

Full Length Research Paper

## Marketing and market integration of cowpea (*Vigna unguiculata* L. Walp) in Uganda

S. P. Ddungu<sup>1\*</sup>, W. Ekere<sup>1</sup>, J. Bisikwa<sup>2</sup>, R. Kawooya<sup>2</sup>, D. Okello Kalule<sup>3</sup> and M. Biruma<sup>3</sup>

<sup>1</sup>Department of Agribusiness and Natural Resource Economics, College of Agriculture and Environmental Sciences, Makerere University P. O. Box 7062 Kampala Uganda.

<sup>2</sup>Department of Crop Production, College of Agriculture and Environmental Sciences, Makerere University, P. O. Box 7062 Kampala Uganda.

<sup>3</sup>Groundnut breeding Department, National Semi-Arid Research Resources Institute, P.O Box Soroti, Uganda.

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Despite the importance of cowpea in Uganda as a leading legume, its production and improvement have not received much attention over the last two decades. Data was obtained on prices of grains of cowpeas on a weekly basis from FIT Uganda between 2008 to 2011 in Soroti, Lira and Kampala. Data collected was analyzed using descriptive statistics, particularly, frequencies and the measures of central tendency. Several approaches were used to investigate the degree of cowpea market integration in Uganda: bivariate correlation coefficients, co-integration and Granger-Causality tests were used to account for the complex interactions of prices in different markets. Results from these tests show that cowpea markets as a whole are not integrated. This is not a surprising result since it can be linked to the general lack of market information. Prices in different markets are not equally responsive to changes in the supply of cowpeas. The results obtained will assist in subsequent cowpea variety improvement actions and decisions.

**Key words:** Market integration, marketing, co-integration, granger-causality, Uganda.

### INTRODUCTION

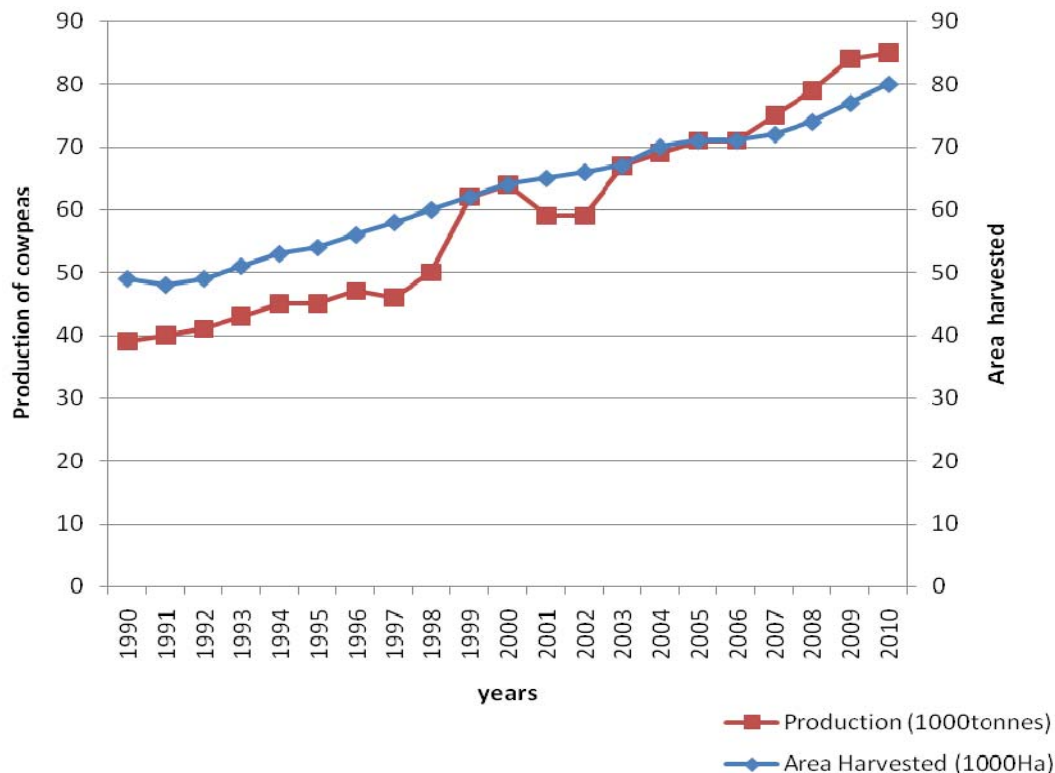
Cowpea (*Vigna unguiculata* L. Walp) is a global legume whose cultivation is believed to have begun from Africa more than 5000 years ago (Davies et al., 2005; Jafferson, 2005). At present, it is the second most important grain legume in Africa (NRC, 2006). It is cultivated around the world, particularly in the semi-arid tropics, primarily as a pulse, vegetable (for both grains and the green peas) as well as cover and fodder crop (Faye, 2005). However, the largest part of the world's production comes from Africa. More than 5.4 million tons of dried cowpeas are produced

worldwide, with Africa producing nearly 5.2 million. Nigeria, the largest producer and consumer, accounts for 61% of production in Africa and 58% worldwide, while Uganda is among the top 10 producer of cowpea ranked 8<sup>th</sup> (Ronner and Giller, 2012). As regards trade, Africa exports and imports negligible amounts of cowpeas (IITA, 2013).

