SEASONAL VARIABILITY OF RICE PRICES, TEMPORAL AND SPATIAL BUSINESS OPPORTUNITIES IN THE MAJOR RICE PRODUCTION AREAS OF TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

Rice farmers have a tendency to sell their rice right after harvesting, thus they have been facing low rice prices which lead to low income, consumption of other food items and welfare. This study assessed the seasonal rice price variation, its magnitude and identified the opportunities in time and space for rice farmers and traders in Tanzania. The five leading rice producing regions; Mbeya, Morogoro, Mwanza, Tabora and Shinyanga were selected to represent rice markets in Tanzania. The selection of these markets allowed comparisons of marketing opportunities within and between regions. The ratio to moving average was employed in the analysis of the time series data from 1996-2012 obtained from the Ministry of Industry, Trade and Marketing in Tanzania. Basing on Coefficient of variation, the results indicated that seasonality existed as prices were the highest in April and the lowest in August. Thus, farmers would gain more by storing rice during the harvest period for future sale around April when prices were high. With respect to business opportunity between regions, the results show that the prospect for inter-regional rice trade was better when Gross real return to storage per unit distance increased between pairs of the markets. However, nearby inter-regional trade is more profitable as compared to far distance. Long-term analysis of market information is crucial to inform inter-regional trade decisions and minimize vulnerability level resulting from seasonal price variability.

DECLARATION

I, Theresia Isaack Nsumba, do hereby declare to the Senate of Sokoine University of Agriculture, that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted for degree award in any other institution**.**

________________________ ________________________

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The above declaration is confirmed by;

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Prof. F. T. M. Kilima Date

(Supervisor)

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DEDICATION

This dissertation is dedicated to my beloved parents; my father, Mr. Isaack Nsumba Kalulu and my mother Leokadia Lazaro Mapondo who had good vision to lay the foundation of my education. The dissertation is also dedicated to my lovely Sons David, Denis and Derick for their kindness, heartedly love and being obedient to me during the whole period of my study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATION AND ACRONYMS

CMA	Centered Moving Average
CoV	Coefficient of Variation
Ê	Average Seasonal Factor
E	Seasonal Factor
ESRF	Economic and Social Research Foundation
FAO	Food and Agriculture Organization
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GRSR	Gross Real Storage Return
GSI	Grand Seasonal Index
GSR	Gross Storage Return
IRR	Internal Rate of Return
NMB	National Microfinance Bank
NPV	Net Present Value
OMS	Open Market Sales
PASS	Private Agriculture Sector Support
RLDC	Rural Livelihood Development Company
ROI	Return on Investment

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Rice is the second most important food and cash crop in Tanzania after maize. It is one of the major sources of employment, income and food security for rural farmers (PASS, 2013). According to RLDC (2009), Tanzania is the second largest producer of rice in Southern Africa after Madagascar with an estimated annual production of 818 000 tones. The area under rice cultivation in 2012 was 720 000 hectares and the average yield was generally low (1.8 t/ ha) while the maximum yield was estimated at 4t /ha (PASS, 2013).

About 71 % of the rice grown in Tanzania has been under rain-fed conditions, while 29% is grown under large-scale rice irrigation schemes that were formerly state-managed farms (RLDC, 2009). The crop is mainly grown in Mwanza, Shinyanga, Morogoro, Tabora, Kilimanjaro, Coast, Mbeya and Rukwa Regions (PASS, 2013). About half of the production comes from Morogoro, Shinyanga, and Mwanza regions (RLDC, 2009).

Rice is an important crop in many areas of Tanzania and has a significant effect on food security and income of smallholder farmers (PASS, 2013). Price variability of rice is normally high, which limits the scope of its production and sustainability. According to FAO (2011) price variability increases poverty among small holder farmers, because rice contributes a large share of their income.

The price variability of rice has been negatively affecting the income of the small holder farmers (FAO, 2011). The price variability, which cannot be managed with existing risk management tools, can destabilize income of the farmers, and inhibit them from investing in agriculture, thus farmers can decide to invest in other sectors apart from agriculture (Awoyemi, 2005). However, price variability can potentially allow the farmers to get high profit if they decide not to sell their harvest until the rice prices go up (Kilima *et al*, 2013).

According to Kawamala (2013), the variability of rice prices has been influenced by more demand than supply, the demand for rice in Tanzania is estimated to keep increasing because, among other reasons, there is a high rate of urbanization and changes in consumers' preference of rice both in urban and rural areas. For example, the rice consumption in 2011 was 1.15 million tones, while in 2020 is forecasted to be 2.84 million tones.

Kilima *et al.* (2013) further argued that the unstable fuel prices cause the rice price to fluctuate more often due to the high cost of transporting the rice from the farm area to the markets, also low rice production and storage technology affect the production of rice in terms of high cost of production and the long incubation period, when poor technology is used in rice production, price tends to rise compared to high technologies which reduce the total cost of production. Therefore, this study provides information on seasonal and temporal market opportunities for farmers and policy makers so that they can facilitate storage of rice and enhance spatial market arrangement so as to secure more income for farmers.

1.2 Problem Statement and Justification

Price fluctuations undermine the ability of smallholder farmers to generate income by making earnings uncertain and reducing the consumption of other purchased food items.

Unpredictable price fluctuations have been identified to have negative welfare effects on smallholder farmers who tend to be net sellers during the harvest and net buyers in subsequent periods (Kilima *et al.,* 2013; Jayne, 2012). Therefore, grain storage is an important decision for smallholder rice farmers with few assets and access to livelihood options as stored grain is an attractive form of precautionary saving for these farmers to ensure smooth supply of food and cash after selling the stored food (Kilima *et al.,* 2013; Park, 2006).

Several studies have examined trends in crop prices but did not explore opportunity for rice business within and between regions. Kilima *et al.* (2013) examined the seasonal price variability of sorghum and pearl millet in drought prone areas of Tanzania. Mustapha and Richard (2013) used secondary data to measure food price variability in African nations including Tanzania. Economic and Social Research Foundation (ESRF) assessed the trend of rice price in different rice markets. However, these studies did not explore temporal and spatial market opportunities resulting from price variation for commodities considered. Unlike these previous studies, this study analyzed the seasonal price variability and identified temporal and spatial market opportunities for rice in study areas.

The findings in this study will help farmers to understand seasonal patterns and enable them to adopt well- informed storage and sale strategies as well as inform policy makers to identify seasonal and long-run changes in price for appropriate policy responses.

Seasonal price variability is a general change in the price level over time. It is one of the problems affecting agricultural sectors (Barmon and Chaudhury, 2012). Price variability is an important component of profit and therefore it is important to quantify it. Furthermore, commodity investment behavior, farm income, policy, and food security are all impacted by price variation. This fluctuation has negative impact on farmers as they fail to forecast future prices, especially when the magnitude is high. When prices remain abnormally high for some times, many farmers tend to increase the area under production expecting to realize the high price in future this leads to over-supply of the commodity and hence the low price. After periods of low prices, some farmers tend to reduce production, thus creating sharp drop in supply and price increase in future.

This scenario of abnormal high price does not benefit the farmers in the long run, it leads the majority to have poor plans as it is only the consistent farmers who benefit from price variation over the long term. However, it is important to note that the welfare impacts of high price levels are ambiguous as farmers can benefit while consumers lose (Kornher, 2015). A reduction in prices has the opposite effect. Conversely, price variability makes future prices less predictable, and thus creates risk for all market participants. According to Barmon and Chaudhury (2012) if the variability is large and cannot be predicted, it creates some level of uncertainty which increases risks for both farmers, traders, consumers and the governments and may lead to sub-optimal decisions. The degree of price variability determines farmer's vulnerability to price shocks (Minot, 2010).

