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Analytical Study of the Factors Affecting Tomato Marketing in Khartoum State, Sudan

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Abstract

Tomato is one of the most popular and widely grown vegetables in Sudan. Khartoum State is considered as one of the main producing and consuming areas of tomato in Sudan.

The objective of this study is to analyze the different factors affecting tomato marketing in Khartoum State. The study used primary data of marketing pathways and prices of tomato. Data was collected through direct interviews with 15 trade-agents in Shambat and another 20 in Omdurman central markets. The study also used secondary data on tomato prices for a period of 15 years obtained from the Sudan Customs, and the Central Bureau of Statistics of the Ministry of Finance and National Economy.

The econometric analysis results indicated that the demand level for fresh tomato in Omdurman market was higher and more stable than in Shambat market. It also showed that Gezira area was the main source of the highest level of tomato daily flows to Shambat and Omdurman central markets. August and July were the higher tomato price months and March and April were the lowest price months in the two markets. The econometric analysis results showed that the changes in Omdurman prices in a certain point of time would result in changes in Shambat price in the next point of time. This would indicate that the two markets were integrated.

The study recommended improvement in market information, establishment and distribution of storage facilities over wide areas to

minimize crop losses, improvement in transportation means, reduction of taxes and fees and encouragement of investment in tomato processing.

Keywords: tomato marketing, Khartoum State, Sudan.

INTRODUCTION:

Tomato (*Lycopersion esculentum* mill.) is one of the leading vegetable crops worldwide, with acreage under production estimated at 4.421 millions hectares and production of a total output close to 120.384 million metric tons in 2003 (FAO, 2004). The crop is used fresh for green salad, for cooking and provides raw material for manufacturing of tomato paste industry and juice. There is an increasing demand for tomato as fresh crop among consumers. Tomato ranks next to potato and sweet potato in production, but as canning crops, it takes the first rank among the vegetables (Michele, 1996).

Tomato originated in tropical America, probably in Mexico or Peru where a variety of wild cherry tomato was brought into cultivation Morning Stare (undated). Europeans came to know tomato in the mid-16th century. The Italians, however, soon embraced tomato varieties of pomid and ora (golden apple) and introduced them into their cuisine. In Sudan tomato are grown all around the country as a winter crop (main season) and as an off-season crop during summer and autumn. It is the second most important vegetable after onion. It is produced around large cities and town along the Nile and on seasonally flooded plains.

The harvested area of tomato production increased from 13 thousand hectares with an output of 170 thousand tons in 1985 to an area of 52 thousand hectares with an output of about 700 thousand tons in 2005 (FAO 2006). This increase indicates a concurrent increase in demand for tomato that warranted this escalation in area and production.

Tomato prices, due to increased demand, increased in real terms from SD 5.87 per kg in January 1990 to SD 202.69 per kg in December 2005.

Furthermore, tomato production is characterized by seasonality and perishability. During summer months (April-September) there is a relative shortage of tomato, while there is

abundance during the winter months. The problem of seasonality is the cause of low prices in the winter months, compared to summer months. Tomato in Sudan is produced entirely for fresh domestic consumption. The bulk of marketed tomato is consumed in towns and cities, namely in Khartoum State. In fact the per capita consumption for tomato is high in Khartoum State reaching 30 kg per annum, while it is lower in the other states such the North state where it is about 10 kg per annum (Ministry of Agriculture, Agricultural Economics Department, 2003).

The fluctuations from day to day and between winter (SD 82.65thouand per ton) and other seasons (autumn about SD 216.17thousand per ton and summer about SD 137.53 thousand per ton) indicate the extent of seasonality and perishability, which makes the crop prices highly sensitive (field survey 2006).

Moreover, the marketing system for tomato is traditional and lacks the conventional trade linkages system. Central wholesaler markets for tomato, for example, do not exist except partially in Khartoum State. Agents acting as middlemen seem to be dominating the markets and this leads to improper functioning of the marketing system of tomato and results in a large gap between farm-gate prices and retail-consumers prices (El Haj, 1987).

Sudan, and particularly Khartoum State, faces many problems in tomato marketing, which are captured in shortage of finance, unstable prices, high taxes and fees in addition to weak infrastructure and seasonality. With respect to marketing, the inadequate marketing services such as market information, poor transport, credit, storage, packing, handling and processing facilities, high taxes and fees hinder the expansion of tomato supply in response to its growing demand. Tomato is a perishable commodity that may be due to the high supply and low demand in winter season, this lead to low prices due to the missed of cooling storage in the markets and the sauce factory (Saeed factory) used the paste from abroad, also tomato is a perishable commodity may be due to the high taxes and road fees or to the traditional means of transportation. It seemed that the problem of seasonality and perishability had been addressed in different ways such as the production of tomato in different areas benefiting from differences in climates (Gadarif and Damazeen …..etc) and by importing tomato from different Arab countries and recently by production tomato in green house. The latter needs high capital, which may not be found among small tomato farmers (Idris, 2006).

The objective of this study is to evaluate the effect of the different factors affecting tomato marketing in Khartoum State with respect to: (Different areas of supply, Different means of transportation and their effect on tomato prices, Effect of taxes and road fees on tomato shipment from the production areas to the market. To estimate the marketing margins and costs. To detect presence of temporal changes of tomato prices to evaluate the seasonal pattern (To estimate effect of seasonality on tomato prices).