In Uganda, cowpea is ranked 4<sup>th</sup> after beans, groundnuts and soybean (Ronner and Giller, 2012) although it is generally consumed countrywide. The

\*Corresponding author. E-mail: [ddungustanley@gmail.com](mailto:ddungustanley@gmail.com), Tel: +256-712-319477.

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**Figure 1.** Average cowpea areas and production in Uganda. Source: FAOSTAT 2013 Database; <http://www.fao.org>

young leaves and immature pods are eaten as vegetables. Relative to other grain legumes and vegetable crops, cowpea possesses multiple advantages to farmers including high yields on poor, sandy soils unsuitable for the production of other crops, high rates of symbiotic nitrogen fixation and lower fertilizer requirements (Carsky et al., 2001; Timko and Singh, 2008). It is thus a valuable component of farming systems in areas where soil fertility is limiting and where it is grown in rotation and/or intercropped with cereals. It is a crop of major importance to the nutrition of poor rural households whose diets tend to heavily rely on starchy foods such as millet, sorghum, maize and cassava. It therefore, has a tremendous potential to contribute to the alleviation of malnutrition.

Cowpea is grown by approximately 2.2 million smallholder farmers in Uganda, mainly in eastern and northern regions, using simple traditional methods. Figure 1 shows the trend of area and production of cowpea for the last two decades (1990-2010). The figure shows relatively similar trend for cultivated area, while production fluctuated throughout the period with several increases and decreases with the highest peak observed in 2000 and a fall in 2002. The reasons for such fluctuations were attributed to weather conditions. Indeed, the country often experiences unpredicted dry periods and floods which might have caused the decreases in addition to insect pests which form a major

constraint for increasing cowpea production (Ronner and Giller, 2012) in the harvested areas, while good seasons might have resulted in increases (the ups). Unlike the production, the area trend shows a sustained increase throughout the years independent of the corresponding production fluctuations. This suggests that the production of cowpea is related to increase in the area cultivated. As stated by Coulibaly et al. (2009) the increase in production may also be attributable to the release, adoption and cultivation of improved cowpea varieties at the early stage of cowpea improvement programs.

At the national level, the average yields stand at 0.93 MT/ha. However, the average cowpea yield is estimated at 1.5 to 3 MT/ha on station field trials, while farm level yields are as low as 0.5 MT/ha due to production constraints such as low yielding local varieties, pests and diseases, poor agronomic practices, land shortage, seed scarcity, drought, poor soils and lack of market (Bisikwa et al., 2014).

Minimal value addition of cowpea takes place and involves sorting and grading by type. It is sold as whole grain mostly, although in some cases they sell split grain. Cowpea trade has been limited to the local/domestic market but is slightly picking at regional level, mainly South Sudan and Kenya. Cowpea has therefore been thought of having brought for the smallholder farmers in Uganda an important food and potentially an important cash crop, especially for varieties demanded by the

export market (Adipala et al., 1999). Since the Uganda government policy is to diversify exports and introduce non-traditional cash crops in the economy, cowpea presents a great economic potential.

Due to the demise of cotton as the main cash crop in Northern Uganda and the emergence of important external markets, 50% of farmers in the region now grow cowpea for cash markets (UBOS, 2010). Production of cowpea is in transition where it was traditionally grown almost exclusively as food crop for domestic consumption to cash crop.

In realizing the potential of cowpeas as an alternative cash crop, McKnight Foundation supported a breeding programme engaged in breeding cowpea to improve food security in the region. In the past two decades, no studies have been carried out that focused on market integration. The cowpea programs implemented in Uganda have focused only on the supply side to ensure enhanced productivity. It is not clearly documented whether in the development of improved varieties market integration related information was evaluated. Lack of market information in many African countries as highlighted by Van der Laan (1999) is principally because marketing research has focused on export crops such as cotton, coffee, cocoa and groundnut and to a lesser extent cereals.

Furthermore, the major producing areas have been under political unrest and are recuperating from long-term insurgency for the past two decades resulting into the destruction of infrastructures, government programmes and loss of life. These are among the factors that affect the ways markets for various crops are integrated.

The market reform agenda being practiced in most developing countries has renewed an interest in the working of agricultural markets as a source of income, employment and food security. However, the success of the market reform process in promoting equity and efficiency is constrained by numerous structural deficiencies in local markets. One of the main consequences of these structural deficiencies is poor market integration resulting into difficulty with which information and trade flows among spatially separated markets (Goletti et al., 1995). In order to succeed, among other things, the reform process needs to take into account the extent of agricultural market integration. Little is known about how the agricultural markets, especially for staple foods, are performing in recent years and whether they are integrated or not. Furthermore, research on cowpea varietal improvement and market performance has not received much attention in the last two decades within the two regions.

This study was therefore conducted to gain a better understanding of cowpea market integration which is necessary to enhance production, improve market efficiency and competitiveness which are essential for cowpea market development. It also aims at determining the existence and level of inter-market price dependencies

and to examine the causal relationships (how markets drive prices) among spatial locations of cowpea markets.