1.3 Research Objectives

1.3.1 Ovarall objective

The overall objective of this study was to analyze the seasonal variability of rice prices in study areas and draw specific lessons to inform chain actors about the business opportunities.

1.3.2 Specific objectives

i To analyze the spatial and temporal rice price variability in the study areas.

ii To identify temporal and spatial market opportunities for rice in the study areas.

1.3.3 Research questions

i. What is the magnitude of rice price variability in study areas?

ii. Are there temporal and spatial market opportunities within and between regions that produce rice?

1.3.5 Organization of the dissertation

This dissertation constitutes five (5) chapters; chapter one covers the introduction of the problem which was dealt by this study, chapter two covers a review of different relevant literature, chapter three covers the research methodology which presents the entire layout of the study undertaken, chapter four covers presentation of results and discussion of findings, and chapter five covers conclusions and recommendations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Seasonal price variability

The available literature shows that price variability is mainly caused by inelastic demand, seasonal nature of agricultural products and long production cycles of these products (Awoyemi, 2005; Barmon and Chaudhury, 2012 ; Camara, 2013). A sudden increase in supply during harvest leads to decrease in price and vice- versa. Other factors include the degree of market integration of products (Mwiinga, 2009) and whether production is rain-fed or under irrigation. If markets are well integrated price tends to be stable owing to spatial movement of commodities. In areas where irrigation takes place seasonal price variability tends to be lower than in rain fed areas. Some scholars have reported that lack of storage facilities as well as limitations in transportation hinder spatial and temporal arbitrage leading to low price. Lack of communication, good quality and proper packaging also lower prices of agricultural produces.

2.1.2 Effect of price variability

It is important to note that the subject-matter of this dissertation was not only seasonal variability of rice prices but also the magnitude and frequency of price movement in both direction and its impact on farmers as well as consumers. Generally the greater the magnitude of variability the larger is the effect on farmers' consumption, income and welfare. Large increase in price may exacerbate poverty as poor consumers will not be able to afford basic food leading to poor nutrition (Mustapha and Richard, 2013; Camara, 2013).

Farmers are normally concerned with low prices, as it threatens their living standards as well as their longer term viability when income is too low to provide for the family or for the operational needs of the farm. Price uncertainty may result in sub optimal production and investment decisions (FAO, 2011).

A better understanding of price variability is needed to help decision makers develop instruments that allow prices to spread within acceptable bands. Some of the instruments increase average prices while others are designed to moderate prices. According to Dorosh and Shahabuddin (2002), domestic procurement is a policy instruments which attempts to raise average prices (and farmer's incomes) while open market sales (OMS) and other market intervention are designed to moderate prices among consumers when there are severe upward pressure on prices. It is important to note that farmers can benefit from opportunities such as temporal and spatial trade.

2.1.3 Temporal trade

Temporal trade opportunity means the expectation of conducting businesses over time. This opportunity occurs when choices at one time influence the future possibilities and outcomes (Miranda *et al.*, 2013). It involves trade across periods where by trader expect price to increase in the future. The decision whether to store a commodity, how much and for how long depends on individual decision maker and the expected return from storage, which is determined by the price when the decision is made relative to the price at some future date minus the cost of storage (Alexander and Kenkel, 2012).

Venturing in storage requires the decision-makers to trade-off costs and benefits expected at different points in time. Some economists have suggested the use discounted utility model which assumes that people evaluate the pleasures and pains resulting from a decision while financial markets evaluate losses and gains, exponentially ‘discounting’ the value of outcomes according to how delayed they are in time (Frederick, 2002). Takayama and Judge (1971) developed the theory of inter temporal competitive equilibrium which was adopted later by Barrett (2005).

The theory suggests that temporal trade should occur if:

$$r_{i(t+1)} = r_{it} + \pi \quad \text{(1)}$$

Where r_{it} is the price of a commodity in location i in time t, π is the nominal interest rate plus physical storage losses and $r_{i(t+1)}$ is the future price of commodity. In this case rice farmers should store rice for future sale if the expected price covers all other necessary costs associated with storage. Thus storage is important as the stored product moderates the supply over time.

2.1.4 Spatial trade

According to literature grain marketing should incorporate the spatial component as the distribution of economic activity in space determines the pattern of markets across and within locations. Conversely, trade allows firms in a region to specialize in the production of a small number of goods, while consumers and firms demand a much larger basket of products. The benefits that firms in a particular location derive from locating near firms in the same sector have to compensate for the extra costs of exporting goods and importing intermediate inputs (Rossi, 2005). This trade-off results in a variety of possible spatial patterns of production and trade flow. Without spatial integration of markets, price signals will not be transmitted from urban food deficit to rural food surplus areas, prices will be more volatile, agricultural producers will fail to specialize according to long-term comparative advantage, and the gains from trade will not be realized (Trung *et al.*, 2007).

This study concentrated on rice market opportunities within Tanzania but across the five major rice producing regions, the purpose being allowing rice farmers to exploit the pattern of trade that exist among the five region so that they have a wide choice of market outlet which can enable them sell their rice profitably. According to Miranda *et al.* (2013), trade is driven by inter-market profit opportunities that exist. A rice farmer will decide to sell his /her product across region if and only if the expected price is enough to cover, storage, transport cost and all other taxes involved in moving rice from area of production or from store to destination such that:

$$P_{t+1} > P_t + S_t + T_t + V_t \qquad (2)$$

where P_{t+1} is expected price in other location, P_t is the price of rice in a producing region, S_t is the storage costs, T_t is the transport cost and V_t stand for any other expenses involved such as the tax. According to Equation (2) a rice farmers will engage in trade if the necessary condition is satisfied. So a rice trader will continue trading and exhaust all the price benefit up to the point where price is equal to expenses associated with movement of rice from one location to another because beyond this point he/she will be making a loss. It is important for rice farmers in Tanzania to have sufficient information regarding price, demand and other expenses before deciding to sell rice in other locations.

2.1.5 Importance of crop storage

Storage plays an important role in smoothening fluctuations in production from one season or year to the other. Storage is also useful in crop and seed preservation, quality improvement, quantity equalization and market price stabilization (Nduku, 2013). Storage helps in stabilizing price of commodities through stock exchange provided the storage costs are not excessively high (Awoyemi, 2005). Some of the costs involved include cost of storage structure, cost of insecticides and storage loss. It has been established that storage is feasible when the expected price of product covers all the costs incurred during the whole period. According to Kornher (2015), storers choose to provide additional storage as long as the marginal costs of storage do not exceed the expected return from storage in the subsequent period. Storage is considered as an essential part of securing food supply as it smoothes consumption of commodity overtime (Alexander and Kenkel, 2012).

Farmers may store commodities to make profit because they anticipate higher prices in the future (Alexander and Kenkel, 2012). Commodities may be stored un-priced as one may speculate that prices will be higher in the future. Alternatively, the stored commodity may be priced for delivery in a future period when higher future prices have been established.

According to Gouel (2012) one of the primary motivations for on-farm storage is to increase harvest efficiency, during harvest there is often a long wait to deliver commodities to local buyers, which can create bottlenecks. Storage is also used as a means to overcome food insecurity because food will be used when there is scarcity (Kornher, 2015).

