 million tons in 2020. Contribution for global banana exports from Latin American and Caribbean region was 16.5 percent while it was 4.4 percent and 0.6 percent from Asia and Africa respectively. However, Sri Lanka's position in global banana export market was 78 while its market share was 0.003 percent (Table 2).

Costa Rica, the Philippines, Netherland, USA, and Belgium were the top five pineapple exporters in the world in 2020. Due to COVID 19 pandemic situation, the two leading global exporters of pineapples, Costa Rica, and the Philippines, both experienced sharp declines in shipments, at -7.7 percent and -5.8 percent, respectively in 2020. Total export quantity of 3.1 million tons in 2020, representing a 7.9 percent fall compared to 2019 (FAO, 2021). For pineapple, Sri Lanka's rank among global exporters was 36 and its market share in world pineapple market was 0.09.

Thailand was the leading exporter of mango (mangoes/mangosteen/ guava) in 2020 followed by Netherland, Mexico, Peru, and Brazil respectively. As stated by FAO (2021), global exports of mangoes, guavas, and mangosteens rose to 2.2 million tons in 2020 and it is a 2.9 percent increment when compared to 2019. Sri Lanka's market share in world mango exports was 0.06 percent while the rank among global exporters was 43 in year 2020.

Mexico, Brazil, Guatemala, Netherland, and USA were the top five global exporters of papaya in 2020. According to FAO (2021) there was a slight increase in global exports of papayas of 2.7 percent in 2020. The key

reason behind this growth is continued production expansion in Mexico, the largest global exporter of papayas. For papaya Sri Lanka's rank among global exporters was 11 while its market share was 1.87 percent (Table 2). Mexico was the largest global exporters of Avocado in 2020 followed by Netherland, Peru, Spain, and Chile respectively. Sri Lanka's market share in world avocado exports was 0.003 percent while the rank among global exporters was 61 in year 2020.

Spain, Mexico, Netherlands, South Africa, and Turkey were the top five global exporters of Lime and Lemon in 2020. Sri Lanka's rank among global lime and lemon exporters was 71 while the market share was 0.01 percent (Table 2).

Table 2: Market Share of Top Five Leading Fruit Exporters in the World and Sri Lanka's Position in Global Region

Commodity	Sri Lankan rank in Global Trade
Banana	78 (0.003 %)
Pineapple	36 (0.09 %)
Mango	43 (0.06%)
Papaya	11 (1.87 %)
Avocado	61 (0.003 %)
Lime & Lemon	71 (0.01 %)

Note: Figures in Parenthesis Indicated Percentage Share of Asian Export in 2020(in Value term US$)
Source: Authors' calculation based on the data from FAOSTAT, 2021

Competitiveness of Sri Lankan Fruits: Asian Context

Top five banana exporters in Asia during 2020 were Philippines, Vietnam, Cambodia, Turkey, and India. Sri Lanka's rank among banana exporters in Asia was 13 while the market share was 0.01 percent (Table 3). India is the only South Asian country among the top five banana exporters in the world.

The Philippines, China (Taiwan Province of), UAE, Thailand, and Malaysia were the top five pineapple exporters in Asia during year 2020. For pineapple Sri Lanka's rank among Asian exporters was 09 while the market share was 0.47 percent (Table 3).

Thailand was the leading exporter of mango (mangoes/mangosteen/ guava) in the world in 2020, followed by other Asian countries such as

Vietnam, India, Pakistan, and the Philippines. Sri Lanka's market share in Asian mango exports was 0.15 percent while the rank was 16 in year 2020.

China; Mainland, Malaysia, Sri Lanka, Philippines, and India were the top five papaya exporters in the Asian Region in 2020. For papaya Sri Lanka's rank among Asian exporters was 03 while the market share was 14.25 percent (Table 3).

In 2020, top five avocado exporters in the Asian region were Israel, China (Hong Kong SAR), UAE, Lebanon, and the Philippines. No South Asian country is among the top five avocado exporters. However, Sri Lanka's market share in Asian avocado exports was 0.21 percent while the rank was 13 in year 2020.

Turkey, China (Mainland), UAE, Vietnam and India were the top five Asian exporters of Lime and Lemon in 2020. Sri Lanka's rank among Asian lime and lemon exporters was 24 while the market share was 0.07 percent.

Table 3: Market Share of Top Five Leading Fruit Exporters in Asia and Sri Lanka's Position in Asian Region

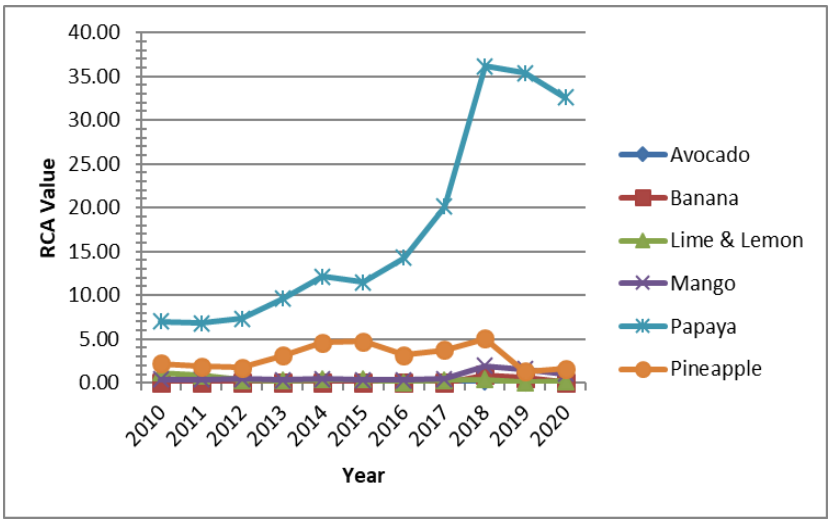
Commodity	Sri Lankan rank in Asian Trade
Banana	22 (0.01 %)
Pineapple	9 (0.47 %)
Mango	16 (0.15%)
Papaya	3 (14.25%)
Avocado	13 (0.21 %)
Lime & Lemon	24 (0.07 %)

Note: Figures in Parenthesis Indicated Percentage Share of Asian Export in 2020(in Value term US$)
Source: Author's calculation based on the data from FAOSTAT,2021

Revealed Comparative Advantage Indexes

Balassa's index was employed in this present study to estimate the revealed comparative advantage of major fruit exports from Sri Lanka. Figure 3 depicts that papaya and pineapple have retained the comparative advantage as RCA values are greater than 1, during the study period 2010 – 2020. Balassa's RCA index values for papaya remained at the top throughout the study period. Mango retained the comparative advantage from year 2018 to 2020. Lime and lemon showed comparative

disadvantage throughout the study period except the year 2010. Avocado and banana exhibited comparative disadvantage during the study period.



