Enhancing Food Security through Access to Domestic Markets in Rural Rwanda: A case study of Nyabihu District

Alfred R. BIZOZA [1,*], Jean Paul NGABO [2]

1. Department of Agricultural Economics and Agribusiness, Faculty of Agriculture, University of Rwanda. P.O. Box. 117, Butare, Rwanda. E-mail: alfredbiz23@gmail.com
2. Department of Agricultural Economics and Agribusiness, Faculty of Agriculture, University of Rwanda. P.O. Box. 117, Butare, Rwanda. E-mail: alfredbiz23@gmail.com
* Corresponding Author

Abstract: Food security constitutes key area for policy and development intervention in Rwanda and elsewhere. The role of the markets is important in promoting food security in terms of food accessibility - one of key components. The aim of this paper is to assess the role of the markets in promoting food security at small scale level, with focus to the maize value chain in four Sectors Nyabihu District, Northern Rwanda. Results from the analysis of data collected among 80 households show that Mukamira and Jenda have higher marketing efficiency compared to Bigorwe and Kabatwa Sectors. Better access to market constitutes major explanation of the observed marketing efficiency; leading to food availability. Extra measures and incentives would be required to continue ensure access to domestic markets by farmers in order to sustain the interventions towards food security in Rural Rwanda.
[Alfred R. BIZOZA, Jean Paul NGABO. **Enhancing Food Security through Access to Domestic Markets in Rural Rwanda: A case study of Nyabihu District.** *Academ Arena* 2014;6(6):1-12]. (ISSN 1553-992X). http://www.sciencepub.net/academia. 1

Key Words: Food security, Market access, Marketing efficiency, Rwanda

1. Introduction

The agricultural sector constitutes the backbone of economic development in Rwanda as in many other parts of Africa. Recent estimates show that agriculture contributes 30 per cent into the national GDP and generates about 80% of total export revenues (MINAGRI 2009). Because of its relevancy, the sector has received a particular attention over time from the government and other development agents. Consequently, main development frameworks such as the country's Vision 2020 and Economic Development Poverty Reduction Strategy (EDPRS) are articulated around the agriculture sector, among other sectors. Since 2000, the Vision 2020 has driven many agricultural development interventions as well as the overall economic development process. Subsequently, the agricultural transformation plan known as PSTA I and PSTA II (2009-12) are leading major changes observed in agricultural sector. Among the objectives of this transformation include: (i) achieve food and nutrition security for all Rwandans and halving poverty, (ii) promote and support private sector initiatives through trade improving policies, value addition and support to public private partnerships (PPPs) and (iii) technology creation, adaptation and transfer by investing in research and skills development to respond to the needs of both farmers and the private sector. These priorities are conditional upon sustainable agricultural intensification, which in turn, require adoption of new technologies that involve purchased inputs to increase labour and land productivity (Dorward *et al*. 2009:7).

Rwanda, in its recent development of the agriculture sector, has focused on agricultural intensification in the last decades. Since 2007, the government initiated a Crop Intensification Program (CIP) as a sub-program of the Rwanda agriculture sector plan (2009-2012). The aim of CIP is to ensure timely and efficient input delivery in rural areas by importing fertilizers in bulk with transport subsidies; leading to productivity increases, food security and rural household income. The core components of this program include land use consolidation, access to input use (fertilizers and seeds), access to extension services, a, regionalization of priority crops (Irish Potato, Rice, Wheat, Maize, Cassava and Beans) and to stimulate reliable, private-sector input and output markets. It is expected that the program will have positive impacts on crop production, food security, and household income. Already, there are some acknowledgments that CIP has improved food security and increased household income (MINAGRI 2011). The remaining research and policy question is to find under which conditions these achievements already registered will remain over a longer period.

Although policies to improve agricultural productivity in Rwanda have been sufficiently initiated, the remaining challenge is to have a strengthened post-harvest handling strategy so that the agricultural production surplus obtained during peak seasons is maintained to avoid post- harvest losses and

shortages when there is off-season (Byerlee *et al*. 2011). Subsequently, if strategies to avoid crop losses at the farm and post-harvest this are likely to induce low production and other related transaction costs such as price increment.

In view of the above background, two important questions are raised: the first regards how to keep farm prices high enough to provide production incentives for farmers while at the same time keeping them low enough to ensure poor consumers' access to food. This question is much linked to the classic food price dilemma. The second concern is about how food must be distributed at minimum costs across the country in order to guarantee continuous food availability during the lean season. There is enough literature that supports the role of the markets in enhancing food security in terms of food availability and accessibility (e.g. Fafchamps 2004).

Furthermore, the notion of agricultural markets in Africa is not a new concept. Previous studies show strong linkages between markets and food security and poverty reduction even in the case of Rwanda (e.g Wanjiku *et al*. 2013). Another example is drawn from Ethiopia where some region would have surplus food while others are starving from lack of food within the same country (Gabre-Madhin 2001). This was also the case in Kenya in 2010. The study by Chamberlin and Jayne (2011) also concurs that the majority of rural smallholder operate under dismal market access conditions, with generally high levels of remoteness and associated high marketing costs and risks, and poor access to information and supporting services. Also, the government plan of 2010-2017 in Rwanda emphasizes the need to enforce agricultural professionalization leading to increased agricultural production, improved storage facilities, and improved market access, sufficient and nutritious food for substance and for markets, among others (GoR 2010). Yet, there is little research in the context of Rwanda to show case on how the access to markets can improve food security. Therefore, the objective of this paper is to assess the effects of market access on food security, with focus to maize value chain in Nyabihu District, Northern Rwanda.

The rest of the paper is organized as follows. Section 2 describes the methodology used to obtain and analyse the data. Section 3 outlines maize value chain in Nyabihu District. Section 4 presents empirical results and discussion from estimating the effect of market access on food security. The paper ends with discussion of the key results and conclusions.