Storage helps to stabilize prices of agricultural commodities by checking the tendency of price behavior: when supply is high prices tend to decrease and when supply is low prices tend to increase. Thus, storage moderates prices when there is ample supply and selling the stored commodities during scarce period moderates price *ceteris paribus* (Geman, 2012).

Information on grain storage is needed to facilitate market decisions (Alexander and Kenkel, 2012). Effective use of this information can potentially prevent distressed sale for immediate money as it gives producers power to wait for the emergence of favorable market conditions and get the best value for their produce. Storage through warehouse receipts systems enables producers, farmer organizations and traders to access security, storage and finance (NMB, 2013). This system allows farmers and traders to acquire a documentary title to their produce, which can be used to obtain finance when presented to financial organization. Storage contributes to reducing volatility, while assisting smallholders to better manage risks and participate in markets.

A decision to store a produce is based on the theory of storage developed by Geman and Smith (2012). According to this theory farmer/speculators will engage in commodity transactions based on their expectations of future price changes, typically when the actual price is below the level speculators/farmer expect to prevail in the next period i.e. the long-term mean of the price adjusted for storage and interest rate costs, speculators will store the commodity in order to sell it at a higher price during the next period. In contrast, when the current price is above the next period’s expected value, speculators will not store the commodity (FAO, 2011).

This theory is best suited for commodities which can easily be stored and whose production is unpredictable including rice. The storage model that describes farmers’ decision making based on the price expectation was deemed appropriate to guide storage decision for rice in the current study.

2.2 Review of Analytical Methods

2.2.1 Measuring price variability

Literature shows that there are different methods used to measure the magnitude of price variability. A seasonal index is a way of measuring the seasonal variation that is, to measure the change that is due to seasonal changes in variable, typically sales (Venture, 2005). It portrays the movement of prices over a "typical" year. It shows the average percent by which prices in each of the 12 months differ from average prices over the surrounding 12 month period. A ratio to moving average is one of the methods that can be used to estimate the magnitude of price variability, where by the seasonal index is estimated and used to identify the season pattern of price (Kilima *et al.*, 2013). Other methods include coefficient of variation (Awoyemi, 2005; Nijhoff and Chapoto, 2009; Barmon and Chaudhury, 2012), standard deviation (MRA, 2014) and generalized autoregressive conditional heteroscedasticity (GARCH) (Ngare *et al.*, 2014).

The relative importance of these methods varies from each other. The GARCH process is often preferred by financial modeling professionals because it provides a more real-world context than other forms when trying to predict the prices and rates of financial instruments because it estimate a best-fit autoregressive model, compute auto correlations of the error term and test for significance. The standard deviation measures the amount of variation around an average. A low standard deviation indicates that the data points tend to be very close to the average change and a high standard deviation indicates that the data points are spread out over a wide range of values (MRA, 2014). The Coefficient of variation (CoV) for a single variable aims to describe the dispersion of the variable in a way that does not depend on the variable's measurement unit. A larger value of coefficient of variation implies that there is higher dispersion in a variable that generated the coefficient. The decision on which method to use depends on the nature of the data to be analyzed and what a researcher intends to find. This study adopted the ratio to moving average to analyze the seasonality of rice price variability in Tanzania. This method eliminates the trend, cyclical and irregular component from original data. Trend, cyclical and irregular component are characteristics of time series data.

2.2.2 Identification of temporal and spatial business opportunities

Return to storage is the difference between the cash price today and the price for delivery on some future date, called either the future price or the forward price. If the contemporaneous future price is higher than the current price, this positive price difference represents the return to storage. Decision makers also undertake storage to capture speculative returns, which is the difference between the current price and the expected future price. In case of speculative storage, returns to storage depend on the realized price on the future delivery date relative to the current price and the decision to deliver a product is made based on the expected future price.

Different methods have been used to identify the temporal business opportunities.
Gross storage returns (GSR) can be used to evaluate the viability of grain storage (Ngare *et al.*, 2014). A higher value of GSR indicates that return to storage is higher in the market hence a farmer can store rice for future sale.

Other means to assess the feasibility of storage include net present value (NPV), internal rate of return (IRR) and the payback period (Nduku *et al.,* 2013). The return on investing in storage structures for future expectation of making business depends on the return to storage from holding grain in the storage structure and the cost of the investment in the storage structure. Alexander (2012) identified the return on investment (ROI) as appropriate means to assess the feasibility of storage such that:

$$ROI = \frac{Return\ to\ Storage - Cost\ of\ Investment}{Cost\ of\ Investment} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

In this case a positive ROI means there is return to storage. According to (Alexander and Kenkel, 2012) annual return to storage is the difference between the gain from the expected increase in future prices minus the variable costs as well as cost of the investment.

2.3 Conceptual Framework

The conceptual framework for this study was based on anticipated effect of rice prices on income, consumption and welfare of smallholder farmers and consumers. When prices are low smallholder farmers are adversely affected as their real income decreases and their ability to smooth consumption of other food staff and acquire assets is also decreased thereby undermining their welfare although the reverse applies to consumers. When prices are high rice farmers stand to gain as their real incomes increase and their ability to acquire assets is also improved leading to welfare gains (Fig. 1). Storage and spatial market opportunities are hypothesized to be efficient means to reduce the seasonal variability in prices. These opportunities can also help in addressing problem resulting from changes in supply brought by climatic conditions and government actions such as export ban and importation of rice.

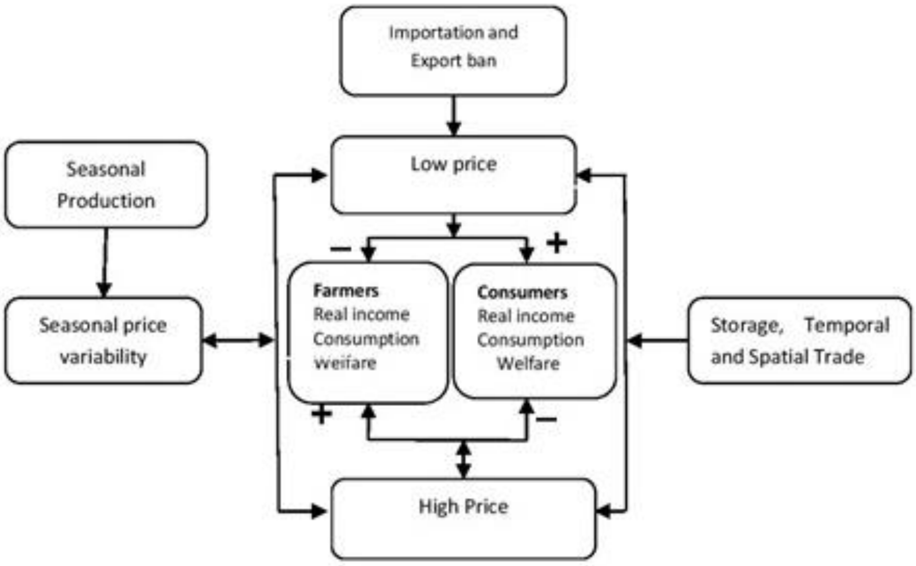

Figure 1: Seasonal variability in rice prices, temporal and spatial arbitrage

Source: Researcher (2017)

In Fig. 1 the effect of seasonal rice price variability on smallholder rice farmers' income depends primarily on four factors: First is the degree (magnitude) of price variability. Generally, the greater the variability, the larger is the effect on farmers' welfare. The second factor is the effect of a given level of price variability on real income (or purchasing power) of the farmer. The proportional effect on income depends on whether farmers are net buyer or seller. Farmers who derive a large share of their income from sale of the rice suffer mostly when prices are low. This also applies to consumers who spend a large share of their income to purchase rice. The third factor is the degree to which the variability in income is translated into fluctuations in consumption (real value of consumption expenditure). Smallholder farmers and consumers with high income or valuable assets are more able to smooth consumption during income shortfalls as they can rely on savings, borrowing, and sale of non-productive assets. Poor farmers and consumers, and those with relatively less assets may fail to smooth consumption easily and might be forced to reduce the consumption of non-food or even food items during hard times. The fourth factor is the degree to which variability in consumption affects farmer's and consumer's welfare. Again, high-income households can experience a reduction in consumption with less adverse effect on welfare. Poor farmers and consumers cannot reduce consumption without risking their health.

