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Temporal Price Analysis of Wheat, Faba bean Dates and Garlic Crops in the Northern State, Sudan

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ABSTRACT: This study conducts temporal price analysis of wheat, faba bean, dates and garlic crops prices to identify seasonal price patterns and their expected changes over time as compared to storage costs. The analytical approach in this study was based on the so-called "classical model". The study based preliminary on the secondary data collected from Dongola wholesaler market during period 2000-2009. The study found that seasonal prices spread increased about 25% from index low to the high on average for wheat, about 21% for faba bean, 18% for dates and 63% for garlic, while the annual interest rate of the year 2009 was 10%. Thus farmers or traders who usually perform storage activity during the harvest to post harvest period will gain excess profit if they buy on the seasonal low price and sell on the seasonal high price and if they could secure storage loans. The large price differences were caused by poor market information and infrastructure, so the improvement of such fields is highly recommended.

KEYWORDS*: Price Analysis; Classical Model; Market Information; Storage.*

INTRODUCTION

The Northern State with an area of 83.20 million feddans is administratively divided into four localities; Halfa, Dongola, Al-Debba and Merawe, each with a number of administrative units. Irrigated agriculture from the River Nile and/or underground water is the main economic activity. The total currently cultivated area in the State is estimated at 476091 feddans, 75% of which is cultivated in winter. Wheat and faba bean cultivated area are about 37% and 25% on the average of the total winter cultivated area in the State, respectively. About 3.83%, 4.10% and 2.58% out of the total cultivated area in the State are grown by different types of spices (fennel, garlic and fenugreek), vegetables and fodder crops respectively. The total perennials crops area in the State is estimated at 49 295 feddans, 74% of which is occupied by date palm (1).

The marketing of the agricultural crops in the State are organized by the private sector. Farmers usually store their products in sacks and sell their commodities directly to the consumers, or through local traders and retailers. This research aims to reduce price differences between seasons by product storage. Storage is encouraged when price differences are greater than storage costs. This could be done through studying the pattern of price variations, price trends, monthly seasonal indices and their deviations, and determining efficiency of the marketing system. The specific objective was to conduct temporal price analysis of wheat, faba bean, dates and garlic crops to identify seasonal price patterns and their expected changes over time.

METHODOLOGY

Data sources and data collection

Data from Dongola wholesaler market (2000-2009) was collected to realize the above objectives. Wheat was selected to represent nutrient crop, faba bean to represent cash crop, dates to represent horticultural crops and garlic gives an example of spices (because of the reliability of its record).

Methods of data Analysis

The analytical approach in this study was based on the so-called "classical model". According to Wayne and James[3] the classical approach to time series analysis begins with the premise that a typical time-series has the following four components i) long-term trend: is the general behavior of a given variable over a long period of time, ii) seasonal variation: refers to variation of a periodic nature, iii) cyclical variation: refers to those up-and-down fluctuations that are observable over extended periods of time and iv) erratic variation: is that variation not accounted for by trend, cycle, or seasonal factors (irregular component).

John and Arthur[4] stated that the most widely used model for time series decomposition is the multiplicative model. The equation below was used to formulate the multiplicative model:

$$Y = T \times C \times S \times I \quad (1)$$

where

Y = Actual value of the variable of interest (price in this case), T = trend component, C = cyclical component, S = seasonal component and I = irregular component

Trend was calculated using the constant and the trend coefficient resulting from the regression equation:

$$Ti = a + bti \quad (2)$$

where Ti = trend value during period i, a = the constant estimated by the regression, and b = the trend coefficient,

and ti = the value of the variable during period i. The seasonal price movements on the other hand, which usually result from fluctuations in supply, demand or both were estimated by a seasonal price index by calculating a centered moving average (CMA) using the formula:

$$CMAt = \sum_{i=t-(n/2)-1/2} Pi/n \quad (3)$$

For CMA^{12} i.e. CMA over 12 months the specific formula is

$$CMAt^{12} = [\sum_{i=t-6}^{i=t-5} Pi + \sum_{i=t-6}^{i=t-5} Pi]/24 \quad (4)$$

A moving average is an artificially constructed time series in which the value for a given time period is replaced by the mean of that value and the values for some number of preceding and succeeding time periods. Consequently, the CMAn eliminates random variations and systematic movements of a duration equal to n. The CMA^{12} thus eliminates seasonality and randomness (Wayne and James, 1989). In terms of equation 1

$$CMA^{12} = TCi \quad (5)$$

The CMA^{12} thus represents the trend and cyclical components of the original series, and eliminates seasonality and randomness. The formula for the seasonal index can then be written as

$$SIi = (TCSEi/TCI) = SEi = (Pi / CMAi^{12}) * 100 \quad (6)$$

The SI is already deflated since it is a result of dividing a nominal series (the original price) by another nominal series (CMA^{12}).