2. Data and Methods

The data used for this study was collected through a household survey conducted in 2012 among 80 respondents in Nyabihu District, Northern Province Rwanda. We followed a stratified random sampling procedure (Bizoza *et al*. 2007; Chiuri *et al*. 2013) to select sample sectors. The survey covered four Sectors out of 12 sectors within the District namely Mukamira, Jenda, Bigogwe and Kabatwa. The target sectors were selected based on their production potentials of maize. Thus, the commodity surveyed is maize. Mukamira and Jenda sectors ((stratum 1) have higher maize production (with an average of 6290 and 4736 tonnes in season 2009A and 2010B, respectively) compared to Bigorwe and Kabatwa (Sectors (Stratum 2) (with an average of 802 and 526 tonnes for the same period, respectively). Clearly, our sample is made with sample population in areas with surplus and those in deficit in maize production.

In each Sector a simple random sample of 20 farmers, 3 brokers, 3 wholesalers and 4 retailers was taken. Information collected from these samples has helped to validate the relationship between access to markets and improved food security in the Rwandan context (FAO 1996). Table (1) presents the sample respondents from each sampled sector. The data was analysed using descriptive and inferential statistics (Babatunde & Oyatoye 2004).

Table 1. Sample respondents per sample sector

Sectors	Farmers	Broker	Wholesalers	Retailers
Mukamira	20	3	3	4
Jenda	20	3	3	4
Bigogwe	20	3	3	4
Kabatwa	20	3	3	4
Total sample	80	12	12	16

Source: own survey, 2011

Geographically, Nyabihu District is located in the Northern province of Rwanda and comprises twelve sectors- a sector is a third level administrative entity from the bottom-up followed by the District. Its estimated geographical space is 521.5 Km^2 with about 280, 210 inhabitants. The population density is estimated at 541 inhabitants per Km^2 compared to 430.64 in 2010 at country level (World Bank 2011). This District is among the well-known potential districts in maize production. For instance, for the period 2007-2009, Nyabihu District is ranked the first in total maize production with an average production of 7, 339.852 tonnes (FAO-Country-STAT-

RWA 2010) (Table 2). The area is characterized with fertile land with clay sandy soil, lateritic and volcanic. The altitude is between 1,460 and 4,507m above sea level with a temperate climate fairly suitable for maize for maize production (DDP 2007).

Table2. Maize production trends per selected Districts (T)

Year/ District	Karongi	Ngororero	Nyabihu	Rubavu	Musanze	Gicumbi	Burera	Rurindo	Kirehe	Nyagatare
2007A	4727	5296	3800	3281	2042	8586	3758	2399	2637	3946
2007B	286	630	3946	3838	1313	1161	1326	789	444	657
2008A	3240	1421	8369	4724	4201	2674	1786	1507	28321	8693
2008B	1275	1067	2600	4232	1689	2250	1404	259	264	711
2009A	2890	2015	17435	9842	7289	8021	5580	2826	2321	3807
2009B	2643	4319	7889	4739	1595	2884	2851	608	2250	2148
2010A	6539	9814	9969	14461	2625	1911	14167	3788	3545	6775
2010B	4025	12326	9806	12036	8983	6395	4846	2185	4746	5913
2011A	4925	12898	22028	20667	18517	8238	18853	5295	3739	8359
2011B	4195	13090	14508	14479	16100	8170	16317	6919	4741	9404
2012A	10 873	16 256	26 928	23 569	21 845	14 300	21 809	8 176	14 690	13 556
2012B	8240	17311	18288	10512	18246	18606	8868	6352	5225	6376
2013A	11951	23058	17152	29486	27857	17779	11292	7259	8953	6588
2013B	4286	5111	9957	17691	6764	7256	9461	4038	7515	8549

Source : FAO-Country-STATA-RWA, 2010
Crop Assessment Reports/Counry-STATA-RWA, 2014