Temporal and spatial business opportunities can allow grain storage that can stabilize prices, farmers' income as well as consumption level leading to better welfare for both rice farmers and consumers.

CHAPTER THREE

3.0 METHODOLOGY

This chapter outlines the methodology that was adopted for this study. It describes the study area, data collection procedures and tools employed in data analysis.

3.1 Description of Study Area

The study was conducted in five regions within Tanzania where rice was produced in large quantities. These regions were Mwanza, Shinyanga, Morogoro, Tabora and Mbeya (Fig. 2).

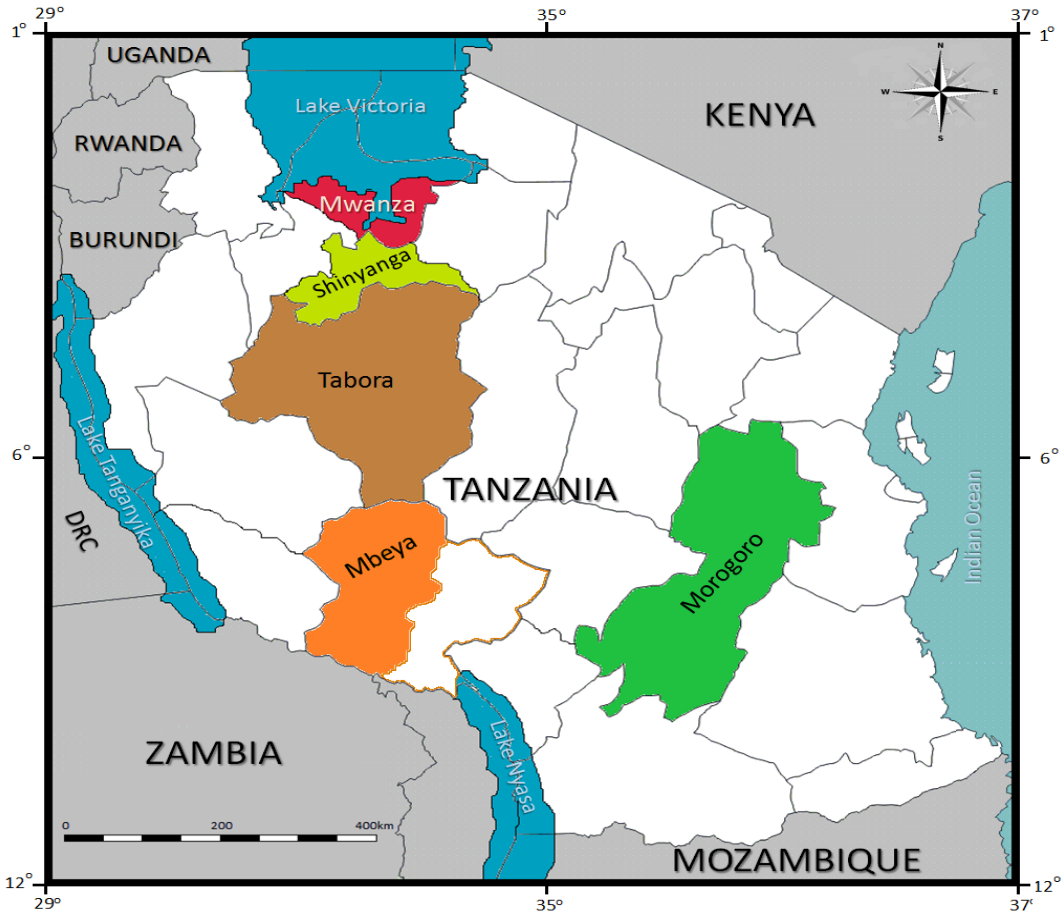

Figure 2: Map of Tanzania showing the study areas

3.2 Sampling Procedures

The study employed purposive sampling, where the five leading regions in the production of rice were selected. According to PASS (2013), the leading regions in rice production are Mbeya (Mbarali, Kyela, Kapunga), Morogoro (Kilombero, Wami- Dakawa) Mwanza, Shinyanga (Bariadi & Maswa), Tabora (Igunga), Kilimanjaro (lower Moshi), Coast (Rufiji, Lindi) and Rukwa.

3.3 Data Collection

The study used secondary data collected by the Ministry of Industry, Trade and Marketing in Tanzania. These data were monthly prices of rice from 1996 to 2012, which also reflects the price of paddy. When the price paddy increases or decreases the price of rice increases or decreases too. In this study the behavior response of rice prices is assumed to reflect the behavior response of paddy prices.

3.4 Data Analysis

3.4.1 Objective one

The ratio to moving average method was used to analyze the spatial and temporal rice price variability and estimate the magnitude of rice price variability in the selected regions. The method is commonly used since it eliminates the trend, cyclical and irregular component from the original data. This analysis was achieved by moving the arithmetic mean values through the time series. Mathematically, it is defined as the ratio of observed values of the price (Yt) to centered moving average (CMA). A centered moving average is normally expressed as a single value and was computed from weighted moving averages over a specified period (Blyn, 1973). For a time series Y with observation Y1,Y2,…, Yn the CMA for the 2nd to nth value (CMA, 2-*n*) was computed as shown in Equation 4

$$CMA_{2,n} = \frac{Y_1+Y_2+Y_3+Y_4 \ldots\ldots +Y_n}{n} \ldots\ldots (4)$$

Where,

$CMA_{2,n}$	=	Centered Moving Average
Y_t	=	Price in time t (t=1,2,3…..n)
n	=	16 years

This moving average represents typical level of time series for the period that is centered. The centered moving average represents the deseasonalized data and was needed to calculate degree of seasonality, which is formally referred to as seasonal factor and was computed as the ratio of the actual value of the time series variable to the deseasonalized value as shown below.

$$E = \frac{Y_t}{CMA} \ldots\ldots (5)$$

Where,

E	=	Seasonal Factor
Y_t	=	Price in year t
CMA	=	Centered Moving Average

A typical set of monthly indexes consist of 12 indexes that are representative of the data for a twelve month period. Each index is a percent with an average for the year equal to 100. Thus, each monthly index indicates the level of rice prices in relation to average of 100 (Kenney and Keeping, 1963).

A typical seasonal index is an average of the seasonal index that removes all random movement of the time-series and it represents a pure seasonal average of the series during the period under analysis, it shows the real seasonal fluctuation for the prices that make the series.