Data collection:

This study was conducted in Khartoum State. The study was based mainly on primary data collected through interview and questionnaires. This questionnaire was prepared in order to obtain information about tomato marketing like tomato quantities, tomato prices, location of tomato production, transportation mean and tomato marketing cost per day from the first January to the last day in December from two markets (Omdurman central market and Shambat central market in Khartoum North). The primary data were supported by secondary data from different sources like Ministry of Agriculture, FAO, the Central Bureau of Statistics and a Computer Search.

Data analysis:

The data collected was subjected to quantitative analysis. Descriptive analysis was based on tabular, graphs and budget analysis. Primary and secondary data used to estimate the seasonal fluctuations of tomato prices in Khartoum State**.** Computer software was used for drawing the graphs.

Temporal analysis:

Temporal analysis is used for price determination. It explained patterns of price behavior through time, seasonal patterns of change trend and cycles. It provide an understanding of why temporal changes. There are two types of temporal variation in prices, inter year and intra year (seasonality of price). Fluctuation and decomposition of nominal prices are examined.

Fluctuation of monthly prices:

To examine monthly prices two steps needed. The first step is to examine the pattern of month to month variation in nominal prices

using different indicators, the first indicator measure the simple range, the difference between the lowest and highest monthly price index. The monthly price indices are based every year on January price (January equal 100). The second indicator is the coefficient of variation (standard deviation divided by the average price). It measures the fluctuation expressed as a percentage of average prices. The second step is to decompose the nominal prices into four types since price movements differ in type according to time.

Trend (T):
Represent the direction of price movement in the long run. Trend in agricultural prices are influenced by general inflation and deflation in the economy, increase in demand or supply in addition to change in tastes and preferences of the consumers, increase in population and income and technological changes in production.

Cycles (C):
It is a pattern or systematic movement of prices that repeats itself regularly over a given period of time usually more than one year.

Seasonality (S):
Defend as intra-year variation or cycles of prices that tend to follow more or less a uniform repeated pattern within 12 months period. The common reason for seasonal price movement is the seasonal fluctuation of supply and / or of demand.

Random movement (E):
Are erratic variations that have no uniformity, hence, offer little or no predictability power over a period of time. Trend is calculated using the constant and the trend coefficient resulting from the regression equation:

$$Ti = a + bti$$

Where Ti = trend value during period I,
a = the constant estimated by the regression,
b = the trend coefficient,
ti = the value of the variable during period I

The seasonal price movements are estimated by a seasonal price index by calculating a centered moving average (CMA). 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 (Wayne and James, 1989). The technique of using the centered moving average substitutes the observed in the time series with the average of that value and a given number of observations taken before and after it. Consequently, the CMAn eliminates random variations and systematic movements of duration equal to n. The CMA12 thus eliminates seasonality and randomness (Osman and Idris, 2002). The formula for the seasonal index can be written as:

$$SI = (Pi / CMAi)$$

The SI is already deflated since it is a result of dividing a nominal series (the original price) by another nominal series (CMA12). It should be noted that there are no values of the CMA12 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 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:

$$GSIi = SIi * 1200/\sum SIi$$

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

$$Ci=CMAi/Ti$$

Hodrick-Prescott Filter:

Hodrick-Prescott Filter is used to estimate the trend component of the price. This is a smoothing method that is widely used among macroeconomists to obtain a smooth estimate of the long-term trend component of a series. The method was first used in a working paper (circulated in the early 1980's and published in 1997) by Hodrick and Prescott to analyze postwar U.S. business cycles (Hodrick and Perscott, 1997).

Previous Studies:

Mendoza (1995) conducted study of marketing channels and margins to analyze the marketing of different products (Tomato in Chiles, s, Vegetable in province of Arica Chile,s and Potato in North of Chuquisaca, Bolivia). The methodology conducted in this study combined the analysis of channels margin and prices at all market level, market functions, their costs and the net incomes of the participants. The result demonstrated that even when there were price variations at all market levels, the marketing margins became larger due to increases in the value added by the marketing system.

Abd Alla (1965) reported that in Khartoum province the early tomato crop is harvested in late September which secures relatively high prices. Commercial tomato growers in Eilafoun usually time their harvest so that it does not coincide with the produce from Northern Gezira, White Nile and Managil Extension. Tomatoes from the later areas, grown during winter, pour into the market during December, January and February resulting in a considerable drop in prices.

Only 26% of the amount of tomato produced in the Gezira was marketed locally within the scheme, whereas the rest was channeled to the markets of Khartoum (46.7%) and Wad Medani (27.3%). Most of Northern and Wadi shair groups production was marketed at Khartoum, while the produce from central (El Madina) and Southern (Wad Elataia) groups of Gezira found outlets either at Wad Madani or locally (Elhaj 1987).

Middlemen and local retailers dealt with 25.9% of the tomato produce in the Gezira. The share of middlemen was about 16% where their activities were mainly concentrated in central and Southern parts of the scheme. This implied that not all of the tomato marketed locally was necessarily used for local consumption within the scheme, but may be transported outside the Gezira by middlemen. The tomato marketed at Khartoum and Wad Madani (74.1% of tomato produced) was mainly sold to brokers (69.5%) and wholesalers (4.6%) in these markets. So middlemen and brokers dealt with the bulk of tomato produced (85.5%) in the Gezira and this agree with the findings of the Horticultural master plan team (1986) which showed that vegetables market were dominated by middlemen.(Elhaj1987).