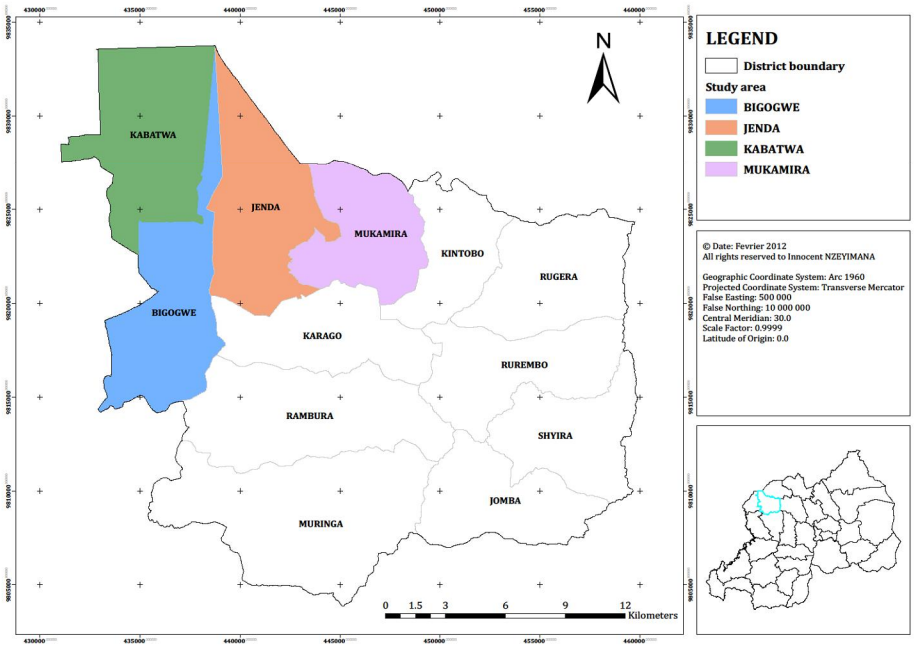

Figure 1: Study area map of Nyabihu District

3. Results and Discussion

3.1. Description of the Maize Value Chain in Nyabihu District

Maize Production and Consumption

Information in this sub-section reveals the estimates of maize production and how this quantity produced is used or allocated to different home uses. Maize is one of the major food and cash crop produced in the Nyabihu District. Two main varieties of maize are produced known as yellow maize and white maize. Out of 80 sample respondents, 54 percent produce the yellow maize variety compared to 17.5 percent who produce the white one during the season 2010A and 2011B. About 29 percent of our samples cultivate the two maize varieties. However, each variety has its respective merits and disadvantages. The yellow variety is low yielding and it is not well appreciated by the existing niche market such as the 'Maizerie de Mukamira'; a miller plant in the study area.

However, this variety has a low vegetative cycle of about 3 to 4 months, with two harvests per year. The white maize variety is highly demanded by the niche market but it has a higher vegetative cycle of about 5 to 7 months compared to the yellow one.

The survey asked the estimates of quantity of maize produced by the respondents per season as well as their allocation between home consumption and the markets. In Table 3 bellow, it is clear that about 47 percent to nearly 60 percent of the maize produced is sold at the farm gate compared to about 30% consumed at household level. The difference between the quantity produced and that of consumption and sales at farm gate is an indication of post-harvest loses in this maize supply chain of about 10percent to nearly 23 percent of total maize production (see next Table 5). Contrary to many other rural areas in Africa, the majority of farmers produce mainly for their subsistence or self-consumption (Orden *et al*. 2004). But, for the case of maize production in the study area, sample farmers seem to engage for domestic markets.

Figure 2 illustrates the maize value chain in Nyabihu District. Though the chain seems to be shortened but it involves high transaction costs. This is similar to many other rural areas in Sub-Saharan Africa due mainly to information asymmetries and inadequate agriculture infrastructure in its broad sense (Ahmed & Donovan 1992).

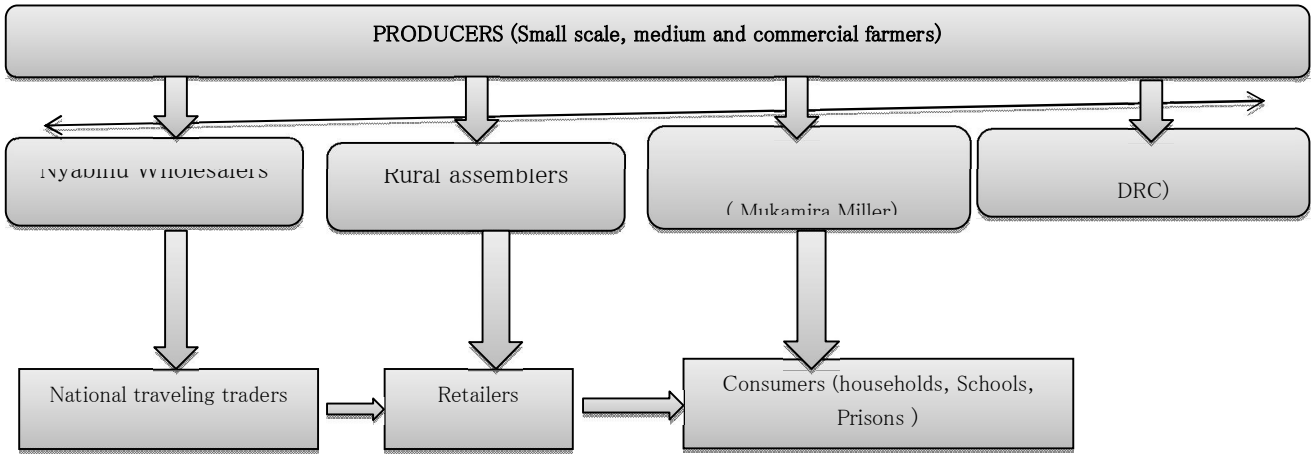

Figure 2: Maize supply value chain in Nyabihu District, Rwanda

Information in Table 3 shows also a relatively increase in terms of quantities of maize production in Mukamira and Jenda Sectors when compared the two seasons (2010A and 2011B); while Bigorwe and Kabatwa experienced a negative trendThe implication of these findings is that there are surplus and deficit areas in the study area calling for an efficient marketing system that easy exchange and enhance access to food through markets. The selling of maize produced at farm gate reflects a poor infrastructure such as lack of appropriate feeder roads and post-harvest facilities (e.g. storage and processing units) which, in turn, explain inefficient marketing system.

Table 3. Total maize production, Consumption, Sales

Sector / Period	Season 2010A (Kg)			Season 2011B (Kg)		
	Production	Consumption	Sold at farm gate	Production	Consumption	Sold at farm gate
Mukamira	25600	5360	15195	29200	6450	18160
Jenda	19850	6850	6800	24300	7300	15000
Bigogwe	8450	3750	3470	5600	2770	2380
Kabatwa	4300	2050	1955	2050	1705	330
Total	58200	18010	27420	61150	18250	35870
% of total production	100	31	47	100	30	59