The cyclical index (CI) of a time-series can be calculated as follows:

$$CIi = TCi/Ti = Ci = CMAi/Ti \quad (7)$$

The grand seasonal index (GSI) is useful to summarize the typical seasonal behavior of a time series. It is calculated by obtaining the average seasonal index for each month of a given year then adjusting this 12-figure series in such a way that it adds up to 1200. Specifically:

$$GSIi = SIi * 1200/\sum Sli \quad (8)$$

Where, SIi = the average seasonal index for month i

It is an average of the seasonal indices that removes all random movements of the time series. Consequently, the GSI represents the pure seasonal average of the series during the period under analysis.

RESULTS and DISCUSION

Table 1 summarizes the preliminary analysis of monthly nominal prices of wheat, faba bean, dates (Barakawi variety) and garlic during 2000-2009. The results showed that the years of highest wheat price fluctuations were 2000, 2003, 2006 and 2007 but the year 2004 had lowest price fluctuations. In concern of faba bean the years 2000, 2001, 2006 and 2007 represented the highest gap of price fluctuations, while in the year 2005 the price fluctuations reached its minimum level. The years 2000 and 2003 and from 2006 to 2009 had highest dates price fluctuations, leaving year 2005 with the minimum price variations. Lowest garlic price variations were in 2003, 2004, 2005, 2007 and 2008 while 2000, 2001, 2002 and 2009 were the years of highest price fluctuations. In addition to that garlic had a big price fluctuations in comparison to the three other crops. This is due to the level of storable crop. Yearly price variability results from changes in supply, demand and poor market infrastructure and information. The supply available in any year is based mainly on current production and carryover of the crops from the previous year and also from the supply of import competing crops. The variation in the production is attributed mainly to the variation in yields and cropped areas (Limia 1994)

Table 1. Preliminary analysis of monthly nominal prices of wheat, faba bean, dates and garlic in Dongola *(2000-2009)*

Year	Fluctuation (%)	**Wheat** Month(s) of lowest price	Month(s) of highest price
2000	40	April	January
2001	50	June	March
2002	44	June	March
2003	45	June	February
2004	16	April to June	Nov. – Dec.
2005	31	April	March
2006	50	Dec.	Jan.-March
2007	46	May	Dec.
2008	40	April	August
2009	38	Jun.Sep.Nov.	February

Year	Fluctuation (%)	**Faba bean** Month(s) of lowest price	Month(s) of highest price
2000	77	April	Feb.
2001	114	Dec.	Jan.
2002	32	Mar.	Jan.
2003	45	Feb.	July
2004	51	June	Jan.
2005	23	Feb.	Jan.
2006	80	Jan.	Sep.
2007	79	Dec.	Jan.
2008	65	May	Dec.
2009	36	Mar.	Sep.

Year	Dates		
	Fluctuation (%)	Month(s) of lowest price	Month(s)of highest price
2000	71	Feb.	July
2001	47	Sep.	May
2002	41	Sep.	May
2003	67	July	Nov.
2004	41	Mar.	Nov.
2005	31	Nov. Dec.	May
2006	67	Dec.	Jan.Sep.
2007	88	Dec.	Nov.
2008	90	Oct.	June
2009	25	Jan.Mar.June	Dec.

Year	Garlic		
	Fluctuation (%)	Month(s) of lowest price	Month(s) of highest price
2000	423	Sep.	Mar.
2001	302	Jan.	Dec.
2002	203	Feb.	Dec.
2003	150	Feb.	Nov.
2004	193	May	Dec.
2005	194	Apr.	Jan. Dec.
2006	158	May	Oct.
2007	125	Apr.Dec.	Feb.
2008	142	Apr.Nov.	Jan.
2009	404	Feb.Mar.	Aug.

Table 2 shows temporal price analysis for wheat as an example to the crops investigated in this study for the period 2000 – 2009. It should be noted that there are no values of the CMA^{12} and seasonal index for the first and last six months of the period under analysis. This is due to the formulae used to compute these series. The trend and cyclical indices for all crops are positives.