The average price of tomato in Khartoum State in 1999 was about 41777.7 D S /ton. The gross return for it was about 214711.1 D S / fed. The crop budget revealed that the average gross margin obtained

was about 126163.6 SD / fed. The result revealed that the crop was profitable at producer level in all areas in Khartoum State (Mohammed 2000).

Tomato prices attained their highest levels during August and decreased to reach their lowest levels in October and November when the bulk of the Gezira tomato production reached the market. Then prices started to increase from December onwards. In spite of the fact that the December-February period is the proper season for tomato production, prices were highest in that period than those of the off-season production in October and November. This was mainly because most of the tomato producers in the Gezira practiced off-season production and this lowered the prices during October-November (Elhaj 1987).

RESULTS AND DISCUSSION:

Marketing system:

There are trade relationships between traders in production areas and consumption areas in the central markets of Khartoum State. Though, each farmer in the production area has an agent in each of the three central markets (Khartoum-Omdurman-Shambat). A farmer or a trader contacts the market agents to determine the market price and to choose which the market with the higher price. There is also communication among the agents in the three central markets, to fetch the highest price of tomato in the three markets. Sometimes the brokers whom in contact with the trader in different central markets purchase tomato from low price markets and sell it in the high price market. From mentioned above, the distribution strategy of tomato depends on the market price. The market with the higher price is the first receiver of tomato production and the surplus is directed to other markets and this phenomenon is observed in all markets in all seasons. Throughout the study period and from personal interviews with traders and agents in each central market it was observed that the demand level for tomato in Omdurman was higher than in Shambat market. Therefore the daily supply of tomato goes first to Omdurman market in every season. This may be due to high population density in Omdurman.

The supply and demand for tomato is stable in Omdurman central market than in Shambat central market. The supply of tomato

fluctuates in Shambat central market since it is the excess quantities resultant based on surplus of Omdurman central market gets its satisfaction from the crop supply.

These central markets kept receiving varying quantities of tomato from different sources. Shambat central market received more than 60% of the total tomato quantity from Gezira area during three seasons. However, Omdurman central market received more than 65% of the total tomato quantity from Gezira area in winter and summer, and more than 40% in autumn. There are three methods for transporting tomato from production sites to consumption sites. These are the Lorries totaling to a number of 4.1 thousands, Dafars totaling to about 3.1 thousand and small vehicles (Boxi) with a total number of about 2.07 thousand.

Most of the tomato comes from the Gezira area throughout the year also tomato come from Sinnar and Eastern Nile throughout the year. As expected large number of vehicles transport tomato from different parts of Sudan during winter. These include Abo-Roof, Bahri, Karari, Omdurman North, Wad Hamid, Gezira Eslang, Gamoeia, Hager El Asal, River Nile and White Nile. Transportation of off season tomato (during autumn) also takes place from Kosti, Halfa, Managle and Gadarif. Transportation of off season tomato (during summar) also takes place from Kassala and Damazeen. Thus the broad spectrum of areas producing tomato in Sudan indicates the variability of zones that are legible for growing tomato almost all the year round.

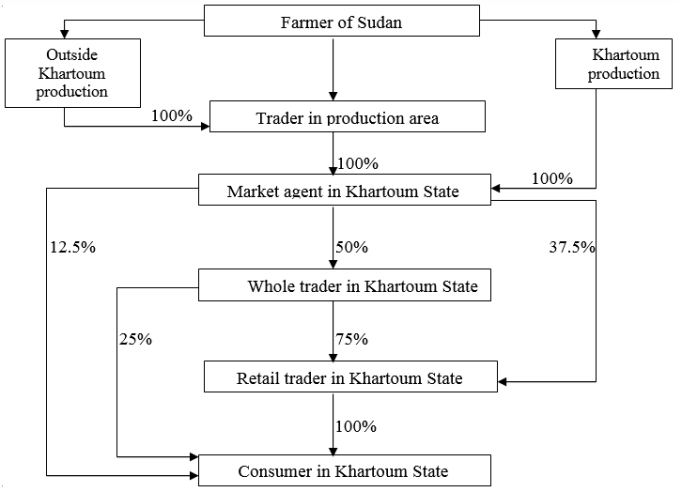
Considering the different types of transportations used in transfer of tomato, the small vehicles are limited to neighboring areas such as Bahri, Gezira and Kosti. Use of small vehicles seemed to be economical where farms are scattered over large areas and collection by large vehicles may result in high cost and more time. The Lorries are used in transporting tomato from remote areas such as New Halfa, Sinnar, Damazeen, Hager El-Alsal in addition to Gezira.

Marketing channel of tomato:

Tomato crop like the other crops goes from the producer to the consumer through different channels. Tomato product goes from the producers either to the primary traders in the production area and then to market agent in Khartoum; or from the producers to the market agent directly in Khartoum State. The market agent share in Khartoum accounts to about 5% of the total gross revenue in both cases.

The Tomato then passes from the market agent through different channels: (i) either directly to consumers; or (ii) to the whole sale trader, who takes a share of one free tin out of each ten tins; and then from the wholesaler to the retail traders. The retail traders put SD 50 on each kg of tomato for sale to the consumer as a margin of revenue. Sometimes, the wholesaler sells directly to the consumers (figure 1).