A seasonal price variation was examined by calculating seasonal price indexes using monthly data where each month's price index was computed as the average (Ê)for years that falls within that month. This average seasonal factor was used to deseasonalize the time series as price levels were expected to vary significantly from year to year. This deseasonalization was achieved through multiplying the (Ê)by 100 which is the average price for the year. The deseasonalized prices were evaluated to determine how much the expected prices changed over years and hence provide information needed to guide storage decision. In other literature this value is called Grand Season Index (GSI) and is calculated as shown in the Equation 6.

$$GSI = SI_i \frac{1200}{\Sigma_i SI_i} \quad (6)$$

Where,

GSI = Grand Season Index

SI_i = The average season index for month *i*

The magnitude of rice price variability was calculated as percentage of the difference between highest and lowest deseasonalized price in each year as shown in Equation 7.

$$N_t = \frac{Maximum\ Price - Minimum\ Price}{Minimum\ Price}\ x\ 100 \quad (7)$$

where,

N_t = Magnitude of rice price variability in year *t*

The average represents the magnitude of rice price variability for the series from 1996-2012. The magnitude of rice price variability in each region was calculated as the average for each year from 1996 to 2012.

3.4.2 Objective two

Temporal and spatial business opportunity was identified using Gross Real Storage Returns (GRSR). This method was used to gauge whether it was feasible to store rice and sell when prices were high. Gross refers to the fact that no adjustments have been made for cost of storage and real refers to the fact that the trend and hence inflationary trend has been removed (Aminu, 2003). This method is used when the information on cost of storage and transport are not available. GRSR is estimated from Average Seasonal factor which measures average change in the seasonal components of prices. The GRSR was calculated by computing the percentage increase from seasonal low to seasonal high as shown Equation 8.

$$GRSR = \frac{Highest\ \hat{E} - Lowest\ \hat{E}}{Lowest\ \hat{E}} x100 \quad \ldots\ldots(8)$$

A higher Percentage value of GRSR indicates that the return to storage of rice is higher in the market.

A pair wise matrix was generated and used to identify the gain obtained from spatial trade as per details in Equation (9).

$$\text{Gain} = \frac{\text{GRSR}}{\text{Distance}} \quad \ldots\ldots(9)$$

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Seasonal Variation in Rice Prices

Results from the seasonal analysis of the five rice markets of Mbeya, Morogoro, Mwanza, Shinyanga and Tabora that are presented in Appendices 1 through 5 were used to create Table 1 which shows the monthly average seasonal factor for each region. Average seasonal factor (Ê) represents seasonal means for the period under analysis thus show the monthly fluctuation of the prices. The observed seasonal variation have implications on real incomes, consumption and producers welfare. The analysis shows that producers faced considerable risks in production and marketing of rice. However, the observed average seasonal factors (Ês) mean that there are temporal and spatial opportunities for farmers and traders to store rice and benefit from high prices later during off seasons.

Table 1: Average seasonal factors

	Monthly Values (Ês)												
Region	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**∑Ê**
Mbeya	106.6	108.4	111.2	110.9	105.7	92.3	88.5	87.0	92.1	95.4	97.2	105.0	1200
Morogoro	104.5	106.9	110.4	113	110.7	98.4	89.8	86.5	92.6	91.3	94.8	101.3	1200
Mwanza	106.9	106	111.7	112.9	102.4	93.9	89.2	89	96.5	94	95.4	101.9	1200
Shinyanga	108.8	108.0	109.4	110.2	103.1	92.1	87.0	86.9	93.9	96	101.6	102.9	1200
Tabora	104.2	109.1	109.7	113.2	99.3	91.7	91.1	90.3	95.5	94.1	98.6	103.3	1200

The findings in Table 1 show that for all five rice markets the average seasonal factor (Ê) values for each deviate from the average values implying the seasonal nature of rice production in the study regions. The average seasonal factor (Ê) values are above the average from January to May with the maximum values in April except in Tabora where Ê values are above average up to April. The reason for this trend is that December to April is growing period, this implies that the supply of rice is low as only rice which was stored is supplied leading to higher prices during the period. The findings are consistent with Jonathan *et al* (2014)' s study on the extent of seasonality in Kenya, Uganda and Tanzania, the study revealed that regular seasonality appears to contribute between 20 and 40 percent of overall food price volatility in the three countries examined, with wholesale rice prices during the peak months estimated to be 30 to 50 percent higher than those during the troughs.

The average seasonal factor (Ê) values are below the average from June to November the lowest level being in August. These values start to decrease because some of the early planted rice is harvested thereby decreasing price over time. Many farmers tend to sell rice right after harvest to meet some cash obligation, including settling debts and paying school fees for their children. The situation is even worse in August when the values are at the lowest levels because most of the rice is harvested during this period. The values start to increase in September to April and attain the highest levels in December. It is likely that the reason for this increase is associated with the abnormally high demand for rice during Christmas ceremonies.

The findings imply that farmers do not have a reliable market for their rice produces during the harvest period, thus they sell rice at low price and generate little profit compared to the cost incurred during production. The same observation was done by Huka *et al.* (2014) who argued that good price of agricultural produce increase personal income of the farmers to the extent that they afford to meet their basic needs which are: to purchase food, clothes and shelter also taking their children to school as well as acquiring better health services.

However, the low price of agricultural produce during the harvest season leave the farmers in poverty due to low rice price.

It is important to note that the Average Seasonal Factor (Ê) value is lowest in Morogoro (86.5%) followed by Mbeya and Shinyanga (86.9%), Mwanza (89.0%) and Tabora (90.3%). It appears that farmers might have an opportunity to tap into the spatial price difference in Tanzanian regions, even when prices are at the lowest level in the production regions by selling rice to nearby regions. The same comments was made by Eskola (2005), who argued that the farmers can sell the rice produce to other regions of Tanzania, where the prices are relatively higher.

4.2 The Magnitude of Rice Price variability

Appendix 6 reveals different pattern of the deseasonalized wholesale rice price in the study areas. This analysis shows that low and high prices occur in different periods. Levels of rice price variability in all five rice markets are summarized in Table 2.

Table 2: Calculation of the Magnitude of Rice Price Variability

Region	Maximum Price(Max)	Minimum Price (Min)	$\frac{Max - Min}{Min} x\,100$	Range	Average
Mbeya	76803.18	54743.50	40.3	22059.00	65773.34
Morogoro	74546.00	53670.53	38.89	20875.47	64108.26
Mwanza	77544.71	49673.00	56.11	27871.71	63608.86
Shinyanga	71662.52	44515.61	60.98	27146.91	58089.06
Tabora	72374.65	46452.00	55.80	25922.65	59413.32

The information presented in Table 2 reveals that the magnitude of variability for Shinyanga, Mwanza and Tabora region are about 60.98%, 56.11% and 55.8%; respectively. This high level of variability is likely to be associated with the drastic fall in rice prices in 1998 and 2001 (about 200% decrease). The magnitude of variability is relatively low in Mbeya (40.3%) and Morogoro (38.9%) than in the other three regions. These findings suggest that farmers in Shinyanga, Mwanza and Tabora are likely to have unstable earnings from the sale of the crop than those in Mbeya and Morogoro. Thus, the unstable earnings might have led the farmers to experience poverty and poor livelihood.

4.3 Gross Real Storage Return

Gross Real Storage Return (GRSR) was computed in each region in order to find out if it was profitable to keep rice in store and sell during off season when prices were expected to increase. Information presented in Table 1 was used to calculate gross real storage return shown in Table 3.