### **Marketing and market integration of cowpea in Uganda**

The marketing of cowpeas like other crops is mainly confined to local markets and farm gates. This is attributed largely to lack of access to urban markets by farmers partly because of the poor road network and poor modes of transportation. Considerable local trade in cowpea therefore exists. Inter-regional trade in cowpea too exists and it is a profitable crop to produce according to Sabiliti (1995) and a lot of the crop finds its way to the Kenyan markets.

Market integration refers to the co-movement of prices and/or flows between markets. More generally, it explains the relationship between two markets that are spatially or temporarily separated. Markets are integrated when their price levels are closely related (Stigler, 1969). Market integration studies attempt to investigate the extent of markets by analyzing the development of prices over time for potential competing products (Asche et al., 2005).

According to Bopape and Christy (2002), there are three forms of market integration: (1) integration across space, (2) integration across product and (3) integration across time. Markets are integrated across space if, when trade takes place between them, price in the importing market equals price in the exporting market plus transportation and other costs of moving the product between the two markets. When integrated across product form, markets are vertically integrated and the price differential between two related commodities should not exceed transportation and processing costs. Markets are said to be integrated across time (inter-temporally integrated) when the expected price differential does not exceed the cost of storage.

The study of market integration can suggest to the producer as to where, when and how much to sell, which in turn will have a bearing on their production strategies and hence resource allocation. Integrated markets are those where prices are determined interdependently (Yogisha, 2006). Fulton et al. (2008) observed that, the examination of the extent of how markets were integrated was an important way of understanding whether sufficient market information was available to the market participants.

Goodwin (2001) had stated that understanding the dynamics and/or the degree to which food markets are spatially efficient has key implications for policy makers. A well-integrated market system is essential to household food security especially in both food deficit regions of the country. In addition, flexible prices are thought to be responsible for efficient resource allocation and price transmission is useful in integrating markets both vertically and spatially. Without spatial integration of

markets, price signals may not be transmitted from urban food deficit to rural food surplus areas thereby leading to increased price volatility. Understanding if markets are integrated is important for policy reforms.

Uganda presents a case where local markets are thought to be fragmented. In fragmented markets, a localized crop scarcity can lead to famine in the area if prices in one local market are not highly responsive to those of another. A well-integrated market system is not only necessary for the efficient allocation of productive resources but also for a reduction in price risks that are likely to impair the wellbeing of economic actors most especially the poor and food insecure households (Ravallion, 1986). This is because the success of market reforms depends to a large extent on the strength of price signals transmitted between different market levels (Moghaddasi, 2009).

The knowledge about the extent to which markets are integrated is important for several reasons. First, by identifying groups of closely integrated markets and by knowing the extent of price transmission across different locations within a country, a government may improve the design of its market liberalization policies. For example, it avoids duplication of interventions and as a result, decreases the fiscal burden on the budget. Second, knowledge of market integration allows monitoring of price moments. For example, the knowledge of the speed of adjustment to shocks (for example, in a country's key commodity sector) arising in different areas of the country is paramount to more efficiently managing a price stabilization policy. Third, integration models can be used to forecast prices in neighbouring markets which facilitates forecasting analysis. Finally, by identifying the structural factors responsible for market integration, investment policy in the marketing infrastructure can be improved, because this allows policy makers to understand which kind of marketing infrastructure is more relevant to the development of agricultural markets in a country (Scott, 1995).

## MATERIALS AND METHODS

In carrying out the market integration study, secondary data were obtained from FIT Uganda on weekly wholesale prices of cowpea grains in three districts namely Soroti, Lira and Kampala from 2008 to 2011. Soroti and Lira were considered as the producing zones, while Kampala was considered a purely consumption zone. Wholesale prices were used because they are easily transmitted. These markets were purposively selected based on availability of price data and whether they are located in the production or consumption zone. A total of three (3) markets were sampled. This is shown in Figure 2.

The time series data (prices) was adjusted to two standard deviations from the weakly means as suggested by Goetz and Weber (1986). Missing values were approximated by linearly interpolating the data to account for any missing values between one and three. Where the missing values are more than three, prices from nearby market was used to replace for missing values since it was hypothesized under spatial arbitrage theory that prices of the same commodity in adjacent markets tend to move in unison

and that they do not divert much from each other according to Tomek and Robinson (1990). The issues of serial correlation and heteroscedasticity in the error terms of the estimated models were tested for heteroscedasticity using the Breush-Pagan (BP) set up. In order to test for serial correction in the error term of the considered model, the Breush-Godfrey approach was applied using an AR (q) model Greene (2002). The data was analyzed using STATA 9 program, after being set to have time series properties and transformed by two major transformations namely natural log and first difference transformations (STACORP Ip, 2005).