Source: Authors' Calculation based on FAO Statistics,2021

Figure 3: Revealed Comparative Advantage of Major Fruits using Balassa's Index

Estimation of Export Potential through Augmented Gravity Model with Stochastic Frontier Approach

Data limitations restrict the study from employing disaggregate level data for each fresh and processed fruit exports. Therefore, aggregate data of major fresh and processed fruit exports such as banana, pineapple, mango, papaya, avocado, and lime were considered for the current analysis. Further, in here Stochastic Frontier Approach (SFA) was performed by applying a time-varying decay efficiency model because data limitations restrict the study from employing an elaborative inefficiency model which would have identified the specific factors that impede or enhance efficiency.

All statistical tests regarding the gravity model were done using STATA version 15. Prior to estimation, all time series variables were tested for unit root by employing the Harris-Tzavalis Unit Root Test. This Harris-Tzavalis Unit Root Test (1999) assumes that the number of time periods is fixed while the number of panels tends to infinity, that is a higher number

of panels compared to the time periods required. The results show that GDPit, GDPjt, POPjt, POPit and REERijt are non-stationary. As stated in empirical analysis it is common that GDP and Population to have unit roots (Wickramarachchi, 2019). Therefore, another unit root test called Hadri (2000) was also employed. In this test the null hypothesis is that all panels are stationary, and the alternative hypothesis is that at least one panel has a unit root. Accordingly, all variables in time series nature were found to be stationary, and the results were also highly significant. The Gravity Model is estimated using SFA. In this study, SFA was employed with a time-varying decay efficiency model. This is justified by the eta value of the output which is statistically significant (p=0.000). The gamma value (ϒ) is 0.63 justifies the use of a stochastic frontier model to estimate export potential as it implies that both behind the border constraints and the country-specific beyond the border factors of importing countries are responsible for a major portion of the total variation in the model (Wickramarachchi, 2019).

Table 4: Estimation Results for Fruit Exports

Predictors	Coefficient	Standard Error	P value
Log (GDPit)	-1.855*	1.085	0.087
Log (GDPjt)	0.311	0.426	0.465
Log (POPit)	12.108**	5.229	0.021
Log (POPjt)	0.381	0.382	0.318
Log (PCGDPDijt)	1.788***	0.462	0.000
Log (DISTij)	-3.117***	0.403	0.000
Log (REERijt)	0.234*	0.132	0.075
Log (COLij)	-1.391***	0.513	0.007
No of Observations	165		
eta	0.113***	0.021	0.000
Gamma	0.628	0.430	

Note: ***Variables significant at 1% **Variables significant at 5.0% *Variables significant at 10.0%
Source: Authors' Estimates

Table 4 summarizes the estimates of SFA. The GDP of Sri Lanka shows a negative sign and it is statistically significant at 10 percent. However, GDP of partner countries shows a positive sign though statistically not significant. Consequently, with the growth of GDP of partner countries the exports of Sri Lanka increase due to their higher income and demand. Both population parameters are positive and only POPit was statistically significant.

As per the results in Table 4, PCGDPD is positive and significant. Hence, the Hekscher-Ohlin theory holds for the exports of Sri Lanka. Differences in income level and factor endowments with respect to partner countries have a positive effect on fresh and processed fruit exports of Sri Lanka.

Distance is negatively correlated with Sri Lanka's fruit exports with statistically significance being at one percent, implying that even at present with modern transport facilities distance plays a crucial role.

REER is positive and significant as per the existing literature (Hulugalle, 1989; Weliwita and Tsujii, 2000). However, this result is in contrast with some past studies (Wickramarachchi, 2019). High domestic inflation sometimes results in appreciations of the real exchange rates. Therefore, the results further indicate that the growth in Sri Lanka's exports is positively influenced by the growth in incomes in the importing countries. Devaluation has failed to play a significant role in boosting fruit exports from Sri Lanka while the growth in the country's exports can be credited to effective export promotion programmes and improvements in the production base (Weliwita and Tsujii, 2000).

Coefficient for COL has a negative sign and it is statistically significant. Further, this depicts that Sri Lanka's fruit export performance is not supported by colonial relationships. Accordingly, most of the estimation results are in line with the existing literature even though some variables were found to be statistically not significant.

Table 5: Sri Lanka's Potential Fruit Exports: 2010-2020 Average (Rs)

Country	Average of Actual Export	Average of Potential Export	Ratio of Actual to Potential	Unused Potential
Australia	14763190.45	112552817.30	13%	87%
Bahrain	13247919.41	32886702.68	40%	60%
Canada	19040751.82	22705239.86	84%	16%
Czech Republic	2638056.54	4557904.12	58%	42%
Japan	39362308.27	123320699.40	32%	68%
Kuwait	19987041.36	151878003.50	13%	87%
Maldives	33867801.60	59793556.34	57%	43%
New Zealand	10555341.82	10086644.79	105%	-5%
Oman	23067407.36	97233954.66	24%	76%
Qatar	48963932.09	381444010.10	13%	87%
Saudi Arabia	145929050.60	123095171.00	119%	-19%
Switzerland	20294583.27	160163072.30	13%	87%

UAE	409273786.30	378165462.60	108%	-8%
UK	22171353.22	31654866.21	70%	30%
USA	142327567.20	164184720.00	87%	13%

Source: Authors' Estimates, 2022

Table 5 and 6 present the country-wise and region-wise results respectively. Table 5 shows that most of the countries except New Zealand, Saudi Arabia, and UAE have potential for trade during 2010-2020. Therefore, Sri Lanka can enhance fresh and processed fruit trade with above countries that have trade potential for over 11 years (2010-2020) in place of the countries which have exceeded the trade potential.