Source: Own survey

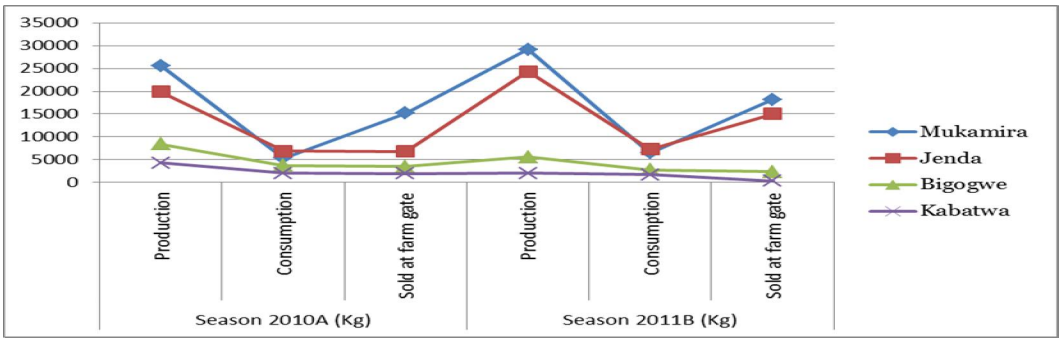

Figure 3: Trends of foof allocation between consumption and Markets.
Source: Own Survey

In this study, sources of maize consumed by household respondents were also investigated. 85 percent of respondents in Mukamira and 70 percent in Jenda reported their own maize produced as major source of maize they consume. On the other hand, sample households in Bigorwe and Kabatwa supplement their own production by about 30 to 35 percent from the domestic markets, respectively. Additional sources of maize although not so important include gift, borrowing, and payment as counterpart for their labour supply for land cultivation (see Table 4). The average estimate expenditure on maize is about RwF 8528 (equivalent to about 15 US dollar at the day). One of lessons in this maize transaction is that the size of the transaction is relatively small while the length of the chain is too long compared to more developed countries where the size of individual transaction across the value chain is seen huge and short (Fafchamps 2004).

Table 4 Source of maize consumed by sample household (%)

	Sectors	Own production	Purchase	Gift	Borrowing	Casual labour	Total
	Mukamira	85.0	10.0	-	-	5.0	100
	Jenda	70.0	15.0	5.0	5.0	5.0	100
	Bigogwe	45.0	30.0	10.0	5.0	10.0	100
	Kabatwa	25.0	35.0	5.0	15.0	20.0	100
Total		48.8	23.2	7.3	8.5	9.8	100

Source: Own survey, 2011

Post-harvest handling of maize production in sample areas

Effective post-harvest handling strategies strengthen crop marketing (MINAGRI 2011). It was revealed in Table 3 (as above) that most of the maize produced is sold at farm gate. Respondents confirm lack of storage facilities (23%) and the need for cash (35 percent) for other pressing needs are the main reasons for selling their maize at farm-gate price. Clearly, poor post-harvest handling mechanisms affect food security strategies. Once these are secured, farmers would make easily their planning in terms of how much to sell when prices are good, how much to consume, and what to sell for immediate income earnings. Secondly, in this situation where post-harvest handling strategies are not well established, farmers become price taker as current conditions do not allow them to wait for the off-season when prices are relatively good.

The efficiency of the markets depends also on existing storage facilities in addition to adequate institutions (e.g. governance structures and property rights). With regard to storage facilities, two important factors are considered namely storage length and incurred losses. Most of storage facilities used by sample farmers are inefficient with regard to length and reduced grain losses. As posted in Table 5 (bellow), woven baskets and sack bags are dominant storage methods used by sample households (75 and 68 percent, respectively). Other techniques such as metal tanks and brick bins encounter low losses and can allow for a longer storage (between 5 to 6 months) but their uses are also beyond farmers' capacity.

Table 4 Maize storage methods and respective storage duration

Storage Method	No of households Farmers	Sample farmer households (%)	Average storage length (Month)	Minimum storage length (month)	Maximum storage length (Month)	Households reporting Loss (%)
Metal tanks	3	4	6.1	5	12	14
Woven baskets	56	70	1.9	1	4	75
Sacks bags	14	18	2	1	5	68
Brick bins	7	8	4.7	3	9	36

Source: Own survey, 2011

Inadequate storage facilities lead to microbial infection. This occurs due partly to improper drying of produce, insect attacks, and insufficient control of rodents, rainfall and high humidity. Once stored crop is exposed to high humidity or actual wetting, this is likely to cause high grain moisture content which, in turn, leads to grain deterioration and fungal infection. It is therefore recommended to use rodents control techniques like use of rodenticides, sanitation, rat guards, rattraps and good rodents proof, insects control techniques, fumigation and residuals contact to prevent maize grain loss. The following Table 6 reports different types of loss agents during maize storage as maintained by sample households.

The above findings have some implications in terms of food security. The availability and stability dimensions of food security require enough and stable food. Once food produced cannot be properly stored, then farmers will face food losses and hence food will not be available. The storage length of about two months (for woven and sack bags) is too short to bridge the two cultural seasons. Thus, grain leftovers are consumed before the next harvest. Consequently, farmers potentially rely on the purchase of maize at local markets at a higher price than what they previously supplied for at farm gate. Therefore, maize storage facilities have the potential to smooth food supply between the peak and lean season and thus influence both food security and the functioning of domestic markets.

Table 5. Maize loss agents during storage (%)

	Sectors	Insects	Mould	Rodents	Rainfall	High humidity	Total
	Mukamira	33.3	16.7	44.4	-	5.6	100.0
	Jenda	15.8	15.8	42.1	15.8	10.5	100.0
	Bigogwe	15.8	31.6	42.1	-	10.5	100.0
	Kabatwa	15.0	40.0	15.0	15.0	15.0	100.0
Total		19.7	26.3	35.5	7.9	10.5	100.0

Source: Own survey, 2011.

Markets and Marketing Efficiency

The main role of the markets is to producers (both at small and large scale) to end consumers. But high service delivery costs in the value chain restrain the supply and access to inputs (Kristen et al., 2009). In the study area, main actors in the maize value chain are nationals, and cross border wholesalers from DRC and Uganda who purchase fresh maize produced from the farm gates and distribute these within and outside Rwanda. This has two major effects: reduced quantity of maize supplied at the domestic markets and low margins or returns to farmers due to high difference between the selling price at the market and at the farm gate. We followed Kohls (1985:83, *cited by* Babatunde & Oyatoye 2004) to estimate marketing margins and marketing efficiency as described by equation (1) and (2).