Table 3: Calculation of Gross Real Storage Return (GRSR)

Regions	Highest Average Seasonal Factor(Ê)		Lowest Average Seasonal Factor (Ê)		GRSR (%)
Mbeya	111.2	March	86.9	August	27.96
Morogoro	113.0	April	86.5	August	30.63
Mwanza	111.7	April	89.2	August	25.20
Shinyanga	110.2	April	86.9	August	26.81
Tabora	113.2	April	90.3	August	20.23

Table 3 indicates that it is feasible to store rice and sell it when price is high. In Mbeya it is more profitable to keep rice in the store for sale in March, while traders in Morogoro, Mwanza, Shinyanga and Tabora contemplating to store grains would gain more if they sale stored rice in April. However, it is important to note that storage is more profitable in Morogoro than other region when storage costs are constant. The findings are similar to the study by Mwanitu (2015) on Profit Efficiency of Kilombero Paddy-Rice Farmers, the study revealed that it is cheaper to store rice in Morogoro, thus paddy-rice farmers were able to realize more gain since they were able to sell their produce in off-season.

4.4 Spatial Trade Arbitrage

A pair wise matrix was used to identify the spatial business opportunity that exists between regions by comparing gain from inter regional trade. The results presented in Table 5 shows potential net gains from inter- regional trade. The gain was computed as the ratio of GRSR to travel distance between market pairs (Appendix 7).

Table 4: Potential gains from inter-regional trade

Regions			Gains	Percentage
Shinyanga	-	Mwanza	0.1645	16.45
Mwanza	-	Shinyanga	0.1546	15.46
Shinyanga	-	Tabora	0.1382	13.82
Tabora	-	Shinyanga	0.1043	10.43
Mwanza	-	Tabora	0.0706	7.06
Tabora	-	Mwanza	0.0567	5.67
Mbeya	-	Mwanza	0.0493	4.93
Morogoro	-	Mbeya	0.0486	4.86
Mbeya	-	Morogoro	0.0444	4.44
Morogoro	-	Shinyanga	0.0384	3.84
Morogoro	-	Tabora	0.0367	3.67
Mbeya	-	Shinyanga	0.0366	3.66
Tabora	-	Mbeya	0.0357	3.57
Shinyanga	-	Mbeya	0.0353	3.53
Shinyanga	-	Morogoro	0.0337	3.37
Morogoro	-	Mwanza	0.0319	3.19
Mbeya	-	Tabora	0.0303	3.03
Mwanza	-	Mbeya	0.0273	2.73
Mwanza	-	Morogoro	0.0263	2.63
Tabora	-	Morogoro	0.0243	2.43

A summary of inter-regional gains presented in Table 4 shows that Shinyanga-Mwanza has the highest gain over all (16.45%) followed by Mwanza-Shinyanga (15.46%) then

Shinyanga –Tabora and Tabora–Shinyanga. The implication is that trading with adjacent region is more profitable than trading with regions which are far from each other as transport cost tend to increase as travel distance increases. According to high transportation costs in the Tanzanian rice producing regions affect considerably the supply chain efficiency of the local farmers, since it is very expensive to transport tonnes of rice from Mbeya to Dar Es Salaam, therefore transport costs become low and affordable if farmers sell their rice produce to nearby regions.

CHAPTER FIVE

5.0 CONCLUSSION AND RECOMMENDATIONS

5.1 Conclusion

This study analysed the season patterns and the magnitude of wholesale rice price in five major rice producing regions using a ratio to moving average. Findings reveal that indexes were above the average from December to May with the maximum in April. Rice farmers could realize high price and thus earn more income if they sell rice during these periods. The indexes were below the Average from June to November with the minimum value in August, selling rice during these periods means realizing less earning. April is an ideal month to sell rice for farmers in the study areas.

The study calculated the magnitude of rice price variability. The findings reveal higher levels of variability (>50%) in Mwanza ,Shinyanga and Tabora than other major rice growing regions that were studied. The implication is that farmers in regions with higher price variability are more likely to have unstable earning from rice than farmers in regions with low price variability *ceteris paribus*. Thus, farmers in Mwanza, Shinyanga and Tabora regions seemed to have comparative advantage in rice storage than farmers in Morogoro and Mbeya.

The prospect for inter-regional trade seems to be more lucrative when specific sources to destination market pairs are involved in rice trade. These pairs are Shinyanga to Mwanza, Mwanza to Shinyanga, Shinyanga toTabora and Tabora to Shinyanga. This implies that farmers in these regions would get more income if they trade with nearby regions than when they decide to trade with the distant regions. Furthermore trade involving sale of rice from Tabora to Morogoro had the lowest gain over all followed Mwanza to Morogoro. This implies that farmers in these regions would get lowest income if they trade to each other.

5.2 Recommendations

Farmers in the study areas stand to gain more if they store rice for future sale in January to May. The strategy is deemed crucial in regions that have high price variability than those with low variability. Initiatives that sensitize farmers to align sale to coincide with seasonal high prices are ideal in addressing farmers vulnerability to price shocks.

The prospect for inter-regional rice trade seems to be better off when trade involves specific pairs of markets in the neighborhoods. Overall, this implies that smallholder farmers would be better when they integrate temporal and spatial sale strategies involving regions in the neighborhoods.

This study hinged on rice surplus regions. Studies that focus on assessing temporal and spatial business opportunities for storable grains involving surplus and deficit regions are worth pursuing.

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APPENDICES

Appendix 1: Seasonal Indices for Mbeya Region

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	∑
1996							0.742	0.784	0.827	0.910	0.963	0.950	
1997	0.952	1.008	1.048	1.069	1.231	1.046	0.972	0.983	0.985	0.975	0.988	1.044	
1998	1.097	1.129	1.175	1.111	0.943	0.855	0.800	0.838	0.845	0.897	0.883	1.015	
1999	1.089	1.234	1.199	1.096	0.984	0.898	0.868	0.838	0.951	0.977	1.042	1.026	
2000	1.023	1.015	1.145	1.096	1.103	0.989	0.842	0.897	0.931	0.993	1.001	1.086	
2001	1.099	1.131	1.103	1.031	1.192	0.812	0.717	0.784	0.872	0.977	1.000	1.121	
2002	1.112	1.122	1.040	1.147	1.021	0.944	0.872	0.776	1.145	0.904	0.772	1.068	
2003	1.102	1.044	1.096	1.084	0.962	0.922	0.940	0.864	0.958	0.884	0.807	1.102	
2004	1.066	1.092	1.152	1.238	1.067	0.923	0.888	0.924	0.902	0.975	1.017	1.058	
2005	1.059	1.077	1.059	1.093	1.053	0.977	0.921	0.859	0.854	0.867	0.849	0.929	
2006	0.964	1.040	1.051	1.231	1.303	0.978	0.949	0.901	0.963	0.986	1.050	1.076	
2007	1.073	1.023	0.965	0.970	0.975	0.985	0.924	0.884	0.935	0.956	0.985	0.987	
2008	1.018	0.874	1.240	1.177	1.120	0.839	0.893	0.859	0.872	0.968	1.035	1.123	
2009	1.110	1.162	1.094	1.016	0.981	0.829	1.027	0.944	0.945	1.007	1.010	1.080	
2010	1.099	1.093	1.099	1.024	0.969	0.888	0.861	0.882	0.868	0.921	0.956	0.997	
2011	1.008	1.061	1.109	1.111	0.957	0.862	0.858	0.818	0.809	0.991	1.120	1.041	
2012	1.080	1.147	1.127	1.153	0.959	0.939							
Mean:E	1.060	1.078	1.106	1.103	1.051	0.918	0.880	0.865	0.916	0.949	0.967	1.044	11.937
Adjusted:E	1.065	1.084	1.112	1.109	1.057	0.923	0.884	0.869	0.921	0.954	0.973	1.049	12
Ê	106.5	108.4	111.2	110.9	105.7	92.3	88.4	86.9	92.1	95.4	97.3	104.9	1200