Table 6: Region-wise Export Results: 2010-2020 Average (Rs)

Region	Actual Exports	Potential Exports	Ratio of Actual to Potential	Unused Potential (%)
European	45103993.04	196375842.60	22.97	77.03
American	161368319.00	186889959.80	86.34	13.66
Oceania	25318532.27	122639462.10	20.64	79.36
Middle East	660469137.20	1164703305.00	56.71	43.29
Asian	39362308.27	123320699.40	31.92	68.08
South Asia	33867801.60	59793556.34	56.64	43.36

Source: Authors' Estimates, 2022

According to the results in Table 6, the American region had been the preferred destination for Sri Lanka's major fresh and processed fruit exports followed by the Middle East and South Asia. The results depict that Sri Lanka has not tapped more than 50 percent of its potential export market in Oceania (79.36%), Europe (77.03%), and the Asian region (68.08%).

4. Conclusion

The highest quantity of total fruit exports was recorded in 2014. This could be an effect of the highest production that was reported in the same year 2014. However, the highest value of total fruit exports was recorded in 2019 due to the highest production in the same year.

According to Compound Growth Rate Analysis, avocado reported the highest growth rates in terms of quantity (44.92%), value (69.28%), and unit value of exports (43.85%) respectively. Consequently, these growth rates were statistically significant at five percent.

According to the Balassa's Index of revealed comparative advantage, papaw and pineapple have retained the comparative advantage as RCA values are greater than one, during the study period 2010 – 2020. Further, Balassa's RCA index values for papaw remained highest throughout 2010 to 2020.

According to the Augmented Gravity Model, importing country's GDP and population have a positive impact on Sri Lanka's fruit exports whereas distance has a negative and significant impact. In addition, the difference between the factor endowments has a positive and significant impact on Sri Lanka's major fruit exports, which is in accordance with the Heckscher-Ohlin theory. However, the real exchange rate has a positive and significant impact on Sri Lanka's fruit exports, implying that the exchange rate policy did not play a significant role in Sri Lanka's fruit exports. Therefore, the growth in the Sri Lanka's fruit exports can be credited to effective export promotion programmes and improvements in the production base.

American region was the preferred destination for Sri Lanka's major fresh and processed fruit exports followed by the Middle East and South Asia. The results depict that Sri Lanka has not tapped more than 50 percent of its potential in Oceania (79.36%), Europe (77.03%), and Asian regions (68.08%).

5. Recommendations

Commercial cultivation of suitable fruit varieties should be encouraged in order to achieve higher gains. A nucleus commercial farmer with an out-grower model is recommended to enhance the exportable fruit supply. In the first stage, this model can be used for most potential fruit crops such as pineapple and papaya. When applying this model government can provide facilities like arable lands, financial assistance, and technical support to potential fruit farmers.

Sri Lanka should pay more attention to the adoption of effective export promotion strategies to evolve and diversify the trade area to find

prospective markets besides expanding the existing markets and in place of markets that have exceeded the trade potential. The country's share in the above markets can be promoted by introducing trade representatives, having bilateral trade agreements, observing international quality standards, and expanding exporters' knowledge of marketing and advertising.

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Regional Market Integration and Price Transmission Analysis of Rice Markets in Sri Lanka: A Vector Error Correction Model Approach

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Abstract

The objective of this paper is to determine the regional integration and price transmission among geographically separated rice markets in Sri Lanka. A vector error correction model was applied to assess if and to what extent regional markets returned to long-run equilibrium following short-run deviations. Average weekly wholesale prices of rice from the year 2000 to 2019 were analysed for Colombo, Pettah market, which was considered as a central market while Gampaha, Kandy, Kurunegala, Puttalam, Dambulla, Thambuththegama and Dehiattakandiya markets were chosen as regional markets. Results of Johansen co-integration tests indicated that the central market is significantly co-integrated with regional markets in the long run. The results of the Vector Error Correction Model revealed that central and regional markets are integrated both in the short and long-run. In the short-run, 3 to 9 per cent of the disequilibrium was found to be corrected within a week and long-run equilibrium is restored within 7 to 25 weeks. The speed of adjustment was higher for regional markets than the central market as equilibrium was established within 13 weeks by regional markets and 18 weeks by Pettah market. The Granger causality test indicates that Pettah rice prices had bidirectional causality with regional markets. Overall results imply that rice markets are well integrated and efficient price transmission processes exist therefore any adjustment made in the central market, Pettah, will be mirrored in regional markets or vice versa.

Keywords: *Rice, regional markets, market integration, price transmission, vector error correction, speed of adjustment*

1. Introduction

Overall market performance in many developing countries was evaluated using the price behaviour of agricultural commodities in regional markets depicting sound integration of internal markets, which is usually reflected by the stabilization policies (Fafchamps, 1992; Baulch, 1997; Fackler and Goodwin, 2001; Abdulai, 2007). The price relationship of analyzing market integration is often used as a proxy for measuring the efficiency of the marketing system and its performance as price series are the readily available data in the agriculture markets. Hence, measuring spatial price linkages between different regional markets is a crucial policy tool for the government because of its implications for the functioning of regional food markets (Dawson and Dey, 2002). Since regional crop production pattern is mainly influenced by ecological conditions, knowing the relationship between the price movements of staple foods in different regions has much important for policymakers. Nevertheless, markets that are not integrated may convey inaccurate price information that might distort producer-marketing decisions and contribute to inefficient product movements (Alderman and Shively, 1991). Therefore, studying price linkages among different regional markets and the degree of price transmission is essential for policy directives towards the law of one price (LOP) in all markets to eliminate price distortions and maximize consumers' welfare while enhancing producers' incentives.

Rice is the staple food crop grown in Sri Lanka mainly to accomplish domestic consumption requirements, and paddy farming is the mainstay for a large number of rural people. Although the price behaviour of rice also draws attention in the policy platforms limited attention has been paid to the degree of rice market integration in Sri Lanka. Studies relating to both vertical and horizontal market integration are rare (Bogahawatte, 1988; Rafeek et al., 2003; Hathurusinghe and Ravichandran, 2004; Jayasinghe-Mudalige, 2006; Rupasena, 2006; Korale Gedara et al., 2016). Nevertheless, no similar study was carried out using the Vector Error Correction Model (VECM) in rice markets in Sri Lanka to identify regional market integration. The inbuilt features of VECM consider external shocks and lagged effects where a contemporaneous price in one market is related to its past values and contemporaneous and past prices in another market. Further, no recent study was conducted using weekly rice prices to

understand the regional market integration in Sri Lanka. Hence, this study aims to fill the existing gap in regional integration and price transmission in different regional rice markets in the country. Thus, the main objective of this paper is to find out the degree of regional market integration and price transmission among geographically separated rice markets in Sri Lanka.