## Empirical models

Here, several measures were used to study market integration. Econometric tests were conducted to test the level of cowpea market integration, which include stationarity tests, correlation analysis and the application of new econometric techniques of co-integration analysis using Johansen trace test for bivariate and multivariate models and Granger causality approach (Palaskas and Harriss-White, 1993). On the basis of the fact that only price information was collected by FIT Uganda from private traders in the study markets, this study tests the existence of co-movement and price relationships among markets using co-integration analyses. Co-integration analysis is based on the existence of a stable relation among prices in different localities (Goletti et al., 1995).

Prices move from time to time, and their margins are subject to various shocks. When a long-run linear relation exists among different series, these series are said to be co-integrated. The presence of co-integration between two series was indicative of interdependence; its absence indicates market segmentation. In particular, a segmented link was one were co-integration was rejected in both directions along which the link can be traced. Following Engle and Granger (1987), the co-integration model was composed of two steps: non-stationarity test using the Augmented Dickey Fuller (ADF) test and co-integration analysis. One method was to measure the significance of price relationships between markets in different geographic areas (across space) and to compute bivariate correlation coefficients ( $r$ ) which are then used as a proxy for the level of market integration. A high ( $r$ ) implies market integration and vice versa. The theory of price correlation was explicitly formulated by Stigler (1969). Stigler and Sherwin (1985) linked the statistical test for price correlation to market integration when they proposed examining price correlation as a test for market integration.

The use of correlation coefficients to ascertain the degree of market integration is quite common (Bopape and Christy, 2002; Fafchamps and Gavian, 1995; Mbene, 2005). However, the non-stationary nature of agricultural time series price data and some other common factors, such as occurrences of drought and inflationary pressures can influence prices in markets investigated in such a way that the ( $r$ ) values suggest market integration even if markets are not really integrated. Hence, testing for market integration by only using correlation coefficients could lead to biased results. Five steps were followed during data analysis:

### **Step 1: Determining the optimum lag length**

The dataset was declared time series and a lag-order selection statistic pre-estimated using a combination of the two criterions: the Akaike Information Criterion (AIC), the Hannan-Quinn criterion or the Schwarz criterion to determine the optimal lag length for the cowpea price series. The number of lags included in models was determined using standard information criteria (SBIC) and AIC with priority being given to AIC.