Figure (1): Marketing channel of tomato



Source field survey (2005-2006)

Market information:

The market information is very important factor to traders, farmers, and consumers that is for its help in putting marketing policies, taking the right decision of marketing and getting benefits. There were many sources of information market like middlemen, trade rooms, different mass media, research centers, universities, traders and agents in the different markets (El Bakdash, 1998). This study found that the farmers and traders get the market information from the agents in the central markets through mobile phone which contacts agents in different central markets and then determine the perfect market (field survey 2006).

The distance wise between Khartoum State and supplying sources (during 2005-2006):

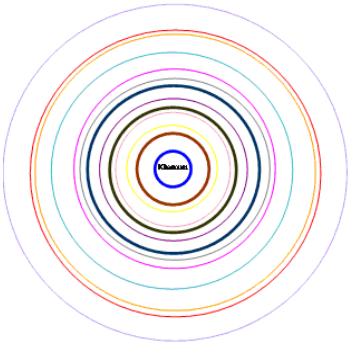
Khartoum State receives tomato from supplying sources laying between less than 80 tons to more than 24 thousand tons (field survey 2006).

Figure (2) also showed that Damazeen had the highest tonnage price of tomato received in Khartoum markets during autumn and summer, followed by Kosti in autumn, and Kassala in summer. The production of Kassala area in summer fetched lower prices than both Kosti and Damazeen. This may be due to its higher production level despite its remoteness from Khartoum. Managil tomatoes supply in autumn had less prices compared to the other areas due to its proximity to Khartoum market.

Figure (2): The distance wise between Khartoum State and supplying sources (during 2005-2006)

Area	Distance from Khartoum (K. M)	Tomato quantity (ton)	Average tomato price (ton) (1000 DS)	Tomato quantity (ton)/Distance from Khartoum	Season
Omdurman	-	527.04	85.46	-	Winter
Khartoum North	-	1535.13	118.63	-	Winter
Hager Al-Assal	100	1892.39	80.60	18.9239	Winter
Shandi	172	106.15	59.91	0.617151	Winter
Gezira	187	24037.34	120.29	128.5419	All seasons
White Nile	200	103.15	71.82	0.51575	Winter
Managil	237	258.88	121.74	1.092321	Autumn
Sinnar	280	1544.41	195.13	5.51575	All seasons
Kosti	320	1053.38	297.20	3.291813	Autumn
Adbra	375	113.97	90.04	0.30392	Winter/Autumn
Gadarif	415	78.44	182.86	0.189012	Winter/Autumn
Halfa	513	2244.7	206.90	4.375634	Winter/Autumn
Damazeen	525	1296.00	330.90	2.468571	Summer/Autumn
Kassala	620	1606.41	231.03	2.590984	Summer

Source field survey (2005-2006)



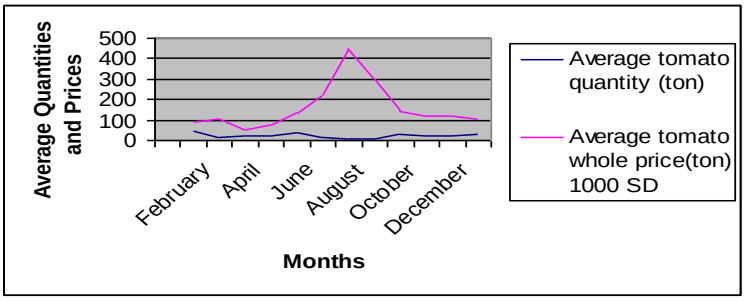
Tomato quantities received by Shambat and Omdurman central markets among seasons and locations per ton:

Khartoum State received a total quantity of tomato amounting to about 37.4 thousand tons during 2005/2006. Most of these quantities were received during winter, about 16.6 thousand tons (44.4 %) followed by autumn, about 11.4 thousand tons (30.6 %) and then in summer, about 9.3 thousand tons (25.0 %). Tomato received by Omdurman central market, approximately equaled that was received by Shambat central market, about 18.7 thousand tons. This occurred as Omdurman market seems to provide a large consumption area. The high demand and less selective in term of tomato quality resulted in higher price. Among all supply areas, Gezira ranked at top in the two markets, supplying about 12.5 thousand tons to Shambat market and about 11.6 thousand tons to Omdurman market. New Halfa ranked second in Shambat market and Damazeen in Omdurman market. However, it was observed from the table that the two markets received more tomato during winter and less during summer.

Analysis of tomato quantities and prices per month:

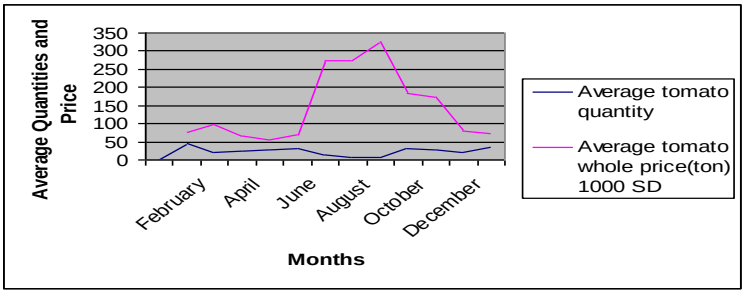
When considering tomato supplies and prices by month, prices tended to increase from May and reached the peak during July and August then started to drop down slowly till September. But the quantities tended to increase from November and reached the peak during December and January. The lowest quantities were received in July and August in the two markets due to the seasonality of tomato production (figures.3 and 4). The supply of tomato to each of the two central markets differed in quantities and seasonality. This was quite observed in the trend of supply over the whole season and the associated prices in each market. The flow of tomato into Shambat market seemed to be smoother than that going into Omdurman market. Similarly the price trend seemed to have regular slope compared to trend of Omdurman market. The price trend in Omdurman was more irregular (figures 3 and 4).