Table 2. Temporal analysis for wheat prices during 2000-2009

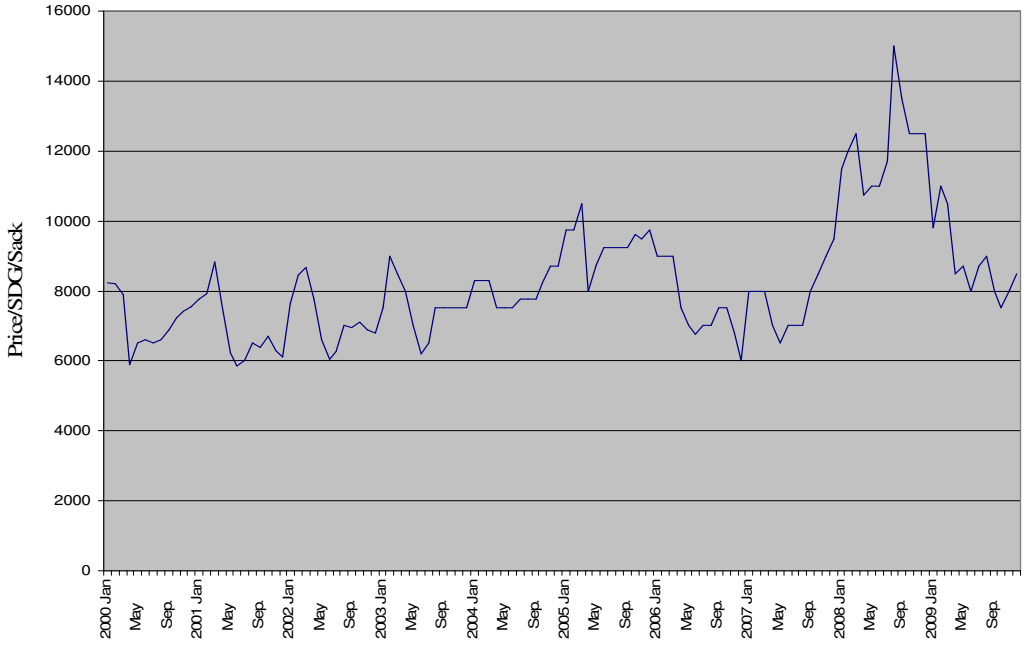
	Wheat price SDG*/sack**	CMA12	SI	Trend	C
2000 Jan	82.50			65.41	.
Feb.	82.00		.	65.42	.
Mar.	79.00			65.42	.
Apr.	59.00		.	65.43	.
May	65.00	.	.	65.44	.
Jun.	66.00	.	.	65.44	.
Jul.	65.00	71.09	.91	65.45	1.09
Aug.	66.00	70.78	.93	65.45	1.08
Sep.	69.00	71.05	.97	65.46	1.09
Oct.	72.43	72.11	1.00	65.46	1.10
Nov.	74.33	72.66	1.02	65.47	1.11
Dec.	75.31	72.23	1.04	65.48	1.10
2001 Jan	77.62	71.72	1.08	65.48	1.10
Feb.	79.37	71.47	1.11	65.49	1.09
Mar.	88.26	71.22	1.24	65.49	1.09
Apr.	75.00	70.79	1.06	65.50	1.08
May	62.21	70.09	.89	65.50	1.07
Jun.	58.67	69.03	.85	65.51	1.05
Jul.	60.00	68.37	.88	65.51	1.04
Aug.	65.00	68.54	.95	65.52	1.05
Sep.	64.00	68.69	.93	65.53	1.05
Oct.	67.08	68.73	.98	65.53	1.05
Nov.	63.00	69.00	.91	65.54	1.05
Dec.	61.00	69.23	.88	65.54	1.06
2002 Jan	76.31	69.40	1.10	65.55	1.06
Feb.	84.68	69.72	1.21	65.55	1.06
Mar.	86.63	70.15	1.23	65.56	1.07
Apr.	77.50	70.55	1.10	65.57	1.08
May	66.11	70.96	.93	65.57	1.08
Jun.	60.34	71.50	.84	65.58	1.09
Jul.	62.50	71.74	.87	65.58	1.09
Aug.	70.00	71.91	.97	65.59	1.10
Sep.	69.50	72.06	.96	65.59	1.10
Oct.	71.04	72.10	.99	65.60	1.10
Nov.	69.00	72.36	.95	65.60	1.10
Dec.	68.00	72.60	.94	65.61	1.11
2003 Jan	75.00	72.77	1.03	65.62	1.11