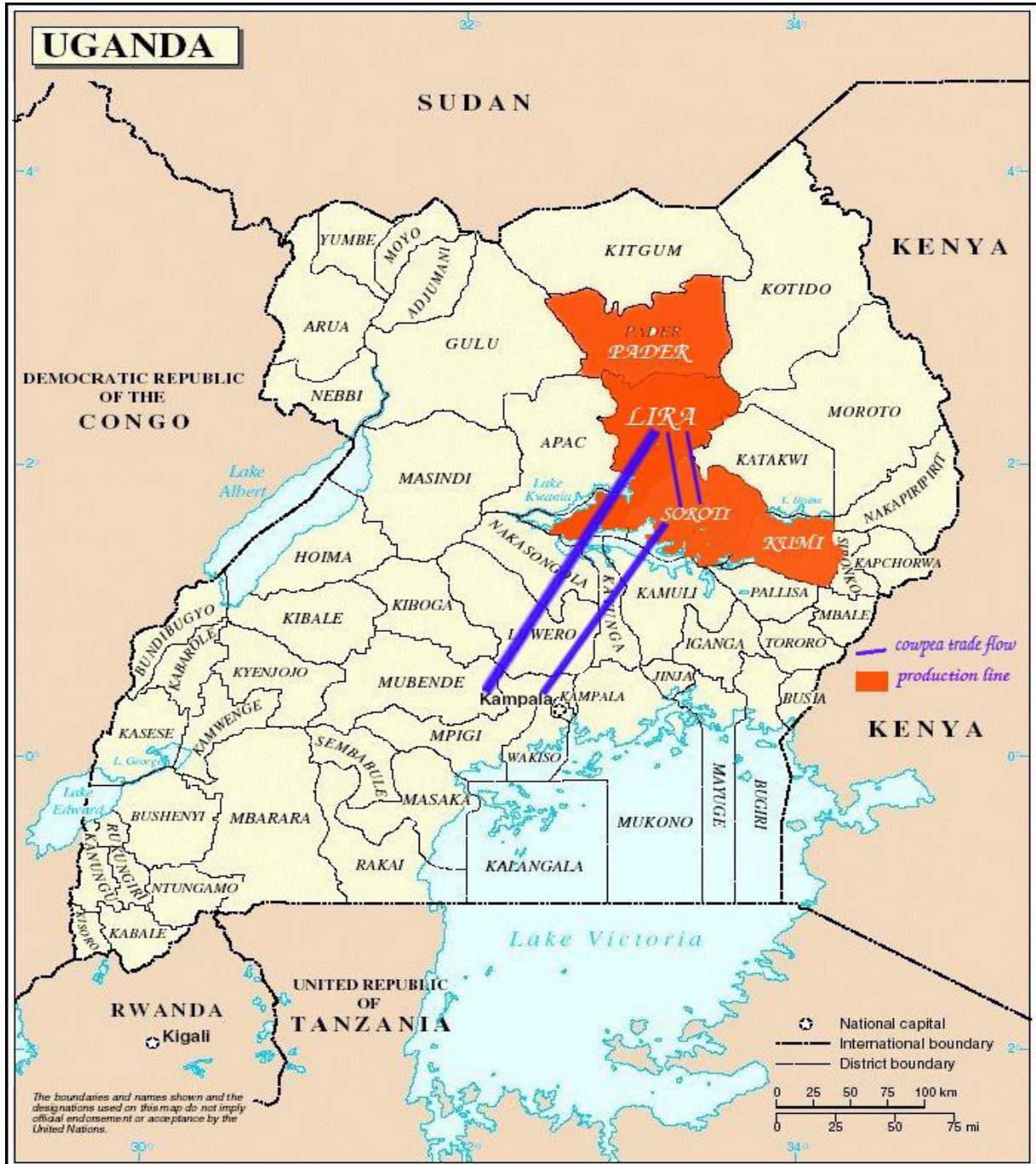


Figure 2. Map of Uganda showing selected study area and location of markets.

**Step 2: Test for stationarity**

The cowpea price series were tested individually for stationarity using the ADF test (Vinuya, 2007; Uchezuba, 2005; Shahidur, 2002). The ADF test which is also known as the unit root test was used to test the null hypothesis that a given price series  $P_t$  is non stationary against the alternative hypothesis that  $P_t$  is stationary by calculating a test statistic  $t$  for  $\beta = 0$  in Equation 1 assuming a random walk process.

Following Gujarati (1995), the model is specified as:

$$P_t = \delta + \rho P_{t-1} + \varepsilon_t \tag{1}$$

Where  $P_t$  is the cowpea price at time  $t$ ,  $P_{t-1}$  is the lagged cowpea price;  $\delta$  is a constant drift;  $\rho$  is the coefficient of lagged cowpea prices and  $\varepsilon$  is the error term;  $t$  is weekly

The model is transformed into a regression test to determine the slope through application of ordinary least squares (OLS) is what is termed the ADF test. The regression was expressed as in

Equation 2 according to Ghosh (2003) and Myint and Siegfried (2005); the test was based on the statistics obtained from applying the OLS method to the following regression equation:

$$\Delta P_{it} = \alpha + \beta P_{it-1} + \delta T + \sum_{\gamma=1}^{k_2} \varphi_{\gamma} \Delta P_{it-\gamma} + \varepsilon_t \quad (2)$$

Where: T = time trend;  $\Delta P_t = P_t - P_{t-1}$ ;  $\Delta P_{t-\gamma} = P_{t-\gamma} - P_{t-\gamma-1}$ ;  $\gamma = 2, 3, \dots, n$ ,  $P_t$  is the price at time t;  $\alpha$ ,  $\beta$ ,  $\gamma$  and  $\varphi_{\gamma}$  are parameters to be estimated and  $\varepsilon_t$  is the error term.  $\gamma$  = number of lags. The null hypothesis of a unit root is  $H_0: \beta = 0$  in Equation 2. The regression was run with a time trend.

According to Bopape and Christy (2002), the trend was only included to rule out the possibility of non stationarity not being due to a deterministic trend. If the observed ADF test statistic is less than the critical values, then the  $P_t$  will be stationary and those found to be non-stationary if the critical value is less than the ADF test statistic. For series that were stationary in levels, these were considered to be integrated of order zero that is, I (0).

### Step 3: Transforming non-stationary series

The non-stationary series were transformed by differencing to obtain stationary series. If  $P_t$  is not stationary at level, it may be stationary at first difference or simply differentiation of this  $P_t$  series. The differenced price series was obtained by simply differentiating Equation 1 through manipulation by subtracting  $P_{t-1}$  from both sides of Equation 1 gives:

$$\begin{aligned} P_t - P_{t-1} &= \delta + \rho P_{t-1} P_{t-1} + \varepsilon_t \\ \Delta P_t &= (\beta - 1) P_{t-1} + \varepsilon_t \\ \Delta P_t &= \alpha P_{t-1} + \varepsilon_t \\ \Delta P_t &= \alpha P_{t-1} + \varepsilon_t. \end{aligned} \quad (3)$$

Where  $\Delta P_t$  is the price difference ( $P_t - P_{t-1}$ ), and  $\alpha$  is equal to  $(\beta - 1)$

To test for stationarity in the differenced time series  $\Delta P_t$  in consideration, the null hypothesis is that  $\alpha = 0$  so that  $\beta = 1$ , in such a case Equation 3 will have a unit root. The series in difference were then tested for stationarity using the ADF test. The alternative hypothesis was accepted for all the series tested meaning that they are integrated of order one that is I(1). The next step therefore was to test for co-integration.