2. Materials and Methods

Weekly wholesale prices of Nadu rice from 2000 to 2019 for the eight regional markets were collected from Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI). Eight markets, namely Pettah (Colombo), Marandagahamula (Gampaha), Kandy, Dambulla, Kurunegala, Puttalam, Thambuttegama (Anuradhapura) and Dehiattakandiya (Polonnaruwa) were chosen for the study based on the weekly price data availability, geographical location of the market, amount of production in the area and consumption pattern.

The Colombo Pettah market was selected as the central market because it is the focal trading zone in central Colombo, with almost all goods and services traded at the wholesale and retail levels. In addition, the Fort railway station and bus station located in Pettah connect people and goods at a domestic level while the nearby harbour facilitates international trade. Colombo is the lowest paddy-producing district in the country, even not contributing to one per cent of the total production. However, it has the second-highest population of 2.3 million after the Gampaha district, indicating that the per capita availability of rice is minimal in the central location because of poor production and can shift to food insecurity during a shortage period. Nevertheless, spatial and socio-economical features of the location have a positive influence to overcome such vulnerable situations swiftly. For instance, the highest mean monthly household per capita income is recorded from the Colombo district compared to all other regions signifying the higher purchasing power of the people whose demand for rice is mostly inelastic. They can overcome price shocks faster than any other region. Further, rice import to satisfy domestic requirements during the shortage period can directly persuade the region as it is located near import arrival.

Among the regional markets, Marandagahamula wholesale market from the Gampaha district is one of the main wholesale markets in the country. Rice trading activities have been in operation for around three decades in the Maradagahamula wholesale market, and there exists a

Marandagahamula-centric rice trading pattern earlier. Most of the paddy brought here was milled by medium and small-scale millers and distributed to other markets, including the Pettah market. It is also notable that wholesale trading starts here as early as morning before the Pettah market functions in a day. In addition, Kandy and Puttalam represent consumer markets as they are located in major consumption regions. The rest of the markets, Thambuttegama dedicated economic centre (DEC), Dehiaththakandiya and Kurunegala markets were selected as producer markets as they are in major paddy-producing areas in the country. Particularly, Thambuttegama DEC is located in the Mahaweli H zone, and the Dehiaththakandiya market in the Mahaweli C zone covers the Anuradhapura and Polonnaruwa farmers, respectively. Dambulla DEC is also a main distributing market, which shows producer market behaviour as most of the nearby producers sell produce to this place. In the study, among all the markets, Kurunegala, Thambuththegama and Dehiattakandiya and Dambulla markets are located in surplus districts henceforth identified as surplus markets. Pettah, Marandagahamula, Kandy and Puttalam markets are located in deficit districts hereafter denoted as deficit markets.

The nominal price data series were deflated using the consumer price index (CPI) with the base year 2013 to eliminate inflation. The data series was deflated using weekly CPI constructed from the monthly CPI of the Department of Census and Statistics assuming a constant index during the weeks in a month. The assumption of homogeneous weekly CPI is appropriate because, usually, farmers make production decisions based on the two seasons in a year; therefore, the prices are not much fluctuated in a month. All price series were transformed to logarithm form to eliminate variations in the movement to level differences and convenience for interpretation.

The presence of a unit root in a variable was tested using Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981). This test performs the linear regression as shown in Equation (1);

$$\Delta P_t = \beta_t + \mu_t + \delta P_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta P_{t-i} + \varepsilon_t \quad (1)$$

Where P_t is the log rice price of a given market at time t; ΔP_{t-i} is the first differences with k number of lags; ε_t is the white noise error term with a mean of zero and constant variance; β, μ, δ and α are the coefficients to be

estimated. The null hypothesis is that a variable contains a unit root, and the alternative is variable is generated by a stationary process. Therefore, failing to reject the null hypothesis leads to a conclusion that the series is non-stationary. The optimum number of lagged difference terms to include was selected based on the Akaike Information Criterion (AIC), Hannan and Quinn Information Criterion (HQIC) and Schwarz Bayesian Information Criterion (SBIC).

The Johansen cointegration test was used to verify the presence of cointegration, i.e. the long-run relationship between market pairs. It provides evidence of how closely prices at different markets are linked. It is derived from the Vector Autoregressive (VAR) model (Johansen and Juselius, 1990). Then Johansen's Maximum Likelihood procedure, determining the number of cointegrating vectors, involved the usage of two test statistics, i.e. trace and maximum eigenvalue statistics.

Once the cointegration test proves the long-run relationship between the price series, the short-run relationship between the first differences of the time series of price variables can be identified by applying the VECM. The elementary advantage of the VECM formulation is that it combines flexibility in dynamic specification with desirable long-run properties. Further, the VECM has a feature to include variables both in their levels and first differences. Thus, it can identify the short-run and long-run adjustments for equilibrium as price adjustments between markets may not happen instantaneously. Hence, VECM in the study takes the following forms:

$$\Delta P_t^c = \delta_1 + \alpha^c [ECT_{t-1}] + \sum \beta_k^c \Delta P_{t-k}^c + \sum \beta_k^{cr} \Delta P_{t-1}^c + \varepsilon_t^c \quad (2)$$

$$\Delta P_t^r = \delta_2 + \alpha^r [ECT_{t-1}] + \sum \beta_k^{rc} \Delta P_{t-k}^c + \sum \beta_k^r \Delta P_{t-1}^r + \varepsilon_t^r \quad (3)$$

Where the δ_1 and δ_2 denote long-run inter-market price margins. The coefficients α^c and α^r called the adjustment parameters are the elasticity of price transmission or the speeds of price adjustment by the central and regional markets, respectively, to deviations from long-run equilibrium. Standard VECM for two prices: central market prices P_t^c and regional market prices P_t^r also can be written in the matrix form as follow (von Cramon-Taubadel, 2017).

$$\begin{bmatrix}\Delta P_t^c \\ \Delta P_t^r\end{bmatrix} = \begin{bmatrix}\phi_c \\ \phi_r\end{bmatrix} + \begin{bmatrix}\alpha_c \\ \alpha_r\end{bmatrix}\left[P_{t-1}^c - \beta_0 - \beta_1 P_{t-1}^r\right] + \sum_i^k \begin{bmatrix}\delta_{ci} & \rho_{ci} \\ \delta_{ri} & \rho_{ri}\end{bmatrix}\begin{bmatrix}\Delta P_{t-i}^c \\ \Delta P_{t-i}^r\end{bmatrix} + \begin{bmatrix}\varepsilon_{ct} \\ \varepsilon_{rt}\end{bmatrix} (4)$$

Where Δ is the difference operator, ϕ, α, β, δ and ρ are parameters to be estimated and are the error terms. As explained in the vector form, here also different parameters have unique interpretations. β_1 is the long-run coefficient of price transmission between P_t^c and P_t^r; β_0 measures the margin between them. α is the adjustment parameter measuring whether P_t^c, P_t^r or both react to correct deviations from the long-run equilibrium relationship.

