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Volume and price behaviour of root and tuber crops: The case of Trinidad and Tobago

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Abstract

Market prices of root crops are influenced by many economic factors along with their volume arrivals and lagged prices. This study seeks to analyse the behaviour of volume arrivals and wholesale prices of selected roots and tuber crops. Monthly wholesale prices and trade volumes for 2006-2015 were derived from the NAMDEVCO database. Linear growth rates were calculated and coefficients of variations were assessed. Seasonality index was worked out and lagged prices were tested to identify any relation with current prices. The results of this study could be used to guide policy decisions and production planning towards market stabilization.

Keywords: Lag prices, market prices, market volumes, root crops, seasonality index, trend analysis

Introduction

Ensuring food security for a growing population is a major mandate of all countries across the world despite stagnant productivity and global environmental changes^[1, 2]. According to the Food and Agriculture Organization of the United Nations, the agricultural production needs to be doubled by 2050 to feed more than 9 billion people^[3]. The increasing demands for food, fibre, and fuel, coupled with global environmental changes, are placing increasing strains on the ability of ecosystems to deliver all of the goods and services that are required^[2]. Diversification of agriculture towards selective high value crops had long been recommended as one of the strategies for meeting these challenges^[4]. However, efforts to increase food production and ensure the availability to citizens face a number of challenges amidst fluctuating weather patterns and the use of agricultural commodities as alternative sources of energy^[5].

Root and tuber crops, including cassava, sweet potato, yams, potato and other minor root crops are important to the agriculture and food security of many countries and overall are a component of the diet for 2.2 billion people in developing countries. In terms of contribution to calorie supply, the importance of root, tubers and derived products crops is small, compared to the contribution of cereals. The contribution of root and tuber crops to the world supply of calories is only 5% compared to 48% for cereals and 46% for other food^[6].

Limited area available for cultivation and myriad of changes in agro-climatic conditions of the countries, especially small island nations such as Trinidad and Tobago exert a strong influence on the supply of most of the crop commodities. Besides vegetables, this is very true for the root crops because of the shorter growth periods and wide ecological amplitude of these crops. The variations in the output of these crops lead to wild fluctuations in their prices, exposing the farmers to more risk as compared to the growers of other crops.

Root and tuber crops cultivated and consumed in Trinidad and Tobago that are of significant economic and nutritional importance are cassava, sweet potato, yam, dasheen and eddoes. Root crops (*often referred to as ground provisions in Trinidad*) are the traditional crops of Trinidad and Tobago farmers. The consumption of root and tuber crops is assuming greater importance in the diet of the population, as prices of imported carbohydrates, such as, flour and rice continue to escalate.

NAMDEVCO data showed that the total traded volume of root crops was 60 million kilograms during the period 2006 - 2015, which represented approximately 30% of total market volumes, and therefore showing the importance of root crops to Trinidad and Tobago^[7]. Root crop volumes increased from 114 tons in January 2006 to 463 tons in December 2015. In the year 2015, 6.9 million kilograms of root and tuber crops were traded, with local sweet potatoes being the most traded with a market share of 31.4% followed by carrots (16.5%) and imported dasheen (16%).

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It was observed from NAMDEVCO [7] data that local sweet potato prices on average increased by TT\$ 3.54/kg between 2006 and 2015, while carrot and imported dasheen prices had positive movements of TT\$ 2.33/kg and TT\$ 3.09/kg, respectively, and the prices of ginger increased (146%) by TT\$ 19.35/kg during that period.

As Kumar, Sharma, & Singh [8] rightly pointed out, market intelligence on potential markets, arrival volumes and existing and expected prices at different market levels and a continuous period of the year would help to mitigate many of the marketing problems. Besides, it would facilitate the farmers in adjusting their cropping pattern in such a way that they could sell their produce at a time when the prices are reasonably high in the market. Market intelligence about the pattern of market arrivals and prices help not only farmers but also the household consumers and governments, especially in a country like Trinidad and Tobago where school nutritional programme is being implemented in a large scale. Therefore, the need for proper marketing intelligence system has been felt and raised from time to time by many scholars [9, 10, 11].

Market prices are influenced by macroeconomic and microeconomic factors along with the supply of their volumes [12, 13]. Therefore price and volume behaviour can have significant impact on each other. In addition, previous prices have an effect on future prices and therefore could influence volumes. As a result of this relationship consumer and producer welfare can be affected due to the volatility of a market [14]. Against this backdrop, this study seeks to analyse the behaviour of market arrivals and wholesale prices of important roots and tuber crops.