### Step 4: Co-integration test

If two markets are integrated of order zero I(0), then the series are automatically integrated and hence co-integrated; this implies that there is a longrun relationship between them, say  $y_t = \beta_1 x_t + u_t$ , where  $u_t$  is I(0). The two series are not drifting apart over time. If either or both of the series are nonstationary (that is, integrated of order above zero) and of the same order of integration (which implies that the AR and MA processes are nonstationary), then the series may be integrated provided they are cointegrated (that is, there is a linear combination of the series and since only one market (Soroti) was of order (1), no co-integration was run. since

### Step 5: Causality test

To achieve objective 4, the Granger-Causality test was used to

assess the nature of cowpea price transmission across markets and causal relationships among spatially separated markets. This method was used to determine how price changes in one market could explain price changes in another market. Granger-Causality tests focuses on the presence of at least unidirectional causality linkages as an indication of some extent of integration (Gupta and Mueller, 1982) and it assesses whether price movement follows a well-defined path, that is, if price movement starts around demand or production zones and spreads across other markets.

For the series in level I(0), the Autoregressive Distributed Lag (ADL) model was used to test for causality. The model in level was specified as follows:

$$P_{1t} = \alpha_1 + \delta_1 t + \beta_1 P_{1t-1} + \dots + \beta_a P_{1t-a} + \varphi_1 P_{2t-1} + \dots + \varphi_q P_{2t-q} + \varepsilon_{1t} \quad (4)$$

$$P_{2t} = \alpha_2 + \delta_2 t + \theta_1 P_{2t-1} + \dots + \theta_q P_{2t-q} + \sigma_1 P_{1t-1} + \dots + \sigma_a P_{1t-a} + \varepsilon_{2t} \quad (5)$$

Where  $a$  and  $q$  are as defined above.

If we take the case of two markets, Kampala and Lira, where  $P_2$  is the price of cowpeas in Kampala, and  $P_1$  is the price of cowpeas in Lira. Causation can occur in two ways: unidirectional- where shocks in one market affect another market but not the reverse - and bidirectional where shocks in one individual market are transmitted both ways.

Therefore, based on Equations 4 and 5, three hypotheses of causality were tested after running a vector auto-regression for each market pair.

- 1) Unidirectional causality: Kampala prices drives or granger cause Lira prices if any or all the coefficients  $\varphi_1$  to  $\varphi_q$  in Equation 4 are statistically different from zero: Lira prices Granger cause Kampala prices if any or all coefficients  $\sigma_1$  to  $\sigma_a$  in Equation 5 are statistically different from zero
- 2) Bidirectional causality (both Kampala and Lira Granger cause each other) if any or all coefficients  $\sigma_1$  to  $\sigma_a$  in Equations 4 or 5 and if any or all  $\varphi_1$  to  $\varphi_q$  in Equations 4 and 5 are statistically different from zero.
- 3) The two markets are independent if all coefficients  $\sigma_1$  to  $\sigma_a$  in Equation 4 or 5 and  $\varphi_1$  to  $\varphi_q$  in Equations 5 and 4 are not statistically different from zero.

## RESULTS AND DISCUSSION

### Market integration of cowpea grain

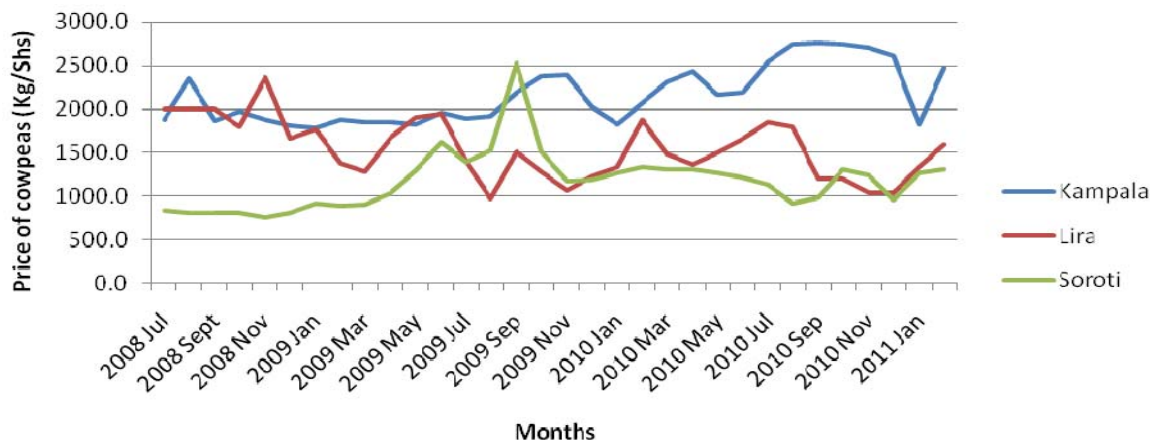
This shows how different cowpea markets in Uganda are interrelated across space. The following discussion is important since data on storage and processing cost were not collected and was not available at the National Statistics Bureau. Weekly wholesale prices for cowpeas collected from 2008 to 2011 by the Fit (U) Ltd were used. Data were collected from Kampala, a major consumption area in Uganda, Soroti and Lira that are primarily production areas. Table 1 summarizes the descriptive statistics computed.

In total, 136 observations on prices were used to test for cowpea market integration. The mean price ranged

**Table 1.** Average weekly cowpea prices in Shs/kg: 2008-2011.

Market	Mean (n = 136)	Standard deviation	Minimum	Maximum
Kampala	2153.4	368.2	1725.0	3191.7
Lira	1542.9	392.5	866.7	2766.7
Soroti	1171.8	346.8	716.7	2833.3

Source: Fit (U) Ltd (2012).