Feb.	90.00	73.08	1.23	65.62	1.11
Mar.	85.00	73.52	1.16	65.63	1.12
Apr.	80.00	73.91	1.08	65.63	1.13
May	70.00	74.33	.94	65.64	1.13
Jun.	62.00	74.87	.83	65.64	1.14
Jul.	65.00	75.50	.86	65.65	1.15
Aug.	75.00	75.54	.99	65.66	1.15
Sep.	75.00	75.16	1.00	65.66	1.14
Oct.	75.00	74.87	1.00	65.67	1.14
Nov.	75.00	74.87	1.00	65.67	1.14
Dec.	75.00	75.62	.99	65.68	1.15
2004 Jan	83.00	76.68	1.08	65.68	1.17
Feb.	83.00	77.31	1.07	65.69	1.18
Mar.	83.00	77.52	1.07	65.69	1.18
Apr.	75.00	77.93	.96	65.70	1.19
May	75.00	78.75	.95	65.71	1.20
Jun.	75.00	79.75	.94	65.71	1.21
Jul.	77.50	80.85	.96	65.72	1.23
Aug.	77.50	82.06	.94	65.72	1.25
Sep.	77.50	83.58	.93	65.73	1.27
Oct.	82.50	84.70	.97	65.73	1.29
Nov.	87.00	85.43	1.02	65.74	1.30
Dec.	87.00	86.68	1.00	65.75	1.32
2005 Jan	97.50	88.04	1.11	65.75	1.34
Feb.	97.50	89.29	1.09	65.76	1.36
Mar.	105.00	90.54	1.16	65.76	1.38
Apr.	80.00	91.72	.87	65.77	1.39
May	87.50	92.62	.94	65.77	1.41
Jun.	92.50	93.39	.99	65.78	1.42
Jul.	92.50	93.52	.99	65.78	1.42
Aug.	92.50	92.89	1.00	65.79	1.41
Sep.	92.50	91.95	1.01	65.80	1.40
Oct.	96.00	91.12	1.05	65.80	1.38
Nov.	95.00	90.18	1.05	65.81	1.37
Dec.	97.50	88.41	1.10	65.81	1.34
2006 Jan	90.00	86.43	1.04	65.82	1.31
Feb.	90.00	84.56	1.06	65.82	1.28
Mar.	90.00	82.89	1.09	65.83	1.26
Apr.	75.00	81.29	.92	65.84	1.23
May	70.00	79.29	.88	65.84	1.20
Jun.	67.50	76.60	.88	65.85	1.16
Jul.	70.00	74.62	.94	65.85	1.13
Aug.	70.00	73.79	.95	65.86	1.12
Sep.	75.00	72.95	1.03	65.86	1.11
Oct.	75.00	72.33	1.04	65.87	1.10
Nov.	68.00	71.91	.95	65.87	1.09
Dec.	60.00	71.81	.84	65.88	1.09
2007 Jan	80.00	71.91	1.11	65.89	1.09
Feb.	80.00	71.91	1.11	65.89	1.09
Mar.	80.00	72.12	1.11	65.90	1.09
Apr.	70.00	72.75	.96	65.90	1.10
May	65.00	74.08	.88	65.91	1.12
Jun.	70.00	76.45	.92	65.91	1.16
Jul.	70.00	79.37	.88	65.92	1.20
Aug.	70.00	82.50	.85	65.93	1.25
Sep.	80.00	86.04	.93	65.93	1.30
Oct.	85.00	89.47	.95	65.94	1.36
Nov.	90.00	92.91	.97	65.94	1.41
Dec.	95.00	96.45	.98	65.95	1.46
2008 Jan	115.00	100.08	1.15	65.95	1.52
Feb.	120.00	105.37	1.14	65.96	1.60
Mar.	125.00	111.00	1.13	65.96	1.68
Apr.	107.50	114.95	.94	65.97	1.74
May	110.00	118.08	.93	65.98	1.79
Jun.	110.00	120.79	.91	65.98	1.83
Jul.	117.00	121.33	.96	65.99	1.84
Aug.	150.00	120.20	1.25	65.99	1.82
Sep.	135.00	118.95	1.13	66.00	1.80
Oct.	125.00	117.18	1.07	66.00	1.78
Nov.	125.00	115.29	1.08	66.01	1.75
Dec.	125.00	113.08	1.11	66.02	1.71
2009 Jan	98.00	110.58	.89	66.02	1.67
Feb.	11.000	106.83	1.03	66.03	1.62
Mar.	10.500	102.04	1.03	66.03	1.55
Apr.	85.00	97.66	.87	66.04	1.48
May	87.00	93.70	.93	66.04	1.42
Jun.	80.00	90.16	.89	66.05	1.37
Jul.	87.00	.	.	66.05	.
Aug.	90.00	.	.	66.06	.
Sep.	80.00	.	.	66.07	.
Oct.	75.00	.	.	66.07	.
Nov.	80.00	.	.	66.08	.
Dec.	85.00	.	.	66.08	.