Materials and methods

Monthly wholesale prices and trade volumes for carrots, cassava, yam, dasheen, eddoes, sweet potato and ginger during the period between 2006 and 2015 were derived from the NAMDEVCO database. NAMDEVCO collects this information at the start of each trading day, (Monday to Friday) and builds a monthly database using daily modal prices price and total daily volumes. Using the data derived as above, the following analyses were carried out through SPSS@20.0 and MS-Excel:

- **Growth rate** was computed using the annual trend in the arrivals volumes and prices of commodities [15]. A linear trend line was used, which had similar equations as follows:

$$Y = \beta_0 + \beta_t + U_i$$

Where,

Y = Monthly volumes / price

t = Time period

U_i = Random errors

From this equation, the linear growth rate was derived using the following formula;

$$\text{Linear growth rate (LGR)} = \frac{\beta_t}{y} \times 100$$

Where,

b = Regression coefficient

\bar{Y} = Arithmetic mean

- **Seasonality** was evaluated through the seasonal indices which were worked out using ratio to moving average decomposition method [15]. Seasonality in prices and market arrivals was estimated as below.

$$Si = \left[\frac{(Ih - Il)}{Il} \right] * 100$$

Where,

Ih = highest value of seasonal index,

Il = lowest value of seasonal index

- **Lag-linear model** was used to analyse the nature of relationship between market arrivals and prices of roots and tubers [8, 15]. The model used was as below.

$$P_t = f(P_{t-1}, Y_t)$$

Where,

P_t = current price,

P_{t-1} = lagged price; and

Y_t = current arrivals of selected vegetables markets

To explain the seasonal relationship between market volume and prices of the selected roots and tubers, data from NAMDEVCO within a ten years span of monthly data, from 2005 to 2015 were subjected to multiple regression analysis. This is used when lagged values of the dependent variable among its explanatory variables. This model is illustrated in the following formula:

$$P_t = \beta_0 + \beta_1 P_{t-1} + \beta_2 Y_t + \epsilon_t$$

Where,

P_t = Price of roots and tubers (TTD) in (t)th month;

P_{t-1} = Price of roots and tubers (TTD) in (t-1)th month

Y_t = Current market volume of vegetable; and

ε_t = Random term

- **Karl Pearson correlation coefficient** was calculated to estimate the degree of the relationship between market arrivals and prices. This is a measure of the linear correlation between two variables, X_i (market volume) and Y (current price), giving a value between +1 and -1 inclusive, where 1 is total positive correlation, 0 is no correlation, and -1 is total negative correlation.

Results and discussion

Trends in volumes and prices of root crops

The trend and pattern of market arrival volumes and prices of selected root crops in Trinidad and Tobago were examined through linear growth analysis and the results are presented in Table 1. Initial analysis indicated that the general trend of market volumes of the selected root crops were negatively monotonous in nature, showing a relatively high negative beta, and thus, indicating that the market volumes decreased over time, which could be result of the changing dietary habits of the population.

Table 1: Trends in volumes and prices of root crops traded at the NWM

Name of crops	Trend for	Constant	Coefficient	R ²	Linear growth rate
Carrots	Volumes	123362.00 (6753.837)	-33.478 (96.878)	0.001	-0.028
	Prices	7.32 (0.302)	0.013 (0.004)	0.074	0.164
Cassava	Volumes	60914.00 (3132.704)	-153.380 (44.936)	0.090	-0.297
	Prices	3.36 (0.273)	0.032 (0.004)	0.361	0.605
Common yam	Volumes	8789.60 (825.027)	-42.165 (11.834)	0.097	-0.676
	Prices	2.80 (0.234)	0.052 (0.003)	0.674	0.877
Dasheen local	Volumes	21010.00 (2722.055)	-8.131 (39.046)	0.000	-0.040
	Prices	5.54 (0.510)	0.063 (0.007)	0.383	0.671
Dasheen imported	Volume	24013.00 (5195.086)	643.000 (74.519)	0.387	1.022
	Prices	7.01 (0.521)	0.027 (0.007)	0.098	0.728
Eddoes local	Volumes	15099.00 (1562.912)	-109.100 (22.419)	0.167	-1.220
	Prices	6.33 (0.825)	0.068 (0.012)	0.220	0.653
Eddoes imported	Volume	20393.00 (4735.185)	510.550 (67.922)	0.324	0.996
	Prices	9.90 (0.68)	0.035 (0.010)	0.097	0.290
Sweet potato local	Volume	45323.00 (7218.214)	993.140 (103.539)	0.438	0.942
	Prices	5.35 (0.473)	0.024 (0.007)	0.094	0.271
Sweet potato imported	Volume	27109.00 (3147.002)	44.834 (45.141)	0.008	0.150
	Prices	7.83 (0.507)	0.015 (0.007)	0.035	0.172
Ginger	Volume	18576.00 (2544.077)	235.520 (36.492)	0.261	0.717
	Prices	11.27 (2.149)	0.158 (0.031)	0.182	0.759