Marketing Margin = (Selling price) – (Farm gate price) *Equ.* (1)

$$MarketingEfficiency = \frac{NetM\arg in}{MarketingCosts} * 100\% \quad \textit{Equ.}\ (2)$$

In Table 7 and Figure 4 below, the average farm gate price is 9075 Rwf while the retailer price is 11, 300 Rwf. Both the market margin and the marketing efficiency were computed at these farm gate and retailer prices. The computed net market margin varies between 800 and 900 Rwf per 50Kg bag in all study sites.

The marketing costs are higher in Bigorwe and Kabatwa Sectors compared to Mukamira and Jenda. This is expected given that most domestic markets are situated in the neighbourhood of Mukamira and Jenda Sectors. Transport costs are the main constituent of the observed marketing costs. Nearly 39 percent of sample farmers carry their produces by their heads compared to 40 percent who can hire vehicle, especially those from Bigorwe and Kabatwa. In addition, the average distance from the farm to the nearest markets is about 93 minutes or one and half hour. Long distance is observed in Bigorwe (estimate of 129.2 minutes) and Kabatwa (151minutes) compared to 34 and 56 minutes for Mukamira and Jenda, respectively. Distances to the nearest tarmac road and nearest towns show serious challenges, especially due to poor infrastructure in the study area and elsewhere in Rwanda (Chiuri *et al.* 2013). Markerting margins and efficiency do not include the processing costs given that most of respondents sell unprocessed maize at the farm gate and hence the prices considered are for unprocessed maize.

Table 7. Maize marketing margins and marketing efficiency in sample sectors

Sectors	Farm gate Price RwF/50Kg	Retailer selling price RwF/50Kg	Marketing cost RwF/50Kg	Marketing margin RwF/50Kg	Net margin RwF/50Kg	Marketing efficiency %
Mukamira	9000*	11000	1100	2000	900	81.8
Jenda	9500	11500	1200	2000	800	66.6
Bigogwe	9000	11200	1400	2200	800	57.1
Kabatwa	8800	11500	1800	2700	900	50.0
Average	9075	11300.	1375	2225	850	63.9

Source: Field survey, 2011 Note: * 1USD = 600 RwF (Rwandan Francs)

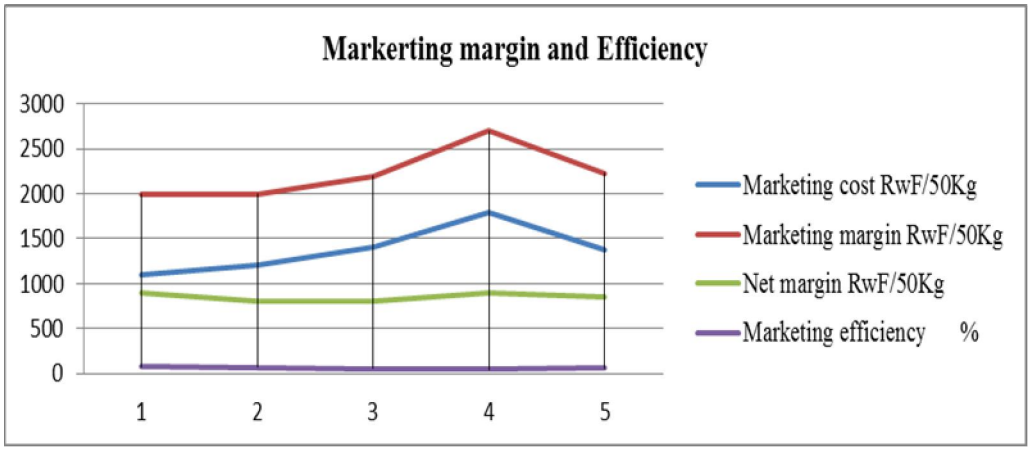

Figure 4: Markerting Margin and Efficiency

The average marketing efficiency for the all study sites is 64 percent. Mukamira and Jenda seem to have higher marketing efficiency (81.8 and 66.6 percent) compared to Bigorwe (57.1 percent) and Kabatwa (50 percent). A very high marketing efficiency would be interpreted as an efficient marketing system (Babatunde & Oyatoye 2004). As for this case study, higher marketing efficiency can be attributed to better physical market accessibility and pricing efficiency (see Olukosi & Isitor 1990). Furthermore, market accessibility depends also on capital intensive infrastructure (such as irrigation, roads, and bridges) and formal and informal institutions (Wharton 1967). Retailing prices are almost similar in the three domestic markets and the trend is somewhat stable in the research areas (see Figure 5) More time series (if available) would have provided general trend over a longer period.