*SDG=Sudanese Ginieh (Pound)=0.40 US$

**Sack=95kilogram

Figure 1 shows some components of the price series, viz; price trend and the seasonal index taking wheat as an example. It is obvious that prices of wheat, faba bean, dates and garlic fluctuate monthly and year after year, and, in general, follow a common seasonal pattern. Theoretically, prices decrease to low levels immediately after harvest and rise thereafter until the next harvest, as farmers and merchants store some supplies to meet the continuous demand. The trend for all crops was an increase over time but with the different level depending on demand and supply of the crop, supply of competing imported crops and the responsiveness of the crop to market prices. The prices of faba bean tended to increase by higher rate compared to the other crops (the slope of the faba bean trend was 0.71), followed by dates (the slope of the dates trend was 0.63), then wheat prices which tend to increase by 0.56 rate and finally garlic which had the lowest increasing rate of about 0.51.


Price/SDG/Sack
16000
14000
12000
10000
8000
6000
4000
2000
0
2000 Jan
May
Sep.
2001 Jan
May
Sep.
2002 Jan
May
Sep.
2003 Jan
May
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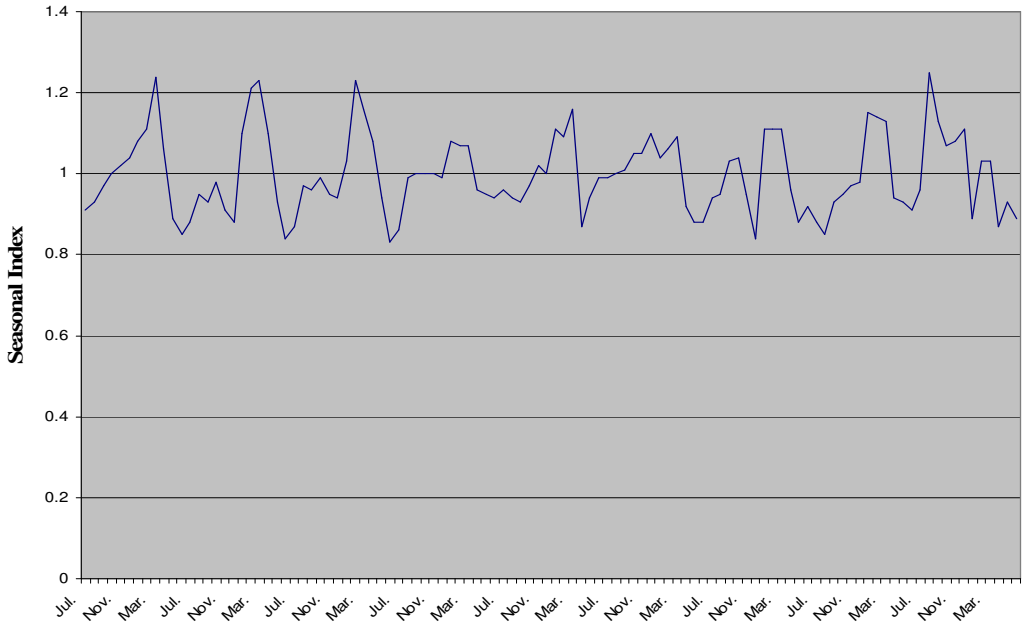
Seasonal Index
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1.2
1
0.8
0.6
0.4
0.2
0
Jul.
Nov.
Mar.