Figures in parentheses indicate Standard Errors

The trend analysis showed that locally produced sweet potatoes had the highest increase in market volumes (993), followed by imported dasheen (643.140) and eddoes (510.550), and locally produced ginger (235.520). Contrastingly, the market volume arrivals of cassava decreased substantially (-153.380), followed by local eddoes (-109.100) and common yam (-42.165). The price behavior analysis indicated that the price of ginger increased notably (TT\$0.158/kg), followed by local eddoes (TT\$0.0683/kg) and local dasheen (TT\$0.0626/kg). As expected, price of none of the root crops decreased over years. Linear growth rate analysis showed that the volume of imported dasheen traded at NAMDECO markets increased annually at a rate of 1.02%, while the volume of local eddoes traded decreased at a rate of -1.220%. It is imperative to note that the volume brought and traded of carrots, cassava, common yam, local dasheen and eddoes in NAMDEVCO markets were decreasing over years. The new regional, local and farmers markets established over the past decade could have been the reason for this declining attitude of arrivals. Apparently, the prices of all root crops were increased over years. The price of common yam

escalated at a highest annual rate of 0.877%, while the price of carrots increased at the lowest 0.164%.

Pattern analysis

The pattern of market arrivals and price behaviour of the selected root crops over the period 2006-2015 was examined using the mean value and the coefficient of variation for each of the twelve months (Table 2). Carrot had the lowest coefficient of variation (CV) in volume arrival (30.18), followed cassava (34.47), ginger (48.86), local sweet potatoes (49.52), imported dasheen (57.16), imported sweet potatoes (57.44), imported eddoes (60.86) local dasheen (71.92), common yam (75.44) and local eddoes (109.22). Lesser the CV indicated that the arrival of respective crop was more or less stable over years, while the larger showed their arrival fluctuated widely. Similarly, the CV of prices was less in carrots (20.91), followed by imported sweet potatoes (32.00), imported eddoes (32.39), imported dasheen (34.44), cassava (35.01), common yam (37.18), local dasheen (37.72), local sweet potatoes (39.65), local eddoes (48.40) and ginger (61.84).

Table 2: Measures of variation in prices and volumes of root crops traded at the NWM

Name of Commodity	Volumes				Prices			
	Min.	Max.	Mean	CV	Min.	Max.	Mean	CV
Carrot	31116.96	240340.00	123874.50	30.18	5.45	12.57	8.13	20.91
Cassava	14949.32	121606.20	52537.78	34.47	3.27	9.99	5.29	35.01
Common Yam	72.00	27608.04	6099.27	75.44	2.96	13.16	5.98	37.18
Dasheen (Loc.)	162.72	70224.57	21960.53	71.92	4.55	17.57	9.33	37.72
Dasheen (Imp.)	2709.00	172443.20	66813.77	57.16	4.42	17.64	8.63	34.44
Eddoes (Local)	0.00	55534.01	8545.45	109.22	4.24	31.02	10.46	48.40
Eddoes (Imp.)	2393.28	147691.10	53863.56	60.86	5.97	22.81	12.00	32.39
Sweet Potatoes (Loc.)	13752.00	222546.70	110850.00	49.52	2.38	15.57	6.79	39.65
Sweet Potatoes (Imp.)	2655.00	94796.90	30153.59	57.44	4.11	16.86	8.74	32.00
Ginger	1228.35	92904.35	33933.61	48.86	8.29	70.79	20.83	61.84