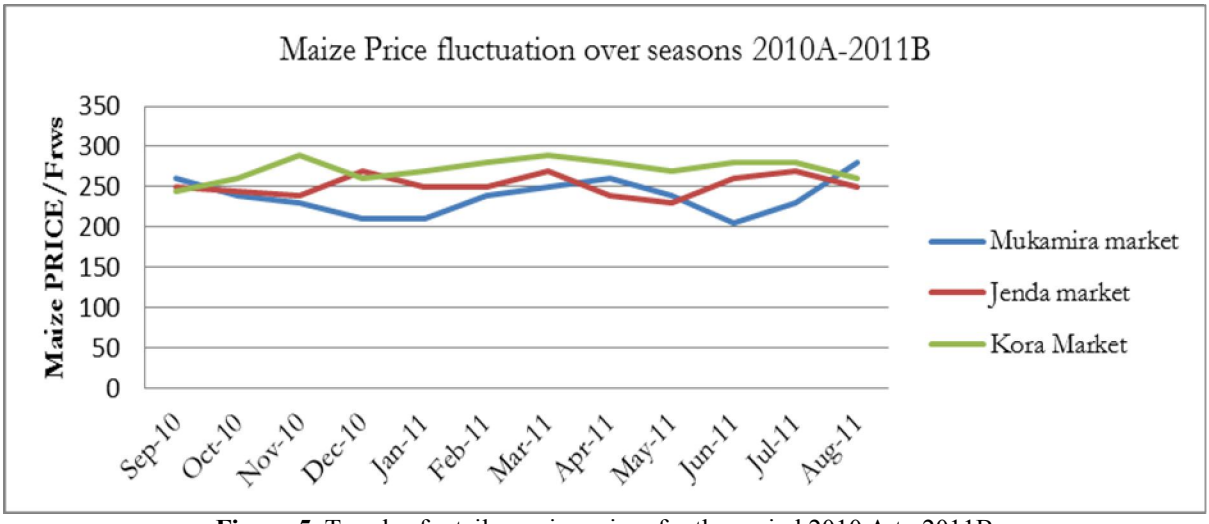

Figure 5. Trends of retailer maize prices for the period 2010 A to 2011B
Source: Own survey, 2011

3.2. Estimating the effect of market accessibility on food security

Model specification

The literature on market accessibility focuses more on the existence of capital intensive infrastructure such as roads and storage facilities (Broun *et al*. 2003; Tembo & Sintowe, 2009). The leading assumption is that investment in infrastructure enables farmer's access to domestic markets and strengthens linkages between markets to other markets, and markets to consumers (Baumol *et al*. 1998). It is assumed that farmers cannot increase their production if they cannot transport their surplus to markets or if the markets are not attractive (Broun *et al*. 2003). Part reason is that agricultural products are private and producers require, therefore, some services that exhibit public good characteristics such as roads and established physical market facilities (Poulton & Lyne 2009).

However, market access involves different notions including the presence of certain physical markets, suppliers and demand. Efficient marketing system in terms of pricing and operational markets can increase food availability as well as its affordability - key dimensions of food security (FAO 1996). We propose to assess the potential effects of access to domestic markets on agricultural production as a proxy for household food security. The effects of markets are measured by a number of parameters as specified in the model. These comprise the presence of physical market, the distance from farm gate to the nearest market, means of transport from home to the market. Table 8 below describes the model variables and socio-economic characteristics of the respondents.

Identified variables contain socio-economic, geophysical and institutional characteristics. These are identified with reference to previous studies on market access and food security (e.g. Agbola *et al*. 2010; Tembo & Simtowe2009). Out of 80 sample households, about 48 percent are female headed households. The average age of sample respondents is about 44 years old, suggesting that the sample population is generally in the active age. Bizoza & Graaff (2010) found a similar average age in Southern and Northern Rwanda. Family size is relatively high (6 members). This has implication in terms of food consumption and hence the family capacity to acquire or supply needed food at the markets.

Table 8. Description of socio-economic characteristics and Model variables (N=80)

Variables	Mean	Std. Dev.	Description
(i) Socioeconomic factors			
Female head	0.48	0.5	Equals 1 if female and 0, otherwise
Age of head	43.73	35.72	Number of years old of the head of household
Family size	6	1.87	Total family members
Head's formal education	0.45	0.50	Years of formal education completed
Total annual household income	27912	31533	Annual income in Rwandan Francs (1USD=600 RFW)
(ii) Geophysical characteristics			
Land Size	0.98	0.89	The size of total land holdings
Means of Transport	0.38	0.49	Equals 1 if the farmer use his/her head and 0, if otherwise (public transport, bicycle, car hire)
Cooperative assistance	0.08	0.28	Equals 1 if a household sells maize through cooperative 0, otherwise
Sector-Production potential	0.50	0.50	Equals 1 if the sector has high potential for maize production and 0, otherwise
Storage facilities	0.19	0.39	Equals 1 if the household owns lower loss facilities such as metal tanks and /or brick bins and 0, if other methods with high potential losses.
Distance	92.96	57.72	Distance from the farm gate to nearest market in walking minutes
Market Position	0.45	0.50	Equal 1 if the household is a supplier of maize and 0, if is consumer.
Physical Market	0.56	0.49	Equals 1 if there is presence of a market within the sample sector and 0, otherwise
(iii) Endogenous variable			
Food Availability	0.56	0.49	The quantity of maize produced for the two seasons

The average land size is less than 1 ha as elsewhere across the country. This sustains the idea of land scarcity that has been documented in previous literature (e.g. Andre & Plateau 1998). If one has to increase its production, improving quality of the existing land through land intensification becomes the main option to expand production area. Other important descriptive statistics include the distance from farm gate to the markets (92 walking minutes). This distance is relatively high as most of farmers have to transport their food by their heads. About 56 percent maintain that the quantity of maize produced is sufficient for their home consumption. The average expenditure on maize consumption suggest that sample respondents spend about 8528 Rwandan Francs which is less than the cost of one 50Kg bag of maize.

To analyse the relationship between food availability and access to market, we estimate a linear model as represented by the following equation (1).

$$Y_i = x_{ki}'\beta_k + u_i \qquad (1)$$

We assume a continuous dependent variable of food availability (Y_i) measured by the total maize production at household level for the two cultural seasons. The x_i represent the explanatory variables specified for this model as above indicated. The u_i capture the residuals of the model. We use the classical Ordinary Least Square Method (OLS) to obtain the model estimates (β_k) (Maddala 1983:120).