Appendix 2: Seasonal Indices for Morogoro Region

	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	∑
2004							0.727	0.759	0.818	0.823	0.813	0.846	
2005	0.951	1.143	1.219	1.324	1.474	1.079	0.901	0.798	0.806	0.779	0.883	0.955	
2006	1.143	1.200	1.264	1.197	0.971	0.891	0.797	0.816	0.900	0.945	0.969	1.089	
2007	1.142	1.102	1.074	1.090	1.020	0.974	0.832	0.783	0.992	0.997	1.010	1.030	
2008	1.023	1.030	1.065	1.131	1.164	0.994	0.914	0.846	0.862	0.910	0.976	1.090	
2009	1.106	1.069	1.073	1.088	1.178	0.917	0.955	0.896	0.824	0.904	0.935	0.964	
2010	1.088	1.127	1.185	1.114	0.975	0.875	0.803	0.781	1.330	0.833	0.827	1.166	
2011	0.901	0.952	0.946	0.973	1.080	1.041	0.983	0.917	0.934	0.930	0.936	1.021	
2012	1.124	1.219	1.224	1.167	1.027	0.815	0.788	0.821	0.940	0.983	1.080	1.112	
2013	1.104	1.082	1.027	1.026	0.987	0.968	0.923	0.924	0.926	0.875	0.873	0.870	
2014	0.920	1.001	1.160	1.272	1.291	1.171	0.948	0.867	0.886	0.932	0.962	0.979	
2015	1.030	0.956	1.067	1.041	1.008	1.011	0.938	0.907	0.907	0.975	0.929	0.942	
2016	0.962	0.965	1.149	1.237	1.158	0.968	0.867	0.864	0.915	0.920	0.990	1.066	
2017	1.063	1.072	1.072	1.127	1.025	0.940	1.032	0.964	0.930	0.919	0.987	1.022	
2018	1.033	1.065	1.044	1.055	1.049	1.018	0.941	0.940	0.925	0.922	0.958	0.975	
2019	0.982	0.967	1.005	1.048	1.102	1.040	0.958	0.891	0.852	0.895	0.969	1.011	
2020	1.082	1.083	1.010	1.109	1.134	0.974							
E	1.041	1.064	1.099	1.125	1.103	0.980	0.894	0.861	0.922	0.909	0.944	1.009	11.950
Adjusted E	1.045	1.069	1.104	1.130	1.107	0.984	0.898	0.865	0.926	0.913	0.948	1.013	12.000
Ê	104.5	106.9	110.4	113.0	110.7	98.4	89.9	86.5	92.6	91.3	94.8	101.3	1200

Appendix 3: Seasonal Indices for Mwanza Region

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	∑
1996							0.893	0.860	0.843	0.880	0.935	0.958	
1997	0.927	0.947	1.208	1.260	1.172	1.022	0.933	0.969	0.945	0.883	0.967	0.993	
1998	1.174	1.171	1.254	1.340	1.069	0.979	0.568	0.634	0.733	0.687	0.776	1.032	
1999	1.223	1.168	0.970	0.956	0.874	0.980	1.031	1.027	1.040	1.055	1.032	1.036	
2000	1.050	1.038	1.056	0.870	0.998	0.926	0.963	1.023	1.081	0.963	1.012	1.125	
2001	1.119	1.097	1.097	1.098	1.012	0.834	0.877	0.899	0.920	0.928	0.936	0.998	
2002	1.031	1.079	1.089	1.078	1.092	0.838	0.814	0.799	1.361	0.823	0.908	0.927	
2003	0.916	0.872	1.000	1.073	1.074	0.972	0.964	0.950	1.021	0.969	0.959	1.028	
2004	0.915	1.114	1.267	1.241	0.988	0.853	0.841	0.885	0.987	1.059	1.071	1.128	
2005	1.111	0.981	0.935	1.048	0.985	0.942	0.893	0.890	0.908	0.889	0.853	0.890	
2006	0.957	1.081	1.155	1.209	1.164	1.076	0.957	0.874	0.908	0.992	1.065	1.161	
2007	1.126	1.144	1.121	1.093	0.779	0.711	0.786	0.823	0.969	0.945	0.928	0.980	
2008	0.973	0.963	1.002	1.111	1.151	1.105	0.919	0.868	0.971	0.961	0.956	1.011	
2009	1.208	1.145	1.148	1.089	0.996	0.874	0.891	0.855	0.950	1.032	0.936	1.009	
2010	1.242	1.082	1.246	1.225	0.799	0.786	0.847	0.842	0.810	0.950	0.884	0.952	
2011	0.943	0.908	1.006	1.018	1.116	1.149	1.021	0.970	0.914	0.934	0.966	0.991	
2012	1.100	1.082	1.216	1.258	1.027	0.901							
E	1.063	1.054	1.111	1.123	1.019	0.934	0.887	0.886	0.960	0.934	0.949	1.014	11.934
Adjusted E:	1.069	1.060	1.117	1.129	1.024	0.939	0.892	0.890	0.965	0.940	0.954	1.019	12.000
Ê	106.9	106	111.7	112.9	102.4	93.9	89.2	89	96.5	94	95.4	101.9	1200

Appendix 4: Seasonal Indices for Shinyanga Region

YEAR	JAN	FEB	MARC	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	∑
1996							0.823	0.854	0.837	0.804	0.956	0.873	
1997	0.927	1.035	1.278	1.298	1.236	0.999	0.843	0.881	0.932	0.969	1.06	1.225	
1998	1.435	1.406	0.845	0.935	0.623	0.666	0.722	0.75	0.886	0.823	0.99	0.988	
1999	1.169	1.025	1.054	1.026	1.058	0.997	0.988	0.88	0.774	0.974	1.084	1.116	
2000	1.048	1.015	1.058	1.09	1.064	1.053	0.918	0.92	0.913	0.992	1.058	1.092	
2001	1.136	1.168	1.169	1.229	0.891	0.766	0.831	0.874	0.839	0.952	1.039	1.005	
2002	0.974	0.966	1.067	1.094	1.117	0.894	0.81	0.656	1.495	0.812	0.838	0.869	
2003	0.927	0.922	1.017	1.087	1.013	0.933	1.012	0.989	0.998	0.993	0.979	0.897	
2004	1.077	1.099	1.139	1.24	1.024	0.869	0.83	0.917	1.008	1.075	1.124	1.129	
2005	1.133	0.975	0.86	0.932	1.069	0.892	0.838	0.821	0.977	0.982	0.926	0.871	
2006	0.953	0.976	1.117	1.251	1.37	1.056	0.895	0.921	0.925	0.934	0.947	0.959	
2007	1.109	1.145	1.178	1.106	1.15	0.9	0.694	0.71	0.76	0.954	1.046	1.061	
2008	1.06	1.079	1.067	0.857	0.861	1.032	1	0.953	0.937	1.074	1.035	1.066	
2009	1.073	1.109	1.18	1.168	0.997	0.87	0.777	0.867	0.915	1.002	1.075	1.145	
2010	1.114	1.052	1.077	0.995	0.99	0.872	0.84	0.87	0.853	0.957	0.975	1.007	
2011	1.056	1.02	1.031	0.916	0.992	1.089	0.999	0.951	0.874	0.958	1.014	1.038	
2012	1.095	1.16	1.24	1.288	0.919	0.738							
E	1.081	1.072	1.086	1.094	1.023	0.914	0.864	0.863	0.933	0.953	1.009	1.021	11.914
Adjusted:E	1.088	1.08	1.094	1.102	1.031	0.921	0.87	0.869	0.939	0.96	1.016	1.029	12
Ê	108.8	108	109.4	110.2	103.1	92.1	87	86.9	93.9	96	101.6	102.9	1200