Seasonality in volumes and prices of root crops

There were fluctuations in all the root crops traded in the NAMDEVCO West market. The study found that seasonal fluctuations existed in market arrivals of roots and tubers (Table 3). The results showed that local sweet potatoes had

the lowest seasonal volume arrival index of 9.10%, followed by cassava (12.04%), carrots (15.86%), imported sweet potatoes (28.58%), imported dasheen (36.34%), ginger (37.78%), imported eddoes (53.34%), common yam (54.51%), local eddoes (68.14%) and local dasheen (82.16%)

Table 3: Seasonal Indices of volumes roots and tubers traded at the NWM

Month	Roots and tubers - Volume									
	Carrots	Cassava	Common Yam	Ginger	Dasheen (Loc.)	Dasheen (Imp.)	Eddoes (Loc.)	Eddoes (Imp.)	Sweet Potatoes (Loc.)	Sweet Potatoes (Imp.)
January	1.01	0.88	1.38	1.34	0.77	1.36	1.17	1.18	1.07	0.97
February	0.85	0.94	1.22	1.08	0.83	1.04	1.30	0.94	0.93	1.01
March	1.01	1.12	1.41	1.16	1.43	1.10	0.66	0.93	0.98	1.24
April	0.93	1.06	1.55	0.93	1.82	0.87	0.52	0.84	0.92	1.29
May	0.95	0.96	1.47	0.77	1.32	0.78	0.59	0.74	0.95	1.05
June	0.97	1.04	1.26	0.79	1.32	0.75	0.32	0.66	0.96	1.05
July	1.05	1.07	0.86	0.58	0.95	0.82	0.86	0.63	1.05	0.86
August	0.98	1.00	0.40	0.72	0.61	0.85	0.97	0.90	0.94	0.93
September	0.94	1.08	0.18	0.90	0.67	0.99	1.29	1.28	1.09	0.90
October	1.10	0.92	0.36	1.17	0.61	1.18	1.47	1.53	1.04	0.87
November	1.16	0.99	0.68	1.38	0.87	1.16	1.68	1.41	1.08	0.91
December	1.04	0.94	1.24	1.19	0.80	1.11	1.17	0.96	0.99	0.92
Seasonality %	15.86	12.04	54.51	37.78	82.16	36.34	68.14	53.34	9.10	28.58

Similarly, there existed seasonal fluctuations in the prices of roots and tubers (Table 4). The results showed that cassava had the lowest seasonal price of 3.30%, followed by imported

sweet potatoes (11.64), local dasheen (12.81), carrots (13.11), imported dasheen (15.64), common yam (29.77), imported eddoes (38.67), ginger (44.93) and local eddoes (60.58).

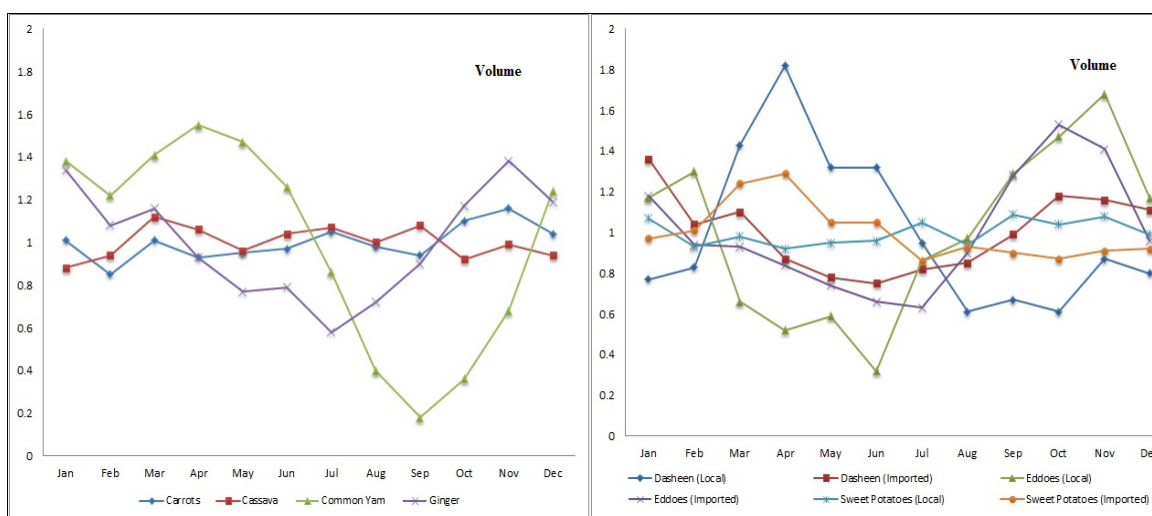
Table 4: Seasonal Indices of prices of roots and tubers traded at the NWM