**Figure 3.** Cowpea price variability. Source: Based on monthly price data collected by FIT Uganda.

from 1171.8 Shs/kg in Soroti to 2153.4 Shs/kg in Kampala. The highest and lowest prices were observed in Kampala and Soroti, respectively. The lowest price in Soroti was primarily due to its being a production zone where most of the farmers grow cowpeas (Emaju, 2000) and therefore the demand for the grain was bound to be low. Furthermore, Soroti is quite a distance from the central market making it a challenge for them to sell directly.

This also means that information flow is likely to be slow and farmers consequently choose to sell at low price than incurring expensive transport costs to Kampala since long distance masks presence of high transaction costs (Uchezuba, 2005). Kampala being the central market had the highest price due to the high demand of cowpeas moreover virtually no grain is produced here.

### Cowpea grain prices

Monthly prices of cowpea collected from six urban markets in three districts (Soroti, Lira and Kampala) from July 2008 to April 2011 indicated seasonal variations (Figure 3). As expected, cowpea grains are cheaper during the harvest period and immediately afterwards. There was a clear difference between the prices in different markets. Average cowpea prices ranged from

1250 Shs/kg in December (harvest time) to 2100 Shs/kg in April (lean period). Generally, crop prices set their seasonal low at harvest followed by a post-harvest rally. Post-harvest rallies occur because the supply of the crop is fixed and consumption gradually diminishes that supply, causing prices to rise. Therefore, in terms of the price relationships between Kampala and other markets, Kampala appeared as the dominant market.

It is noted that there are some short run fluctuations for Soroti and Lira markets, while in Kampala market the fluctuations are high and these markets exhibited a non-clear co-movement over time. The lower prices in Soroti and Lira were possibly due to the fact that these areas are production zones and therefore, information flow to these markets is very slow due to long distances and poor infrastructure like feeder roads and lack of storage facilities.

Prices for agricultural products in different markets are largely influenced by seasonality in production, fluctuations in production and the general economic growth within a country. As such price variability becomes a common phenomenon in agricultural outputs due to stochastic nature of the products. The stochastic nature of agricultural outputs is heavily linked to natural factors such as weather and economic factors such as structural transformation in markets, length of different marketing channels, transport and other marketing

**Table 2.** Price correlation matrix.

Markets	Kampala	Soroti	Lira
Kampala	1.00		
Soroti	0.15	1.00	
Lira	-0.31	-0.29	1.00

**Table 3.** Stationarity results using ADF.

Market	Levels		First difference			Critical values	
	t-statistic	No. Lags	t-statistic	No. Lags	Order	1%	5%
Lira	-3.78	1			I(0)	-3.15	-3.45
Kampala	-3.50	3			I(0)	-3.15	-3.45
Soroti	-2.32	2	-8.60	1	I(1)	-3.15	-3.45

infrastructure. Demand factors such as consumer habits, substitution between products and per capita income also influence prices (Katengeza, 2009).

The consumers and other market participants can be affected by a host of daily events such as shocks that affect their behaviour and their response to prices. In turn, their reactions have repercussions on other agents and the ensuing dynamic process leads to determination of prices at each point in time. As such it is of particular importance to understand the variability in prices over time and space in order to give an insight of price behaviour within the period of study.

### The price correlation matrix

Correlation coefficients are preliminary tests for market integration (Mbene, 2005). The size of the correlation coefficients indicates the strength of the relationship between two markets whereby a large coefficient represents a strong relationship. Table 2 shows the bivariate correlation coefficients, which range between -0.31 and 0.15. The coefficients are very low indicating a weak relationship between Kampala, Lira and Soroti markets hence very weak market integration. The lowest correlation coefficient (-0.31) was observed between Kampala and Lira. For Lira, the low coefficients (-0.31 to -0.29) seem to be consistent with the hypothesis that long distances and poor transportation infrastructures make arbitrage unprofitable and isolate markets (Timmer, 1974). The probable reason would be the lack of information, the social class of people in terms of consumers' preference, substitution effect of related commodities like soya peas, beans and groundnuts and the low volume of cowpea consumed and traded.

Correlation coefficients however, are not a proof of market integration but rather are rough indicators of integration and efficiency. There have been criticisms against this approach by several authors such as Barrett (1996) and Negassa et al. (2003) who argued that testing

of market integration is based on correlation coefficients of local prices mask presence of other synchronous factors such as general price inflation, seasonality and population growth among others. As such, Golleti et al. (1995) argued that this problem could be conquered by computing correlation coefficients based on price differences since price differences would largely eliminate the technical problems related to spurious correlation arising from presence of common trends.

### Stationarity result

The results, presented in Table 3 indicated Step 1 as discussed earlier when using the co-integration test. At 1 and 5% levels of confidence, the t-values for integration were greater than the ADF critical values except for Lira and Kampala which are stationary [I(0)], implying that these markets are integrated. This implies that these markets did not share the common trend with Soroti market.