Figure (3): Average tomato quantities and prices per month (Shambat Market)



Source: field survey (2005-2006)

Figure (4): Average tomato quantities and prices per month (Omdurman Market)

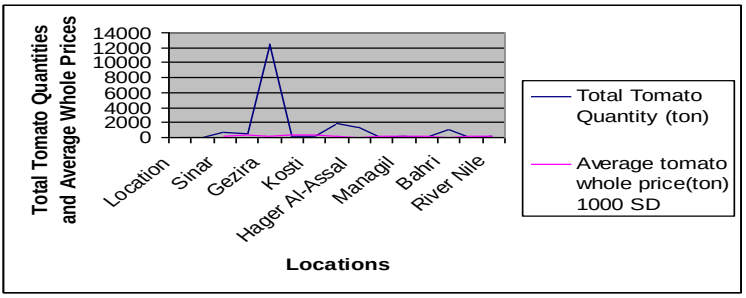


Source: field survey (2005-2006)

Analysis of tomato quantities and prices per location:

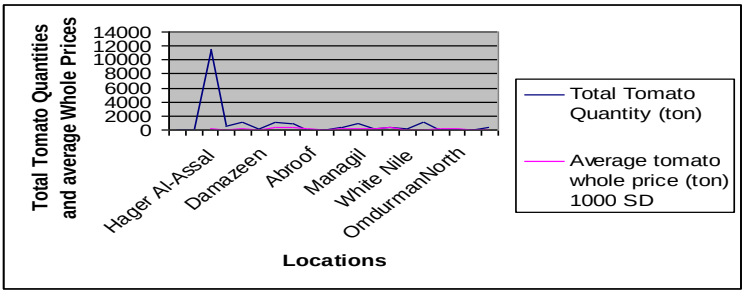
When considering tomato supplies and prices by location it was clear that the high total quantities received in Shambat were from Gezira (about 66.79%) followed by New Halfa (10.34%). The tomato received in Omdurman were received from Gezira (about 61.72%) followed by Damazeen (5.81%). The high prices of tomato in Shambat fetched come from Kosti (17.87%) and Damazeen (17.43%). In Omdurman, the high prices of tomato fetched come from New Halfa (11.33%), Sinnar (10.89%) and Damazeen (10.85%). The main reason for high prices could be due to off season production in those areas (figures 5 - 6).

Figure (5): Average tomato quantities and prices per location (Shambat Market)



Source: field survey (2005-2006)

Figure (6): Average tomato quantities and prices per location (Omdurman Market)



Source: field survey (2005-2006)

Budget analysis of tomato marketing: Analysis of variable cost of tomato marketing:

The variable cost of marketing of tomato was determined by calculating the cost of the following items: cost of handling, road fees, transportation cost, share of market agent, Zakat and gate fees. The total variable cost of marketing cost is the sum of the above items.

The cost items were calculated in order to determine the respective share of each item in the total cost of marketing (table 1).

Handling and loading cost: Handling and loading cost includes the handling and loading in the farm and market. The survey results showed that the average cost of handling and loading was about S.D 5.13 thousand per ton (15.47 % of the total marketing cost).

Road fees: Road fees depend on the transportation means. The survey results showed that the average cost of road fees was about S.D 5.97 thousand per ton (18.01 % of the total marketing cost).

Transportation cost: Transportation cost depends on the transportation means and the distance between Khartoum State and supplying sources. The survey results showed that the average cost of transportation was about S.D 16.11 thousand per ton (48.59 % of the total marketing cost).

Market agent share: The market agent share about 5% from the farm return. The survey results showed that the average cost of market agent share was about S.D 3.93 thousand per ton (11.85 % of the total marketing cost).

Zakat and market gate fees: The survey results showed that the average cost of Zakat and market gate fees was about S.D 2.07 thousand per ton (6.23 % of the total marketing cost).

Analysis of tomato marketing budgets:

To identify the magnitude of each item in the total variable cost of marketing, the respective percentage of each item itemized per ton cost of marketing was calculated. In Khartoum State the main cost items were found to be transportation cost which constituted about 48.59% of the total variable cost of tomato marketing per ton (table 1).

Table (1): Budget for tomato marketing and cost of marketing percentage share in Khartoum State

Items	Thousand Dinar/ton	Percentage (%)
Market price at Khartoum	145.56	100
Variable cost of marketing		
Handling and loading cost	5.13	15.47
Road fees	5.97	18.01
Transportation cost	16.11	48.59
Marketing agent share	3.93	11.85
Zakat and market gate fees	2.07	6.23
Total variable cost of marketing	33.21	100.15
Marketing Gross Margin	112.35	77.18

Source: field survey (2005-2006)

Farmer's share:

$$\text{Farmer's share (\%)} = \frac{\text{Farmer's price}}{\text{Retail sale price}} \times 100 = \frac{72411.68}{145560} \times 100 = 49.75\%$$

This is almost similar to what El Haj (1987) has found in his study of vegetable (focusing on tomato) marketing in Gezira Scheme.