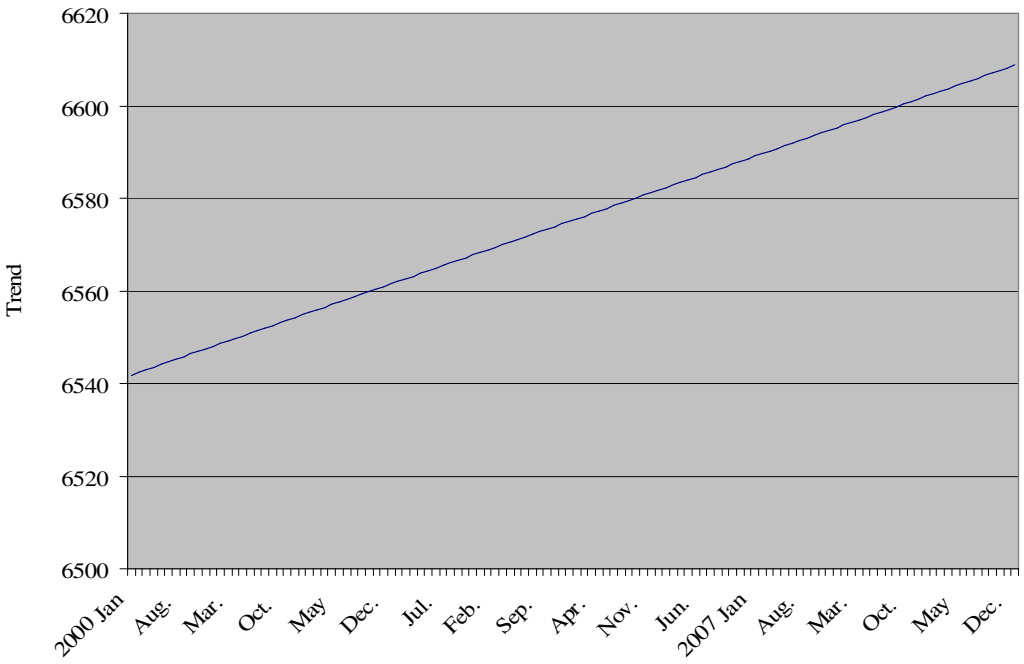


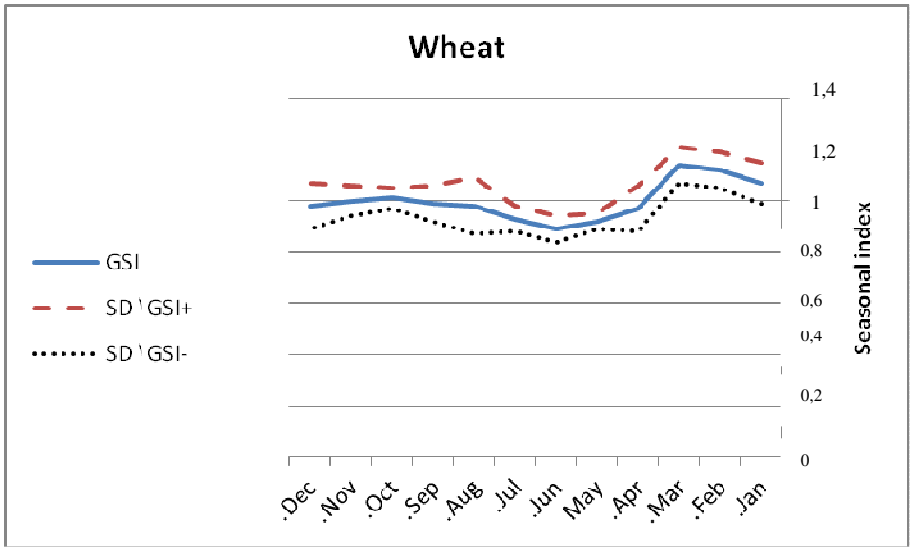
Figure 1. Nominal prices, trend and seasonal index for wheat