The market which followed a random walk included Soroti. The null at 1 and 5 % cannot be rejected, while Kampala and Lira have no UNIT ROOTs in their current original form. Thus, the null hypothesis at all levels was rejected and concluded that the series are stationary.

Soroti market was considered to be integrated of order one I(1), while results indicates that Lira and Kampala markets were stationary for cowpea price series at levels implying that there exists a long run equilibrium relationship between these markets and that the markets are integrated and spatially linked. The implication here is that prices of cowpea in these two markets move together for a long period of time.

Market integration amongst these markets could be adduced to proper and efficient use of market information flow from Kampala to Lira since Kampala is an upscale market the flow of information to and from is easy. Furthermore, the integration is due to the flow of cowpeas



**Table 4.** Causality results for markets.

Number of lags	Market i	Market j	$\beta_i$	P <sub>i</sub> -value	$\beta_j$	P <sub>j</sub> -vale	Direction of Causality
	Lira	Kampala					
1.			-0.03	0.804	0.037	0.349	
2.			-0.10	0.450			
3.			-0.09	0.474			

P-value = 0.05.

from surplus region to the deficit areas hence cowpeas flow from Lira to Kampala. The storability of the cowpeas resulted into integration as stated by Debaniyu (2013) in which he reported that, the possibility of traders being able to store their products, avails them the opportunity of obtaining reliable information about prices and demand between markets thus promoting integration between markets.

These results indicate an improvement in spatial cowpea market integration in Uganda in the years following the end of the civil war in the north. However, this improvement cannot be attributed to peace alone as market integration is a function of so many factors. For example, Goletti et al. (1995) observed that marketing infrastructure (e.g. roads and communication), volatility of government intervention, and the degree of self-sufficiency in production are the major determinants of market integration.

Kampala and Lira markets were considered to be integrated at  $I(0)$ , hence they are confirmed to be co-integrated. It can be concluded from this results that cowpea markets have a co-integrating relationship with markets in the production and consumption regions, indicating that market participants in this market are well informed about price changes and adapt variously to it. Results further show that Kampala is not co-integrated to Soroti. Traders in Soroti engage in trade with the neighbouring countries like Kenya and South Sudan. Also, the lack of co-integration could be attributed to lack of proper and well-functioning infrastructure such as roads. This could have led to difficulty in transferring the commodity from surplus regions to deficit areas. This also masks the presence of high transaction costs which is a key factor in efficient arbitrage conditions (Uchezuba, 2005). In addition, Teravaninthon and Raballand (2009) listed the ways that poor roads increase transport costs: higher fuel consumption, higher maintenance costs, faster depreciation of vehicles, tire replacement costs, and lost time due to lower speeds. Several studies have quantified the effect of road quality on transport costs and market integration.

### Granger-Causality

In order to determine whether there are any causal relationships in prices among co-integrated markets,

Granger-Causality test was carried out and the results are presented in Table 4.

Results indicate no causality implying independent causation between markets at Kampala and Lira. These markets do not depend on each other, meaning that prices in one market do not react to any deviation or changes of price in the other market from its equilibrium path.

It is concluded that there is no leading market whose price changes influences all other markets as presented in the Granger-Causality results. The result revealed that price changes of cowpea in the markets studied are organized around more than one market. This is similar to the nature of markets in developing countries, where markets are usually more complex than is portrayed by the Ravallion radial configuration of markets.

Co-integration between two variables was proposed by Granger (1986) as indicative of the existence of causality between them. Additionally, if two markets are integrated, the price in one market would be found to have an impact on the price in the other market. The independent causality from the results of Granger-Causality tests are non consistent with such a statement. On the other hand, lack of Granger-Causality may not imply an absence of transmission, as price signals may be transmitted instantaneously under special circumstances, which are expected for a staple food commodity like cowpeas (Abdulai, 2006).

### CONCLUSIONS AND POLICY RECOMMENDATIONS

Cowpeas remain an important legume in the three ecological zones of Uganda. However, price fluctuations have constrained farmer's production and productivity of this important legume.

Prices in different markets are not equally responsive to changes in the supply of cowpeas, thus cowpea markets in Uganda as a whole are not fully integrated. This is not a surprising result since it can be linked to the consumer habits, transport costs and general lack of market information.

There is no leading market whose price changes influences all other markets since price changes of cowpea in the markets studied are organized around more than one market. This relates with the nature of markets in developing countries, where markets are

usually more complex than is portrayed by the Ravallion radial configuration of markets.

To realize the potential of cowpea, infrastructure and accessibility to markets have to be improved. There is need to improve on paved road and telephone density so as to ease the flow of goods and information hence improving cowpea market integration.

There is need to improve on provision of market information on price dissemination to all actors. This can be through improving information access through media information, agricultural shows and formation of an efficient information system.

Following the results from this study, two further studies need to be done. Firstly, there is need to empirically test all the hypothesized factors affecting market integration of cowpeas in Uganda. Such a study will need to use annual data that is still difficult to get. Secondly, there is need to analyze the value chain of cowpea in Uganda to map all products, consumption patterns, actors and possible products along the product chain in order to fully understand the flow of cowpea from the domestic to regional markets.

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