Per Month: The budgeting analysis of tomato in Shambat and Omdurman central markets by month. From the tables it was clear that the highest average marketing cost, average gross return and average gross margin were indicated in August and July (the off-season of tomato production).

Per Location: The budgeting analysis of tomato in Shambat and Omdurman central markets by location. From the tables it was clear that in Shambat market, the local producing areas incurred more benefit rather than the other areas due to the low marketing cost. In Omdurman market, in addition to some local areas off season areas production also had highest benefits like River Nile and New Halfa.

Per Season: Tables (2 and 3) show the budgeting analysis of tomato in Shambat and Omdurman central markets by season. From the tables it was clears that higher average gross return and average gross margin was during autumn season in the two markets, followed by summer season and finally by winter season. This may be due to the off season production characteristics of tomato. The autumn production season is more than the summer production in quantity and with better quality.

Table (2): Budgeting analysis of tomato per season (Shambat Market)

Season average	Average Total cost (1000 SD/Ton)	Average Gross return(ton) (1000 SD/Ton)	Average Gross margin(ton) (1000 SD/Ton)
Summer	37.36	143.14	105.78
Autumn	46.15	226.17	180.02
Winter	24.69	87.15	62.46

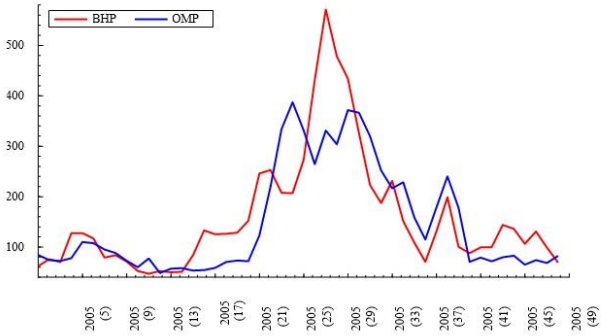
Source: field survey (2005-2006)

Table (3): Budgeting analysis of tomato per season (Omdurman Market)

Season average	Average Total cost (1000 SD/Ton)	Average Gross return(ton) (1000 SD/Ton)	Average Gross margin(ton) (1000 SD/Ton)
Summer	34.44	131.92	97.48
Autumn	32.30	206.81	174.51
Winter	23.95	78.15	54.20

Source: field survey (2005-2006)

Figure (7): Weekly tomato prices in Shambat market (SHP) and Omdurman (OMP) in (2005-2006)



Source: Sudan Customs, Ministry of Finance, Natural Economy Central Bureau of Statistics.

Table (4): Unit root tests

Variables		ADF- Stat.	1% Critical values	5% Critical values
Levels	BH.P	-2.5259	-4.1728	-3.5112
	OM.P	-2.1166	-4.1728	-3.5112
First Difference	BH.P	-4.2287**	-4.1781	-3.5136
	OM.P	-4.2397**	-4.1781	-3.5136

- (**) denotes rejection of the hypothesis of unit root in the series at 1% significant level. Source: field survey (2005-2006).

Table (5): Johansen co-integration test

Eigenvalue	Likelihood ratio	5% Critical value	1% Critical value	Hypothesized No. of CE(s)
0.4244	31.333	25.32	30.45	None **
0.1208	5.924	12.25	16.26	At most 1

(**) denotes rejection of the hypothesis at 5 %(1%) significance level.Source: field survey (2005-2006)

Table (6): Normalized co-integrating coefficients: 1 co-integrating equation

OM.P	Constant	Trend	SH.P
1	47.9696	-1.2010	-1.038
S.E		(1.001)	(0.125)

Source: field survey (2005-2006)

The vector error correction model:

The relationship between tomato prices in Omdurman and in Shambat were estimated using the error correction model. It stated that when time series co-integrated they would have an error correction representation.

A vector error correction model is estimated the results are reported as follows:

$$\Delta OMp = -0.27*\left(OMp_{t-1} - 0.92*BHp_{t-1}\right) + 0.26*\Delta OMp_{t-1} + 0.03*\Delta BHp_{t-1}$$

T-value (-3.08) (2.05) (0.23)

$$\Delta BHp = 0.288*\left(OMp_{t-1} - 0.92*BHp_{t-1}\right) - 0.52*\Delta OMp_{t-1} + 0.58*\Delta BHp_{t-1}$$

T-value (2.59) (-3.93) (3.93)

$R^2 = 0.30$ $\overline{R}^2 = 0.27$

In this vector error correction model, a long run equilibrium relation including no intercept or trend was used as error correction term. The vector error correction model results showed that there was a significant short run relationship between the prices in the two markets of Shambat and Omdurman. The result indicated that changes in Omdurman prices in a certain point of time would result in changes in Shambat price in the next point of time. This implies that Omdurman prices cause Shambat prices to move accordingly. The two markets are termed as integrated.

Temporal analysis results:

Temporal price analysis provides insights regarding the impact of government policies on the evolution of seasonal price movement and offers useful guidelines for improving these policies.

The analysis is applied to the price of tomato in Khartoum State between January 1990 and December 2005 and the results are presented in form of tables and graphs.

Nominal prices of tomato are deflated and expressed graphically.