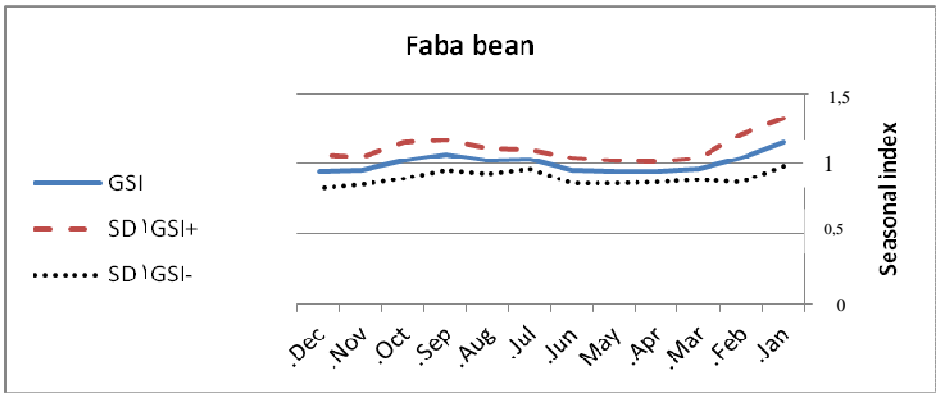
Table 3 reveals the analysis of seasonal indices for wheat. Seasonal price analysis tests the effectiveness of market arbitrage over time. Standard deviations on monthly indices reveal the stability of the seasonal price pattern and measure their variability i.e. indicate the usual level of uncertainty for a given month[6]. For all crops, in general, the standard deviations were lowest when the market's uncertainty was at its minimum level-i.e. just after harvest. And when the information of the market's conditions is readily unavailable, the standard deviations were at their peak just before harvest, which showed great uncertainty compared to other months.

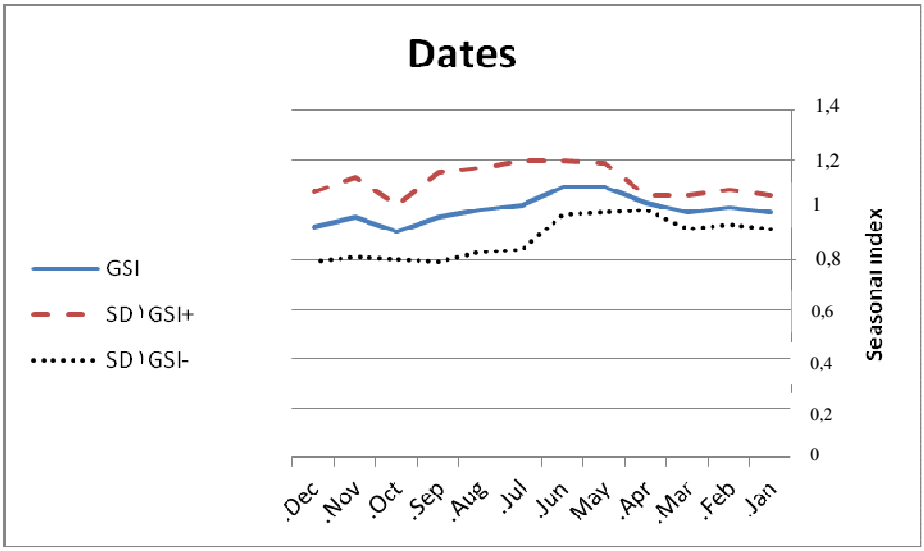
Table 3: Analysis of seasonal indices for wheat (2000-2009)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
2000	.	.	.	.	.	.	*.91*	*.93*	*.97*	*1.00*	*1.02*	*1.04*
2001	*1.08*	*1.11*	*1.24*	*1.06*	*.89*	*.85*	*.88*	*.95*	*.93*	*.98*	*.91*	*.88*
2002	*1.10*	*1.21*	*1.23*	*1.10*	*.93*	*.84*	*.87*	*.97*	*.96*	*.99*	*.95*	*.94*
2003	*1.03*	*1.23*	*1.16*	*1.08*	*.94*	*.83*	*.86*	*.99*	*1.00*	*1.00*	*1.00*	*.99*
2004	*1.08*	*1.07*	*1.07*	*.96*	*.95*	*.94*	*.96*	*.94*	*.93*	*.97*	*1.02*	*1.00*
2005	*1.11*	*1.09*	*1.16*	*.87*	*.94*	*.99*	*.99*	*1.00*	*1.01*	*1.05*	*1.05*	*1.10*
2006	*1.04*	*1.06*	*1.09*	*.92*	*.88*	*.88*	*.94*	*.95*	*1.03*	*1.04*	*.95*	*.84*
2007	*1.11*	*1.11*	*1.11*	*.96*	*.88*	*.92*	*.88*	*.85*	*.93*	*.95*	*.97*	*.98*
2008	*1.15*	*1.14*	*1.13*	*.94*	*.93*	*.91*	*.96*	*1.25*	*1.13*	*1.07*	*1.08*	*1.11*
2009	*.89*	*1.03*	*1.03*	*.87*	*.93*	*.89*	.	.	.	.	.	
Mean	*1.07*	*1.12*	*1.13*	*.97*	*.92*	*.89*	*.92*	*.98*	*.99*	*1.00*	*1.00*	*.99*
SD	.076	.067	.071	.087	.029	.052	.047	.110	.066	.039	.055	.092
Maximum	1.15	1.23	1.24	1.10	.95	.99	.99	1.25	1.13	1.07	1.08	1.11
Minimum	.89	1.03	1.03	.87	.88	.83	.86	.85	.93	.95	.91	.84