Appendix 5: Seasonal Indices for Tabora Region

YEAR	JAN	FEB	MCH	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	∑
1996							0.751	0.820	0.874	0.928	0.919	0.945	
1997	0.865	0.938	0.958	1.208	1.156	1.210	1.230	0.833	0.863	0.914	1.106	0.996	
1998	1.332	1.578	1.071	0.989	0.720	0.638	0.726	0.644	0.731	0.833	0.903	1.182	
1999	1.113	1.066	1.100	1.029	0.991	1.017	1.006	0.988	0.845	0.942	1.060	1.039	
2000	1.028	1.046	1.046	1.049	1.041	0.972	0.951	1.048	0.958	0.928	1.021	1.116	
2001	1.164	1.181	1.238	1.329	0.491	0.752	0.903	0.940	0.987	0.892	0.956	0.880	
2002	0.731	1.182	1.163	0.984	1.138	0.896	0.875	0.935	1.374	0.822	0.766	0.976	
2003	0.897	0.935	1.048	1.186	1.023	0.942	0.893	0.913	0.942	0.988	1.010	1.009	
2004	1.021	1.030	1.154	1.191	1.046	0.903	0.893	0.869	1.026	1.071	1.081	1.108	
2005	1.122	1.007	0.987	0.963	0.973	0.926	0.944	0.907	0.887	0.866	0.863	0.859	
2006	0.983	1.090	1.123	1.299	1.176	1.008	0.903	0.949	0.946	1.010	1.063	1.085	
2007	1.059	1.061	1.067	1.049	0.944	0.742	0.771	0.854	0.941	0.948	0.962	1.080	
2008	1.023	1.039	1.142	1.176	1.015	0.866	0.881	0.893	1.005	0.983	0.998	1.053	
2009	1.118	1.135	1.109	1.034	0.968	0.911	0.960	0.969	0.974	0.981	0.994	1.005	
2010	1.025	1.048	1.091	1.078	1.021	0.925	0.896	0.911	0.918	0.926	0.911	0.940	
2011	0.939	0.921	0.986	1.160	1.093	1.020	0.886	0.880	0.896	0.917	1.062	1.140	
2012	1.132	1.085	1.157	1.259	0.986	0.840							
E:	1.034	1.084	1.090	1.124	0.986	0.910	0.904	0.897	0.948	0.934	0.980	1.026	11.918
Adjusted:E	1.042	1.091	1.097	1.132	0.993	0.917	0.911	0.903	0.955	0.941	0.986	1.033	12.000
Ê	104.2	109.1	109.7	113.2	99.3	91.7	91.1	90.3	95.5	94.1	98.6	103.3	1200

Appendix 6: Variability of Rice Price in the Study Regions- 1996 to 2012

	Mbeya			**Morogoro**			**Mwanza**			**Shinyanga**			**Tabora**		
	Price Tsh/100kg		**% Change**	**Price Tsh/100kg**		**% Change**	**Price Tsh/100kg**		**% Change**	**Price Tsh/100kg**		**% Change**	**Price Tsh/100kg**		**% Change**
year	**Highest (H)**	**Lowest (L)**	**H-L/100**	**Highest (H)**	**Lowest (L)**	**H-L/100**	**Highest (H)**	**Lowest (L)**	**H-L/100**	**Highest (H)**	**Lowest (L)**	**H-L/100**	**Highest (H)**	**Lowest (L)**	**H-L/100**
1996	34300	21200	62	33,222	19,000	74.85	27,500	21,423	28.37	26,125.00	17,500.00	49.29	43,417	26,250	79.62
1997	43542	29473	47.74	50,500	27,708	82.26	41,136	27,583	49.13	33,423.08	24,388.89	54.10	52,000	26,250	98.3
1998	39475	24625	60.31	41,000	26,192	56.53	39,155	14,444	171.07	37,363.64	13,291.67	181.11	47,150	15,540	203.62
1999	37831	27500	3757	36,531	25,357	44.07	35,600	24,780	43.66	37,230.77	22,500.00	65.47	37,500	28,406	32.01
2000	40000	29933	33.63	39,167	28,800	21.26	33,953	20,000	69.76	40,708.33	35,000.00	16.31	42,111	37,500	12.30
2001	37500	22281	68.31	36,833	25,357	45.26	41,250	25,000	65.00	41,000.00	21,000.00	95.24	43,267	15,250	183.72
2002	36313	24250	49.74	39,021	23,000	69.66	58,104	40,722	42.68	31,329.60	13,583.33	130.65	32,395	16,444	96.9
2003	37417	32500	15.13	43,607	24,667	76.79	53,278	41,231	29.22	38,187.50	21,777.78	75.35	40,000	23,429	70.73
2004	59722	45455	31.4	61,500	41,750	47.31	74,958	56,818	38.60	49,045.00	35,985.71	36.29	54,167	41,286	31.2
2005	56500	44545	26.84	58,875	49,909	17.96	72,917	41,000	77.85	49,250.00	36,773.00	33.93	52,889	40,682	30.00
2006	89625	58682	52.73	92,292	53,600	72.17	78,000	56,818	38.60	85,792.00	53,727.00	59.68	77,500	53,773	44.12
2007	74625	60192	23.97	73,071	64,813	13.76	72,917	41,000	77.85	68,500.00	38,962.00	75.81	65,625	39,900	64.47
2008	108583	67963	59.8	106,875	72,292	47.84	98,182	65,000	51.05	99,318.00	59,100.00	68.05	86,750	63,292	37.06
2009	109167	85462	27.74	121,591	98,955	22.88	117,500	83,077	41.44	109,808.00	72,077.00	52.35	93,542	77,885	20.1
2010	107708	77396	39.16	112,083	92,642	20.99	113,333	65,833	72.15	97,500.00	72,500.00	34.48	87,692	71,083	23.37
2011	175846	97875	79.67	139,250	99,107	30.78	157,750	86,250	82.90	165,500.0	98,214.00	68.51	173,500	83,214	108.49
2012	217500	181308	19.96	181,875	139,250	30.61	202,727	133,462	51.90	208,182	120,385	72.93	200,864	129,500	55.11
Total	1305654	930640	735.7	1,267,293	912,399	774.98	1,318,260	844,441	1031.23	1,218,262.9	756,765.38	1169.55	1,230,369	789,684	1191.12
Ave	76803.18	54743.5	43.28	74546.65	53670.53	45.58706	77544.71	49673	60.66	71662.52	44515.61	68.79	72374.65	46452	70.07