3. Results and Discussion

Prices are mainly determined by demand and supply forces and have a major influence on farmer income and the people's purchasing power. For instance, consumer behaviour, cost of production, transportation, resource use efficiency, uncertainties, productivity, seasons, infrastructure, decisions of market agents and policies adopted by the government often influence the price variation of agricultural commodities. Hence, it is important to understand the characteristics of wholesale prices in different locations over time before analyzing the price linkages between market pairs.

Table 1: Descriptive Statistics of Real Wholesale Rice Prices, 2000-2019

Markets	Mean (Rs/kg)	Standard deviation (Rs/kg)	Minimum (Rs/kg)	Maximum (Rs/kg)	Coefficient of variation (%)
Pettah	64.20	9.45	44.63	100.48	14.72
Marandagahamula	62.08	8.55	38.17	92.39	13.77
Kandy	62.57	8.31	44.65	88.40	13.28
Kurunegala	62.09	8.98	42.79	89.15	14.46
Dambulla	63.62	9.21	41.36	94.78	14.48
Thambuththegama	61.65	9.21	43.81	96.11	14.94
Puttalam	57.96	8.81	34.37	87.31	15.19
Dehiattakandiya	62.54	8.87	42.12	89.02	14.18

Note: There are 1040 weekly observations in the sample from 2000-2019 (The base year 2013).
Source: Own computation from HARTI secondary data

Table 1 presents the descriptive statistics of real wholesale rice prices in the markets considered in this study. Mean, standard deviation, minimum,

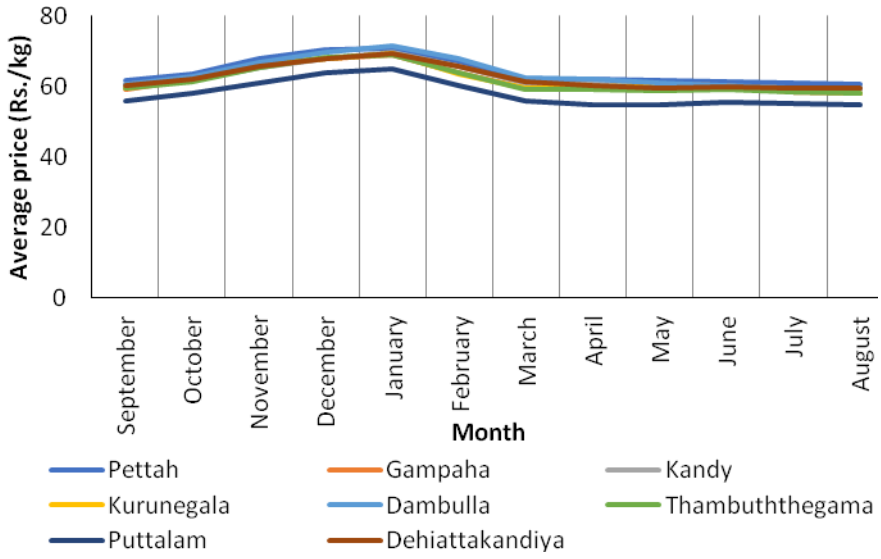
maximum and coefficient of variation are calculated for weekly real wholesale prices from 2000 to 2019. The maximum real price ranged from Rs.87 – Rs.100 per kg, with the highest, was recorded from the Pettah market, i.e. from the central market. The minimum price ranged from Rs.34 - Rs.45 per kg, with the lowest reported from the Puttalam market. Notably, both the highest and the lowest were recorded from the deficit market. The average monthly household consumption of rice in those districts is 29.5 kg and 25.5 kg, respectively, which is comparatively low compared to other markets (Department of Census and Statistics, 2020a). It implies that both show lower supply and demand patterns.

In addition, the highest average price was documented from the Pettah market with the value of Rs. 64 per kg while the lowest is Rs. 58 per kg from Puttalam. Among all markets, the highest mean price difference from Pettah was also evident from the Puttalam market (Rs.7 per kg), while the lowest was from the Dambulla market. However, it is evident from the statistics that many other factors influence the price rather than the quantity of production, and the cost of transportation is one such factor endorsing the economic theory. For instance, the central market, Pettah, is located in a deficit area, and most of the commercial scale mills are located in surplus areas, but with the improved transportation network, arbitrage of the rice supply between surplus and deficit areas has taken place, minimizing price fall and hike. Nevertheless, the data suggest that the mean difference in prices between a central market with regional market pairs was marginal, but it does not necessarily imply that the law of one price occurs due to arbitrage. Key Informant Interviews also revealed that a few large millers who dominate the rice industry involve direct distribution to the wholesale market, and hence the almost similar price is observable.

The extent of variability in average wholesale rice prices was estimated using the coefficient of variation for the study period (Table 1). Overall average variability was 14 per cent, which is reasonably lower. It indicates that rice prices are almost stable and narrowly fluctuate to a certain extent over time in the markets examined in the study. Weerahewa (2004) also found that stability in rice prices from 1991 to 2001 accounted for the coefficient of variations of approximately 20 per cent. The difference between the highest and lowest variability is one per cent, implying that variation is not much different from each other. It suggests the presence of more price stability in the wholesale rice markets. Variability fluctuated between 13.3 per cent for Kandy and 15.2 per cent for the Puttalam

market. Nevertheless, Table 1 also suggests that narrow variation in the variability in markets does not link with the regional supply and physical distance from the central market.