Model estimates

The effect of market access on household food security is computed by estimating the above equation (1) following Cameron & Trivedi (2009). Contrary to earlier studies which estimate this effect by considering, mostly, income as a proxy to market accessibility (e.g. Agbola *et al*. 2010). In this case study, we have unpacked the access to market into different components of physical market accessibility: the presence of physical market infrastructure

in the respondent's areas, the distance from farm gate to the nearest market, and the means of transport used to carry the produce. All these components help to measure the physical market accessibility. We also consider household's annual income as a proxy to measure individual's ability to produce or purchase maize for their home consumption or inputs for maize production also known as market affordability or household's ability pay for maize or inputs.

Results from the analysis (see Table 9) support that the current estimated distance from farm gate to the nearest market discourages more access to food. Its coefficient is estimated and is found to be statistically significant (1% level of significance) and negative as expected. The implication is that the more markets are distant from farm gate, the lesser is their accessibility by farmers and this discourages farmers to produce for the market and access food through the market. The survey asked what means of transport often used by sample households in supplying or buying maize from their domestic markets. About 39 percent use their heads for maize transport compared to 61 who use other means of transport such as public transport, bicycle, and car hire. The estimate of the means of transport is positive and statistically significant (at 10%). This result suggests that if more means of transport are available; this encourages farmer's production and also facilitates access to markets for both the purchase and the selling of surplus food. The presence of physical market facilities or infrastructure in the respondents' areas was also estimated positive and statistically significant at 1% level. The implication is that more market facilities are in place; these encourage home production as well as consumption, all else equal. This result is consistent with MINAGRI (2011) that 'the accessibility to national/regional markets (measured in terms of physical distance and time taken to reach market centers) plays a pivotal role in sustaining the production'

Other identified variables to explain the market affordability include household income. The effect of household income on household's food production and availability was found positive and statistically significant at 1% level of significance. These estimates seem to suggest the relevance of market factors in promoting food security as well supported by the study results and confirm the main assumption made in this study. Therefore, these results help to put into perspective the role of domestic markets and purchasing power of famers on food security in rural Rwanda.

Table 9: OLS Estimates of the effect of markets on food availability

Variable	Robust Coefficient (T- Value)
Distance from farm gate to the market	-8.46(-2.75)***
Presence of Physical Market	794.48 (3.22)***
Means of Transport	736.94 (1.86)*
Annual Income	0.012 (3.14)***
Constant	1059.045 (2.03)**
R-Squared	0.3174
Probability – F statistic	15,09***
Observations	80

Dependent Variable: Total Maize Production

Notes: *** (Significance level 1%); ** (5%); *(10%)

4. Conclusions

This article analyses the impact of access to markets on food security in the Northern Rwanda, with focus to the maize value chain. Results maintain that that farmers produce maize for their subsistence and marginally for the domestic markets. Furthermore, deficit sectors (Bigorwe and Kabatwa) depend to some extent on maize from the surplus areas such as Mukamira and Jenda. These results support the thesis of exchange between deficit and surplus areas. Further validation of this assumption can still be done at country level with more sample areas and households in futthe upcoming research projects. . Farmers, national travelling wholesalers and cross border wholesalers from DRC and Uganda are the main actors in the maize value chain in the study sites. The average marketing efficiency for the study area is about 64 percent. Mukamira and Jenda have higher marketing efficiency due to their closeness to the domestic markets compared to Bigorwe and Kabatwa sectors. Higher marketing efficiency in this case would imply lower transactions costs. Mukamira and Jenda are situated nearby domestic markets making the distrance and transport costs to be reduced. Similarly, the analysis of price trends in the three markets – Mukamira, Jenda, and Kora- show that maize prices in these three markets are somewhat similar and stable over the two study seasons (2010A-2011B).

Another significant insight from the analysis is that physical market accessibility and market affordability are two important determinants of food security in the research area. Findings reveal that predicted market access (measured by distance and means of transport) have positive and significant effect

on food availability (also measured by the quantity of maize produced) at 1percent level. This result is consistent with MINAGRI (2011) that 'the accessibility to national/regional markets (measured in terms of physical distance and time taken to reach market centers) plays a pivotal role in sustaining the production'. This implies that establishing infrastructures for domestic markets can stimulate more crop production not only for subsistence but also for markets. Consequently, more crop specialization leading to the notion of comparative advantage is likely to follow. Presence of physical markets is necessary but not sufficient. Meeting the sufficiency condition require, in addition to sufficient food, the ability of consumers to purchase needed food crops. This calls also to the micro-economic budget line condition. In this study, this was measured by the household's income needed to support the production or the purchase of food at household level.

Returning to this study's objective, some general conclusions can be drawn about the role of domestic markets to ensure food security. Food security is and will continue to remain an ultimate goal for the agricultural development of Rwanda. The on-going programme of crop intensification – known also as Rwandan green revolution in the agriculture sector- will be sustainable upon condition of market development in rural areas with focus to more infrastructure such as feeder roads to easy market exchange. More access to markets stimulates both crop production and easy commodity exchange among deficit and surplus zones Evidences from other parts of the country (such as Eastern part) show surplus production of maize due to crop regionalization with no sufficient markets. This is likely to demotivating farmers for more production, especially the mono-cropping and crop regionalization policies are likely to be affected if no actions in that line are taken. Therefore, more development and policy interventions towards food security should not focus only on food production but also on creating an enabling environment for market access. This article acknowledge that the analysis was done at a relatively small scale level to assess how market access can improve food security. We recommend that these are findings are tested at a larger scale in the upcoming research projects. Consequently, the linkages between markets and food security will be more established in rural Rwanda to inform on the policy and development interventions.