Month	Roots and tubers - Price									
	Carrots	Cassava	Common Yam	Ginger	Dasheen (Loc.)	Dasheen (Imp.)	Eddoes (Loc.)	Eddoes (Imp.)	Sweet Potatoes (Loc.)	Sweet Potatoes (Imp.)
January	0.95	1.03	0.92	0.89	1.08	1.02	0.83	0.88	0.93	0.96
February	1.01	1.01	0.84	0.69	0.97	0.87	0.81	0.83	0.91	0.91
March	1.01	0.98	0.88	0.71	0.89	0.84	0.83	0.92	1.01	0.96
April	1.05	0.99	0.91	0.75	0.87	0.91	0.96	1.04	1.06	0.99
May	1.03	0.99	0.87	0.86	0.90	1.09	1.10	1.17	1.10	1.12
June	0.92	1.00	0.91	1.04	0.96	1.05	1.39	1.31	1.10	0.96
July	1.01	1.01	1.02	1.45	1.01	1.16	1.61	1.39	1.14	1.09
August	1.13	0.99	1.02	1.40	1.00	1.12	1.19	1.21	1.13	1.09
September	1.12	0.98	1.16	1.33	1.08	1.10	1.06	1.04	0.94	1.10
October	0.94	1.00	1.30	1.03	1.08	0.97	0.80	0.77	0.88	0.98
November	0.88	1.02	1.16	0.92	1.13	0.97	0.72	0.70	0.91	0.94
December	0.95	1.01	1.02	0.92	1.04	0.92	0.71	0.74	0.90	0.91
Seasonality %	13.11	3.30	29.77	44.93	12.81	15.64	60.58	38.67	14.00	11.64

Volumes

The volume seasonal index of local dasheen was falling below the average during the months from August to January, while indices of both local and imported eddoes were raising

above the average during the same period (Fig. 1). Dasheen index reached a maximum of 82% above its average in April, while local eddoes peaked at 68% in November and imported eddoes (53%) in October.



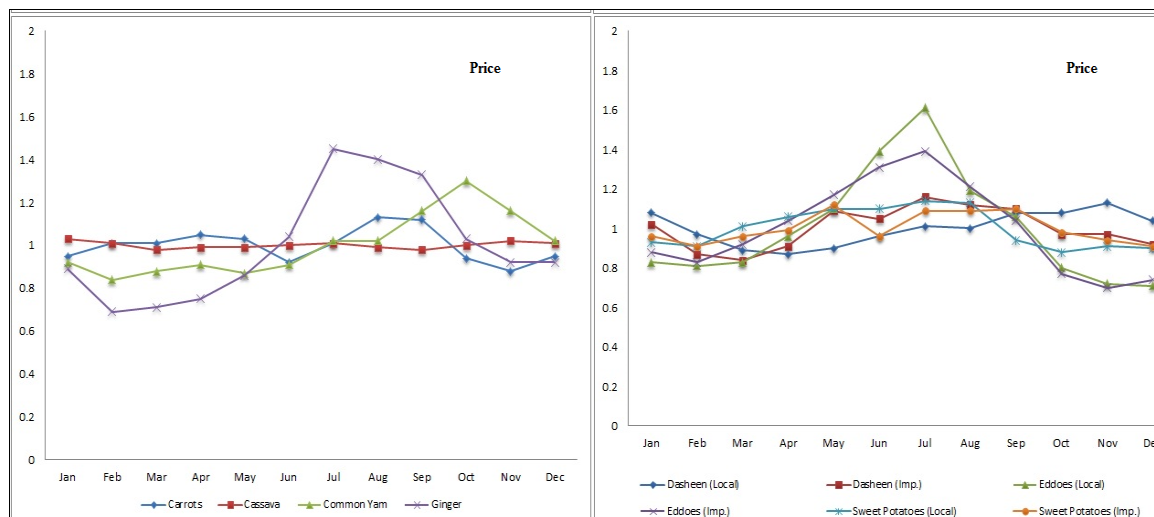


Fig 1: Seasonal indices of volumes of arrivals and prices

Prices

The price index of ginger was above average from July to September and eddoes (both imported and local) during the months from May to September. The prices of roots and tubers peaked in July with local eddoes reaching 61% more than average followed by ginger (45%) and imported eddoes (39%).