Strong seasonal variations in rice prices determine the definite time path of the rice prices. Figure 1 illustrates the monthly variation of real wholesale prices of rice markets starting from September with the onset of the *Maha* season to the end of the *Yala* season, i.e. month of August of the following year. It is important to note that all the markets, irrespective of whether markets are located in surplus or deficit areas, show a similar price pattern because around the country has comparable situation even though the prices are fluctuate alike with time depending on the harvesting season, stock availability and consumer demand. Here stock refers to paddy stock, not rice, because of the poor keeping quality of the rice.



Source: Own computation for HARTI data

Figure 1: Seasonal Movement in Average Rice Prices among Regional Rice Markets

The seasonal pattern of rice price changes has been characterized by an increase since September and a maximum in January and then again a declining trend. Since August/September, an initial rise in prices indicates

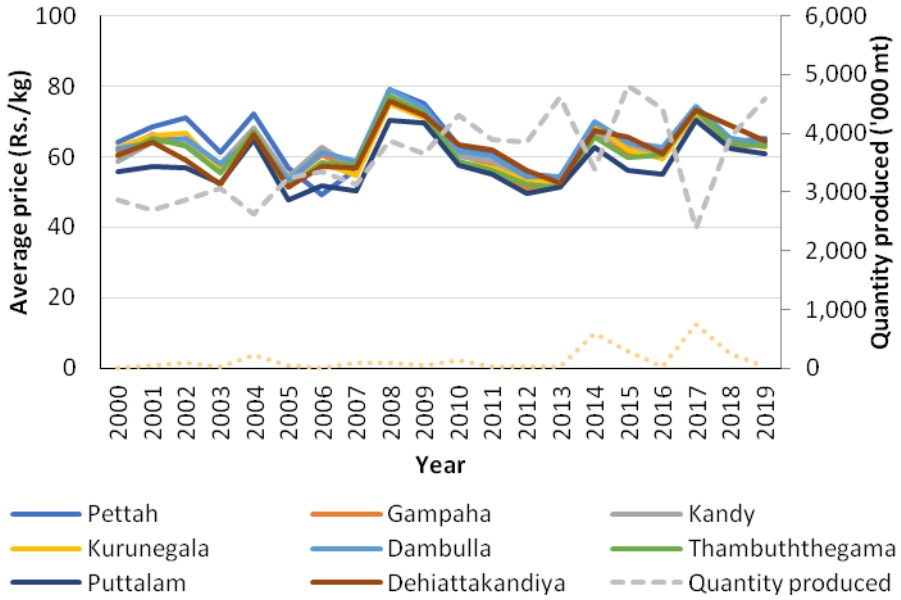
the end of the *Yala* harvesting season. Since there is a long gap till the next harvesting season of *Maha* in January/March, prices rise to reflect the limited storage facilities with the millers. Thus they tend to release the rice stock to the market, expecting a new harvest. Thus, during the off-season, the wholesale price is high due to the limited supply of rice stocks to the market. Further, the peak is reached in January with the high demand in the festive season, including Christmas and New Year. This increase from August to January fluctuated between 14-16 per cent in all the markets and affect urban consumers of the low-income category. Generally, these price hikes are dealt with by releasing imported rice into the market which causes a price decline.

Then the declining trend is observable from the commencement of the *Maha* harvesting season from January at a rapid rate at the outset up to March and then slows down. The average price decline from January to March is 15 per cent representing 16 per cent in Marandagahamula, Kurunegala, Thambuththegama and Puttalam, while 13 per cent in Dehiattakandiya and the rest recorded a 15 per cent fall. This sharp price decline affects the marginalized farmers in production areas. It is more interesting to note that there is no significant price hike during the Sinhala Tamil new year period, only reporting a one per cent rise from March to April in markets in deficit areas such as Pettah and Marandagahamula but no change in Kandy, Kurunegala and Thambuththegama. Besides, the gradual release of *Maha* stock to accommodate the *Yala* harvest also lead to stabilizing prices during this period. Again, at the beginning of the *Yala* harvesting season, rice prices declined from June, but the drop is insignificant due to the relatively lower production in *Yala*.

This further point out that traders mainly millers who supply rice to wholesale and retail market play a key role in controlling the market supply, thus the prices. On the other hand, farmers cannot control the supply due to a lack of storage facilities, financial obligations, and ad hoc government policies on procurement and imports. There is criticism of state sector price policies as always targeting price stabilization at the rice market by permitting the private sector to import rice with duty concessions. Therefore, a proper import policy should have been in place to import rice to compensate for the declining rice supply during the off-season.

Figure 2 primarily depicts changes in annual average real prices of rice in regional markets over the last 20 years to understand them from a broader

angle. It is noticeable that individual price series do appear to move together, indicating the country has an almost similar price pattern. Generally, Pettah and Dambulla market shows the highest prices over time as the demand is high as those are focal markets distributing food to the rest of the regions of the country. Puttalam prices were generally the lowest over time compared to other regional markets with lower demand for rice.



Source: Central Bank of Sri Lanka (2020); Department of Census and Statistics (2020b); Hector Kobbekaduwa Agrarian Research and Training Institute (2020)

Figure 2: Annual Average Rice Prices, Quantity Produced and Imported (2000-2019)

Further, it is identifiable from Figure 2 that there were periodic spikes in wholesale prices, especially in 2002, 2004, 2008, 2014 and 2017. This can be explained by the secondary axis of the graph, which shows the annual quantity of rice produced in the country and the quantity imported to compensate for the demand. It shows that overall an upward trend of production and its decline in particular years mainly due to prevailing climate change scenarios such as drought and flood conditions in the country ultimately led to a high rice import and subsequent price fall. It is important to note that a drastic reduction in production in the year 2004, 2014 and 2017 evident from Figure 2 and rice imports of 222, 601 and 752

thousand metric tons respectively shows 84, 96 and 96 per cent increased import than the previous year. However, the sharp price hike was visible in 2008, and it is 26 per cent higher than they were in the previous year associated with the world food price crisis in 2007/2008 and then reduced with the government's price ceiling. It is argued that the unusual rise in prices in 2008 was also mainly related to artificial rice shortages created by flawed import policy, government pressure to reduce wheat flour consumption, and anti-competitive activities as well as by flood and other related issues (Dayaratne-Banda *et al.,* 2008). Noticeable surge in annual real wholesale prices of staple food in subsequent years led to an adverse effect on lower-income households, thereby making rice a socially and politically sensitive commodity in the market as well.