References

5. Agbola OP, AdenaikeT& Babalola DA, 2010. Determinants of farmers' access to output markets and the effects on income: a case study of Ikenne local government area, Nigeria. Acta SATECH 3(2):33-39.
6. André C &Plateau JP, 1998.Land Relations Under Unbearable Stress: Rwanda Caught in the Malthusian Trap. Journal of Economic Behavior and Organization Vol 34 pp1-47
7. Ahmed, R. & Donovan C, 1992. Issues of infrastructural development. A synthesis of literature. International Food Policy Research Institute, Washington D.C.: 1-33.
8. Babatunde R & Oyatoye E,2004. Food Security and Marketing Problems in Nigeria, The Case of Maize Marketing in Kwara State. University of Hohenheim, D-70593 Stuttgart, Germany.
9. Baumol WJ & Blinder AS, 1998. Macro-Economics: Principles and Policy (the Dryden Press series in Economics). Harcourt Brace College Publishers, New York.
10. Bizimana C, 2011. Determinants of land rental markets: Theory and Econometric Evidence from rural Rwanda. Journal of Development and Agricultural Economics 3(4): 183-189.
11. Bizoza AR, 2012. Three-Stage analysis of the adoption of soil and water conservation in the Highlands of Rwanda. Journal of land Degradation & Development. Published online. DOI: 10.1002/ldr.2145
12. Bizoza AR, Ortmann G & Lyne MC, 2007. Determinants of the Potato Yield in Gikongoro Province, Rwanda. Africa Insight 37: 1969-1985.
13. Bizoza, A.R. & Graaff Jde,2012. Financial cost-benefit analysis of bench terraces in Rwanda. Land Degradation & Development 23 (2): 103-115.
14. Braun JV, Hazell P, Hoddinott J & Babu S, 2003. Achieving long-term food security in Southern Africa: International perspective, investment strategies and lessons. Keynote paper prepared for the Southern Africa Regional Conference on Agricultural Recovery, Trade and Long-term Food Security "March 26-27, 2003, Gaborone, Botswana.
15. Cameron AC & Trivedi PK,2009. Microeconometrics Using Stata. A Stata Press, College Station, Texas.
16. Chamberlin J & Jayne TS, 2011. Unpacking the mean of "market access". Working paper No. 2011-10. Department of Agricultural, Food Security Resources Economics, Michigan State University, East Lansing, USA.
17. Chiuri W, Birach E,Buruchara R, Adekunle AA, Fatunbi AO, Pali PN, WimbaB, Bizoza AR, Birasa N, Nyamwaro S, Habumugisha P, Tuyisenge J, Bonabana-Wabbi J, Karume K, Kasenge V, Kamugisha, R, Fungo B,

Tumwesigye s, Kato E & Nkonya E, 2013. Market Access for agro-enterprise Diversity in the Lake Kivu Pilot Learning Site of the sub-Sub Saharan Africa Challenge Program. African Journal of Agricultural and Resource Economics 8(3): 120-134.

18. Derek Byerlee D, Melinda Smale M and Jayne T, 2011. Maize Revolutions in Sub-Saharan Africa. Agriculture and Rural Development Team, Development Research Group: Policy Research Working Paper No 5659, The World Bank.
19. DPD,2007. Plan de Développement du District de Nyabihu 2008 -2012. Western Province, Rwanda.
20. Dorward RA& Omamo WS, 2009. A framework for Analyzing Institutions. InKirsten,F.J, Dorward, R.A. Poulton,C, and Vink N. (eds). Institutional Economics Perspectives on African Agricultural Development. International Food Policy Institute, USA.
21. Fafchamps M, 2004. Market Institutions in Sub-Saharan Africa: Theory and Evidence. The MIT Press. Cambridge, Massachusetts, London, England.
22. FAO (1996). FAO World Summit 1996. Rome, Italy.
23. Gabre-Madhin EZ, 2001. Market Institutions,Transaction Costs, and Social Capital in the Ethiopian Grain Market. Washinton, DC, IFPRI Research Report No 124.
24. GOR, 2010. Gahunda ya Guverinoma. Government of Rwanda, Kigali, Rwanda.
25. Kohls RL,1985. Marketing of Agricultural Products**.** Macmillan Publishers, New York,
26. Maddala GS, 1983 . Limited –Dependent and Qualitative Variables in Econometrics. University Press, Cambridge.
27. MINAGRI,2009. Annual report 2009/2010. Ministry of Agriculture and Animal Resources. Kigali, Rwanda.
28. MINAGRI,2011. Strategies for Crop Intensification in Rwanda: Shifting focus from producing enough to producing surplus. Ministry of Agriculture and Animal Resources. Kigali, Rwanda.
29. Olukosi JO & Isitor SV, 1990. Introduction to Agricultural Market and Price; Principles and Applications. Agitab Publishers, Zaria. Raphael Babatunde and Eniola.
30. Orden D, Torero M& Gulati A.2004. Agricultural markets and Rural Poor. Draft Background paper for workshop of the Poverty Reduction Network (POVNET). IFPRI, Washington D.C. USA.
31. Poulton C & Lyne MC,2009. Coordination for Market Development. In Kirsten,F.J, Dorward, R.A. Poulton,C, and Vink N. (eds). Institutional Economics Perspectives on African Agricultural Development. International Food Policy Institute, USA.
32. Tembo D & Sintowe F, 2009. The effects of Market Accessibility on Household Food Security: Evidence from Malawi. Conference on International Research on Food Security, Natural Resource Management and Rural Development.,6-8,October, University of Hamburg.
33. Wharton C. R. Jr, 1967: 'The Infrastructure for Agricultural Growth'. In Herman J. Southworth and Bruce F. Johnston (eds) 'Agricultural Development and Economic Growth', Cornell University Press, Ithaca, NY.
34. World Bank, 1986. Poverty and Hunger: Issues and Options for Food Security in Developing Countries. A World Bank Policy Study, Washington, USA.
35. World Bank, 2011,. Rwanda Economic Update: Seeds for higher growth. Washington, USA.

4/30/2014