Figures (8) and (9) show the nominal prices and the deflated prices for tomato in Khartoum market.

The fluctuations in monthly prices for the period 1990 – 2005 are shown by two indicators. The first indicator is the simple range (difference between lowest and highest monthly price index (January equals 100) is measured. The second indicator is the coefficient of variation (the standard deviation (SD) divided by the mean). The month of lowest and highest price points is also presented.

Price analysis:

In this part the behavior of tomato prices is analyzed using the Central Bureau of Statistics monthly secondary data. The analysis discusses the fluctuations trend and seasonality in tomato prices during the period 1990-2005 in Khartoum State.

Figure (8) depicts that the nominal prices of tomato on monthly basis have been increasing during the period 1990 – 2005. On the other hand, figure (9) depicts that the deflated prices of tomato on monthly basis have been volatile during the period 1990 –1994, but sustainable at low levels after 1994 up to 2005.

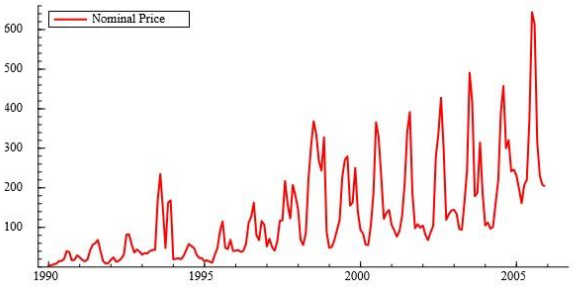
The fluctuations in tomato prices are measured by the difference between the highest price index and the lower one in the year with January prices being set at 100. Prices were highly fluctuating during the period (high coefficients of variation), and that the differences are high. In Khartoum, monthly price fluctuations exceeded 100 percent in all years.

Lowest price fluctuation percentage is shown in year 1996, since during this year prices of tomato were high while highest price fluctuation was shown in 1995 and 1990 because prices increased sharply from January to August. The coefficient of variation in general was high, this is because the variation in prices in Khartoum State between harvest season and the lean season is high. During the harvest time prices fall to lower level and rise in lean season i.e. according to supply and demand. Lowest prices did not follow stable pattern but most of the lowest price were found in March and April (tomato season of winter months). While highest prices follow stable pattern, all the period, the highest price were found in August or July (this is the lean season of tomato).

Hodrick-Prescott Filter:

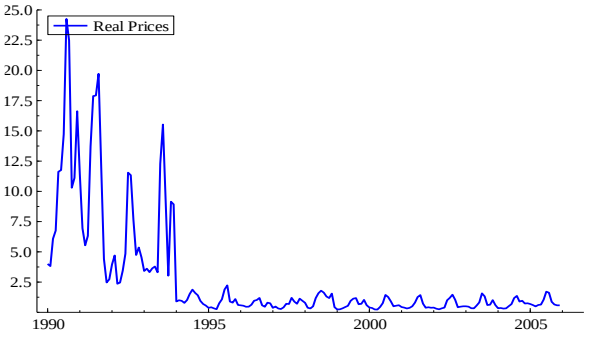
Hodrick-Prescott Filter is used to estimate the trend component of the price. This is a smoothing method that is widely used among macroeconomists to obtain a smooth estimate of the long-term trend component of a series. The method was first used in a working paper (circulated in the early 1980's and published in (1997) by Hodrick and Prescott to analyze postwar U.S. business cycles. Figure (10) shows that tomato prices have been increasing over time (positive trend).

Figure (8): Monthly nominal prices of tomato (1990-2005)



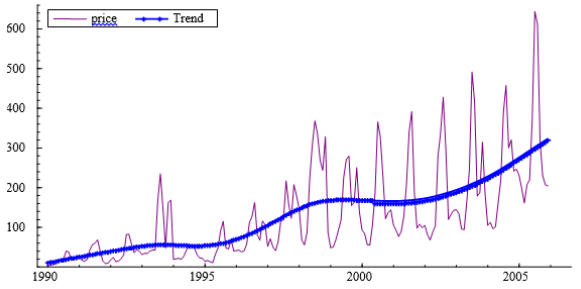
Source: Sudan Customs, Ministry of Finance, Natural Economy and Central Bureau of Statistics (2006).

Figure (9): Monthly deflated prices of tomato (1990-2005)



Source: Sudan Customs, Ministry of Finance, Natural Economy and Central Bureau of Statistics (2006).

Figure (10): The tomato prices and its long- term trend (1990-2005)



Source: Sudan Customs & ministry of Finance, Economy Central Bureau of Statistics (2006).

Testing for seasonality in prices:

The graphical representation of the average monthly prices is depicted in figure (11). The average prices of tomato are high in July, August, and September, and low in January, February, March and April. This indicates that there are seasonal changes in these prices.