Visual inspection of the graphs is important to illustrate how the mean and variance of the price data behave normally and after the first difference to give a basic indication of stationarity. Figure 3 plots the natural logarithms of the weekly wholesale real price of rice in all eight markets from 2000 to 2019, while Figure 4 is the first difference of the same.

The graphs reveal that the real wholesale price series appears non-stationary with no deterministic trend. Augmented Dickey-Fuller (ADF) test was performed to confirm the non-stationary price series. The Dolado procedure was followed to choose the trend specification (Dolado *et al.,* 1990), the general ADF model contains both a constant and a trend. If a unit root is not rejected for the general test form, the test is performed with the drift without time trend, which improves the efficiency and the power of a test. ADF statistics at the 5 per cent significance level revealed that both the trend and the drift are statistically insignificant. Therefore, ADF tests at the level are performed without a drift or time trend. The optimum number of lagged difference terms included in the covariate list was selected based on AIC, HQIC and SBIC.

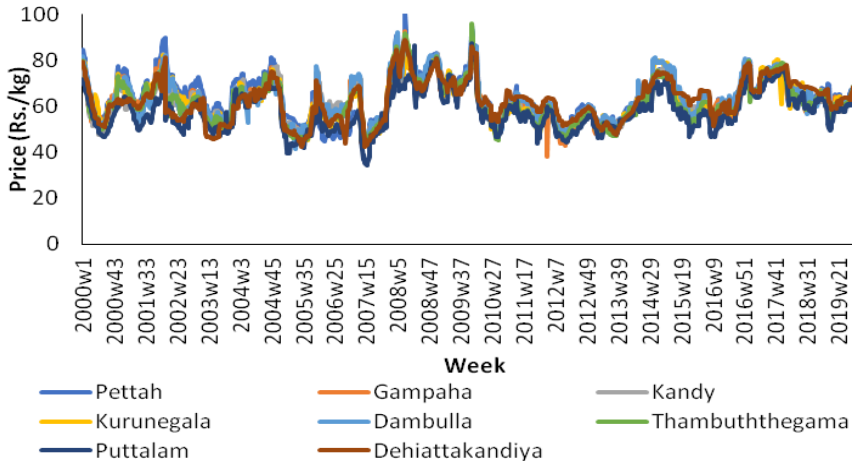


Figure 3: Weekly Wholesale Real Prices of Rice (The base year 2013)

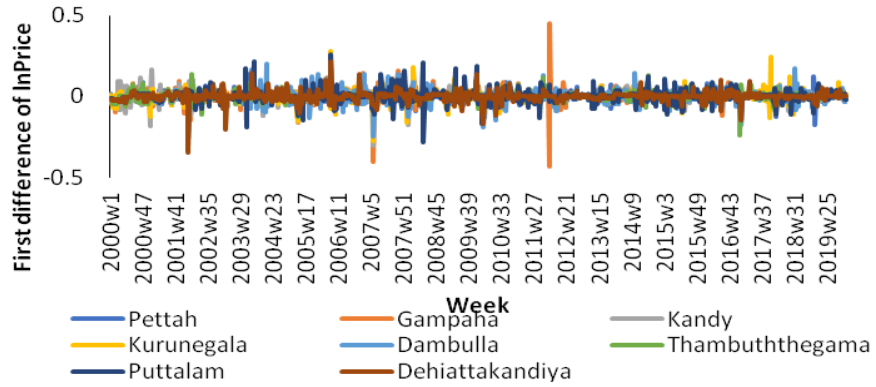


Figure 4: First Difference of Weekly Wholesale Real Prices of Rice (The base year 2013)

The results of the ADF test obtained at the levels and first differences of the log of wholesale real rice price are presented in Table 2. The 1 per cent, 5 per cent and 10 per cent critical values for ADF tests are -2.580, -1.950 and -1.620, respectively. Since test statistics obtained for each price series are less than the critical value in absolute terms, the null hypothesis of the variable containing a unit root is rejected. It revealed that price series are non-stationary at the level. After taking the first differences of the price series, the test becomes stationary. These test results suggest that all the price series are integrated of order one or I(1), one of the conditions for testing cointegration to determine the long-run relationship between markets.

Table 2: Results for Unit Root Test in Levels and First Differences

Market	Level	First Difference	Lags
Pettah	-0.24	-16.22***	2
Marandagahamula	-0.21	-22.84***	1
Kandy	-0.18	-22.48***	1
Kurunegala	-0.24	-16.60***	2
Dambulla	-0.23	-21.27***	1
Thambuththegama	-0.14	-12.83***	4
Puttalam	-0.16	-22.54***	1
Dehiattakandiya	-0.17	-15.64***	2

Note: *** indicates statistical significance at 1%.
Source: Own computation from HARTI secondary data

Table 3 presents the results of the seven pair-wise comparisons of prices between Pettah with each regional market. The trace and maximum eigenvalue statistics at r=0 for all seven market pairs exceed their critical value of 12.53 and 11.44 respectively at a 5 per cent significance level, leading to the rejection of the null hypothesis of no co-integration equations. Then both statistics at r=1 for market pairs are less than the critical value of 3.84. Therefore, we cannot reject the null hypothesis that there is one cointegration relationship between central and other regional markets. Hence, at least one stationary cointegration relation for all price relationships and the LOP holds between Pettah and all regional markets. These results further indicate that the market pairs move together in the long run, and there is market integration.

Table 3: Results of Johansen Test for Co-integration

Market Pair	Test Statistics			
	Trace H_0: r=0	Max H_0: r=0	Trace or Max H_0: r=1	Lags
Pettah - Marandagahamula	53.0813**	53.0201**	0.0611	2
Pettah - Kandy	43.0864**	43.0240**	0.0624	2
Pettah - Kurunegala	63.0970**	63.0232**	0.0738	2
Pettah - Dambulla	41.7513**	41.6733**	0.0780	2
Pettah - Thambuththegama	39.1873**	39.1320**	0.0553	2
Pettah - Puttalam	62.9018**	62.8419**	0.0599	2
Pettah - Dehiattakandiya	39.7987**	39.7402**	0.0585	2

Note: ** indicates statistical significance at 5%.