Figure 2 illustrates the average of the seasonal indices (GSI) for wheat, faba bean, dates and garlic. The lines over and under GSI indicate that fluctuations were erratic and unpredictable. The seasonal price indices for wheat were above average in January, February, March, April and October and exactly equal average in November and blow average in the rest of the year (Figure.2). The seasonal price index of wheat increased from a low of 0.89 in June (wheat is harvested in April) to a high of 1.14 in March just before the next harvest. For faba bean the seasonal indices are above average in July, August, September, October and January and February and below average in the rest of the year (Figure 2). The seasonal price index of faba bean increased from a low of 0.94 in April, May and December (Figure 2). Such a finding is not surprising because the demand for the crop increases during the period of sowing in October and decreases later (faba bean is harvested during February - March) to a high of 1.15 in January before the next harvest. For dates seasonal indices were above average in February and from April to July, equal average i.e. 1.00 in August and below average in the rest of the year (Figure. 2). The seasonal price index of date increased from a harvest low of 0.91 in October (date is harvested in August-September) to a high of 1.09 in May and June. While seasonal indices for garlic were above average during October to February and below average in the rest of the year (Figure. 2). The seasonal price index of garlic increased from a low of 0.67 in April to a high of 1.30 in November. Prices below average of the seasonal indices in the preharvesting period may be due to an increase in supply of the crop which was carried over from the previous year and from import competing crops.







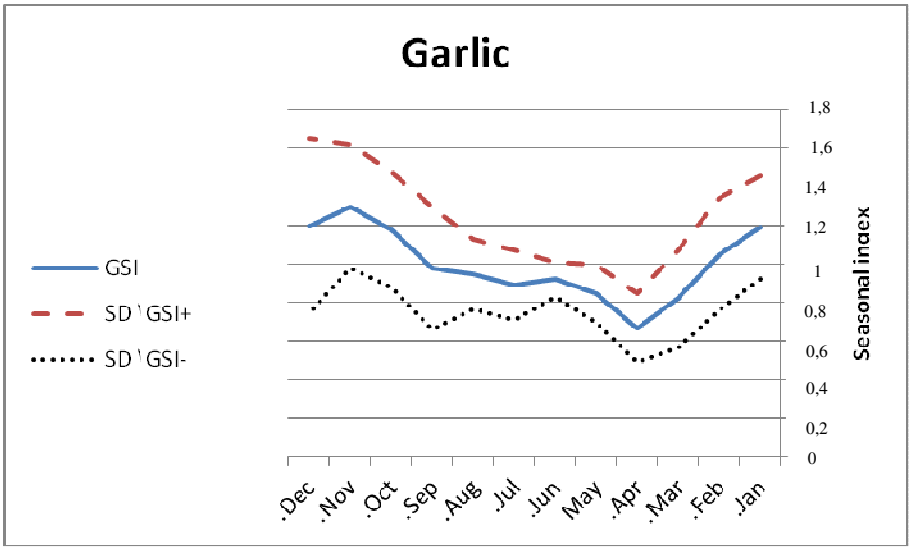


Figure 2. The GSI for wheat, faba bean, dates and garlic crops

CONCLUSION

Osman and Idris[7] stated that in a competitive market, the increase the increase in seasonal prices will equal the cost of storage (interest charges on capital invested in the stored commodity, costs of the storage facility, physical losses and normal profits). Seasonal prices spread increased about 25% from the index low to the high on average for wheat, about 21% for faba bean, 18% for date and 63% for garlic, while the annual interest rate of the year 2009 was 10%. Thus farmers or traders who usually perform storage activity during harvest to post harvest period will gain excess profits if they buy on the seasonal low and sell on the seasonal high and if they could secure storage loans.

Seasonal fluctuations in wheat, faba bean, dates, and garlic crops prices are likely to be harmful for both producers and consumers. Hence a basic objective of a policy maker is reasonable price stability. In addition, there is a need to invest in collecting and disseminating market information. Lack of market information adds to marketing costs and inefficiency.

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