In order to test for seasonality in the tomato prices, two dummy variables are used in a regression model D1; is a dummy for the season that starts in April and ends in June. D1=1 in April, May, and June, and zero in the rest of the year. While D2 is a dummy variable that takes into account the effect of the season which starts in July and ends in November, the D2=1 is given for July, August, September, October, and November and D2=0 is given for the rest of the year. The period which starts in December and ends in March is set as a base season. The regression result is reported in the following equation:

$$\text{Price} = -34.21 + 0.57 * Trend + 43.82 D1 + 53.40 * D2 + 0.59 * \text{Price}_{t-1}$$

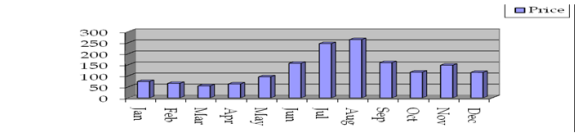
T-value (-3.04) (4.78) (3.63) (4.55) (9.77)

$$R^2 = 0.73 \qquad \overline{R}^2 = 0.72$$

$$Durbin - Watson\ Stat. = 1.45$$

The regression result confirms that there is a significant difference in prices in the first season represented by D1 (April, May, June) from prices in the second season represented by D2 (July, August, September, October, and November). Both prices are significantly differed from prices in the rest of the year. The seasonal dummy variables are highly significant which indicates the existence of seasonality in prices.

Figure (11): Average monthly tomato prices (1990-2005)



Source: Sudan Customs, Ministry of Finance, Natural Economy and Central Bureau of Statistics (2006).

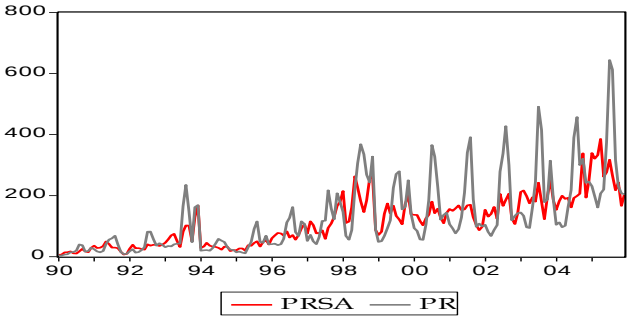
Seasonal adjustment:

Seasonal adjustment refers to the process of removing cyclical seasonal movements from a series and extracting the underlying trend component of the series. There are two classes of seasonal adjustment

methods, multiplicative and additive. Multiplicative methods are appropriate if the series can be decomposed into a product of the trend component and a seasonal component, while additive methods are appropriate if the series can be decomposed into a sum of the trend component and a seasonal component. In this case the series of tomato prices (1990-2005) is seasonally adjusted using the ratio to moving average (multiplicative) method.

The seasonally adjusted series and the original series of prices are depicted in figure (12) below. The graphical representation shows that there is a difference between the seasonal adjusted series and the original prices series. The monthly seasonal factors are reported in table (7).

Figure (12): Tomato prices (PR) and seasonally adjusted prices (PRSA) (1990-2005)



Source: Sudan Customs, Ministry of Finance, Natural Economy and Central Bureau of Statistics (2006).

Table (7): Monthly seasonal factors for tomato

Month	Seasonal Factor
January	0.68
February	0.62
March	0.48
April	0.54
May	0.84
June	1.35
July	2.03
August	2.30
September	1.46
October	0.95
November	1.25
December	1.01

Source: calculated from data collected from Council of Ministers Central Bureau of Statistics (2006).

Finding and Conclusions of the study:

The study found that demand level for tomato in Omdurman was higher than in Shambat market and tomato flows into Omdurman market first, and any surplus goes to Shambat market. These flows causes fluctuation in Shambat market as it results as a residual after Omdurman market gets satisfied from the crop supply. The study depicted that these central markets kept receiving varying quantities of tomato from different sources. Khartoum State received a total quantity of tomato amounting to about 37.4 thousand tons during 2005/2006. Most of these quantities were received during winter, about 16.6 thousand tons (44.4 %) followed by autumn 11.4 thousand tons (30.6 %) and then by summer 9.3 thousand tons (25.0 %). Among all supply areas, Gezira ranks top in both markets, supplying about 12.5 thousand tons to Shambat market and about 11.6 thousand tons to Omdurman market. However, it was observed that the two markets received more tomato during winter and less during summer. There are three methods of transporting tomato from production sites to consumption sites, these are Lorries totaling to a number of 4.1 thousands, Dafars totaling to about 3.1 thousand and small vehicles (Boxi) with a total number of about 2.07 thousand.

The study revealed that the prices of tomato tended to increase from May to reach it peak during July and August, and then starts to drop down gently at September. However, the quantities start to increase from November and reach its peak during December and January. July and August had the highest prices and Omdurman market had highest inflow of tomato during autumn. The result of the seasonality analysis indicated the presence of a short run stable period in tomato prices in both Shambat and Omdurman markets. The vector error correction model results showed that there is a significant short run relationship between the prices in the two markets Shambat and Omdurman. The relationship states that changes in Omdurman prices in a certain point of time will result in changes in Shambat price in the next point of time. This implies that Omdurman prices cause Shambat to follow. The two markets are integrated.

Recommendations of the study:

The study recommends the government to:

1. Encourage alternate substitutes to fresh marketing of tomato to reduce price fluctuations. This may include encouraging of investment

in tomato processing making use of the surplus production of tomato during winter with the aim of stabilizing farmers prices,

2. Provide information on demand, supply and prices of tomato in different markets to farmers (preparation of leaflets and pamphlets) through market agents,

3. Increase extension services on post harvest losses reduction among farmers, traders and transport drivers,

4. Encourage market extension services to promote grading of tomato produce among producers and market agents in order to maximize their financial rewards from producing and selling of tomato,

5. Encourage investment in storage facilities development and distribution over wide areas to minimize crop losses and to polarize the surplus tomato production in winter season.

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