Source: Own computation from HARTI secondary data

Therefore, regional rice markets are highly integrated with the prices at the central market in the long run. It further implies that with the improved infrastructure, including a good road network, a common domestic rice market in Sri Lanka, where inter-market prices adjust to achieve long-run market equilibrium. The presence of a cointegration relationship justifies the necessary condition for applying VECM to the market pairs to analyse the nature of price transmission between central and regional markets. The results of VECM comprised the estimates of long-run elasticity, speed of adjustment coefficients and calculated half-lives are presented in Table 4.

The results of VECM revealed that central and regional markets are integrated both in the short and long run. In the short-run, the estimated parameters range from 0.03 to 0.09, indicating a 3 to 9 per cent of the disequilibrium was found to be corrected within a week, and long-run equilibrium is restored within 7 to 23 weeks. The speed of adjustment was higher for regional markets than for the central market. It ranges between 6.1 per cent and 4 per cent for regional and central markets, respectively. At the same time, price linkages indicate that equilibrium was established within 18 weeks for the Pettah market and 13 weeks for regional markets.

Table 4: Long-run Elasticity and Speed of Adjustment Coefficients

Market Pair with Pettah	Long-run Elasticity (β)	Speed of Adjustment			
		Pettah Market (α^c)		Regional Market (α^r)	
		Coefficient	Half-life	Coefficient	Half-life
Marandagahamula	-1.01***	-0.05***	13.5	0.06***	11.3
Kandy	-1.01***	-0.03***	25.4	0.06***	11.2
Kurunegala	-1.01***	-0.05***	12.7	0.07***	9.7
Dambulla	-1.00***	-0.02		0.08***	8.8
Thambuththegama	-1.01***	-0.05***	14.2	0.03**	23.0
Puttalam	-1.03***	-0.03***	20.5	0.09***	7.3
Dehiattakandiya	-1.01***	-0.03***	22.7	0.04***	17.1
Average		0.04	18.0	0.06	12.6

Note:** and *** indicate statistical significance at 5% and 1% respectively.
Source: Own computation from HARTI secondary data

An efficient price transmission process exists; therefore, any adjustment made in the Pettah market will be reflected in regional markets. Further, it indicates lower rice scarcity among regional markets. Nevertheless, there is sluggishness in returning to market equilibrium after a shock due to poor infrastructure facilities such as roads and assembly markets and the supporting services including transport, packaging and storage.

On average, 4 per cent of any disequilibrium will be corrected within a week by the Pettah market. In comparison, 6 per cent of such shocks will be corrected within a week by regional markets. This suggests a 2 per cent difference in the rate of price transmission between the central and regional markets and hence in the level of spatial integration of the rice markets. In other words, it can be interpreted that after a shock, the central market will return to equilibrium in 18 weeks while regional markets will return to equilibrium in 13 weeks implying shocks are more quickly corrected by regional markets than those of central markets. The relatively faster speeds of adjustment minimize the possibility of the regional scarcity of rice (Dawson and Dey, 2002). Particularly, the Puttalam and Thambuththegama markets possess the highest and lowest integration with the Pettah central market. It indicates the importance of disseminating updated market information throughout the country so that traders in remote markets cannot set the prices of essential commodities like rice subjectively.

Studies have also found that closer markets were more integrated and that the speeds of adjustment are higher. Short distances and reasonably open markets mean that transaction costs are relatively minor obstacles to agricultural trade (Abdulai, 2000; Barrett and Li, 2002; Dawson and Dey, 2002). For instance, distance rural markets like Thambuththegama and Dehiattakandiya recorded 2.9 per cent and 3.9 per cent speed of adjustment, respectively, which is the slowest among the rest, taking 23 and 17 weeks correspondingly. However, with the better transport and communication infrastructure, the distance between the market pair shows no exact relationship between the level of cointegration. Also, there is no regional shortage in rice supply in Sri Lanka, indicating efficiency in the rice supply chain through market forces.

Overall above results suggest that regional rice markets in Sri Lanka are well integrated with reduced transaction costs between the markets with the agriculture-enabling infrastructure created with the improved roads and markets, transportation and communication networks. However,

there are obvious reasons for the inefficient transmission of price signals between the surplus and deficit markets and market competitiveness. For instance, room for infrastructure development, oligopsony power in paddy purchasing, limited storage facilities, unplanned government policies, seasonality, limited access to credit and finance, and inflation-like macroeconomic issues (Hathurusinghe and Ravichandran, 2004; Weerahewa, 2004; Rupasena, 2006; Senanayake and Premaratne, 2016).

The Granger causality test results show the direction of price transmission among the markets as it supplements cointegration analysis (Goletti and Babu, 1994). The results of Granger causality (Table 5) showed that rice markets are well integrated and exhibit bi-directional causality. Any disequilibrium between markets is resolved through arbitrage, suggesting efficiency in the transmission of market information among the market participants. Hence, there is no market dominance by Pettah or regional markets in rice price formation.

Table 5: Results of the Granger Causality Test

Market pair with Pettah	Pettah market	Regional market	Direction
Marandagahamula	38.36***	41.33***	Bidirectional
Kandy	24.88***	62.08***	Bidirectional
Kurunegala	34.77***	34.11***	Bidirectional
Dambulla	8.25**	99.57***	Bidirectional
Thambuththegama	75.24***	44.76***	Bidirectional
Puttalam	9.80**	39.50***	Bidirectional
Dehiattakandiya	27.40***	22.22***	Bidirectional

Note: *, **, and *** indicate significance at 10%, 5% and 1% respectively.
Source: Own computation from HARTI secondary data

4. Conclusion

Regional rice markets in Sri Lanka are well integrated and an efficient price transmission process exists; therefore, any adjustment made in the central market (i.e. Pettah) will be mirrored in regional markets or vice versa. Having obtained a high degree of integration in the short and long run, room may still exist for further improvement in the degree of integration between Pettah and regional markets considering the varying speed of adjustments. This suggests that the regional rice markets have distinct competitiveness, and the policymakers require paying close attention in this regard. Therefore, this study suggests that to implement measures to

strengthen regional market integration, improve market monitoring and information dissemination, enhance market infrastructure and logistics, promote competition and market liberalization, implement policy coordination and harmonization, support farmers and consumers, and continuously monitor and evaluate market dynamics for efficient price transmission in Sri Lanka's rice markets.

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