Relationship between root crop prices and traded volumes

In order to understand the relationship that existed between market arrival volumes and price, regression equations were estimated (Table 5). The seasonal relationship between the market volume, current market price and lagged market price (t-1) of the selected roots and tubers were based on monthly data for a period of ten years (2005-2015). A multiple

regression model was used to analyze the relationship between current price, lagged price and the market arrival of roots and tubers. Overall, the regression analysis showed that the lagged price for each roots and tubers had a positive and significant relationship with current prices, and negative, but mostly significant with market arrivals. The results connote that the lagged price of all the roots and tubers explained higher variations when compared to current market volumes, thus indicating that the lagged price of the selected roots and tubers is an important factor in determining the current price than the market arrivals. For example, as could be seen from Table 5, that cassava had the largest R² (0.977), indicating that 97.70% of the variations in current prices of cassava were explained by lag price and volume of cassava.

Table 5: Relationship between prices and traded volumes of root crops in the NWM

Name of commodity	Constant	Lag price		Volume		R ²
		Coefficient	P-value	Coefficient	P-value	
Carrots	6.144	0.418	0.000	-1.153E ⁻⁰⁰⁵	0.003	0.074
Cassava	0.464	0.965	0.000	-5.08E ⁻⁰⁶	0.003	0.977
Common Yam	1.075	0.888	0.000	-5.58E ⁻⁰⁶	0.003	0.846
Dasheen (loc.)	1.177	0.909	0.000	-1.363E ⁻⁰⁰⁵	0.142	0.864
Dasheen (Imp.)	2.088	-1.03E ⁻⁰⁵	0.013	0.836	0	0.723
Eddoes (Loc.)	4.217	0	0.003	0.684	0	0.550
Eddoes (Imp.)	4.910	0.743	0.000	-3.492E ⁻⁰⁰⁵	0.000	0.660
Sweet Potatoes (Loc.)	1.749	0.812	0.000	-4.51E ⁻⁰⁶	0.110	0.668
Sweet Potatoes (Imp.)	2.615	0.773	0.000	-2.095E ⁻⁰⁰⁵	0.025	0.639
Ginger	8.021	0.847	0.000	0	0	0.771

The relationship between price and volume were inverse with the exception of imported dasheen ($\beta=0.836$, p-value<1%) and local eddoes ($\beta=0.684$, p-value<1%). Imported dasheen lag price also showed an inverse relationship with current price with its coefficient value of -1.03E⁻⁰⁵. Therefore as the lagged price increases the current price would decrease. All the other root crops which were significant had positive coefficients with Cassava's lag price having the greatest influence on current price ($\beta=0.965$, p-value<1%). This meant that for every TT\$1 increase in the lagged price current price would increase by 96 cents. It should be noted that all the linear relationships with the exception of carrots had R² values greater than 50% which meant that more than 50% of the current prices were explained by the current volume and the lagged price.

Conclusion

The trend analysis indicated that the general trend of market volumes of the selected root crops were negatively monotonous in nature, showing a relatively high negative beta, and thus, indicating that the market volumes decreased over time, which could be result of the changing dietary habits of the population. The analysis also showed that locally produced sweet potatoes had the highest increase in market volumes, followed by imported dasheen and eddoes, and locally produced ginger. Contrastingly, the market volume arrivals of cassava decreased substantially, followed by local eddoes and common yam. The price behavior analysis indicated that the price of ginger increased notably, followed by local eddoes and local dasheen, while price of none of the root crops decreased over years. Carrot had the lowest

coefficient of variation (CV) both in volume arrival and price, indicating that their arrival and prices are less fluctuating over a period of time. Local sweet potatoes had the lowest seasonal volume arrival index of 9.10%, while cassava had the lowest seasonal price index of 3.30%. The volume seasonal index of local dasheen was falling below the average during the months from August to January, while indices of both local and imported eddoes were rising above the average during the same period. The prices of roots and tubers peaked in July with local eddoes reaching 61% more than average followed by ginger (45%) and imported eddoes (39%). There existed inverse relationship between price and volume arrival of roots and tubers, with the exception of imported dasheen and local eddoes. The results indicated that Government should focus some attention to improve the current market information system to become more efficient and effective, whereby making the information easier to access, disseminate more up to date and timely market information on the regular basis so as to make proper production and marketing decisions.

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