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A value chain and market integration analysis of the cassava market in the Democratic Republic of Congo

by

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Submitted in partial fulfilment of the requirements of the degree of

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DEDICATION

To my Lord and Saviour Jesus Christ, who took my place on the cross and saved my life from hell

DECLARATION

I declare that this research thesis is my original work and has not been submitted for a degree at any other University. Any error in omission or thinking is entirely my responsibility

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PAULIN NJINGULULA MUMBEYA

Date: November 2011

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May God bless and give his grace and favour to each and every one.

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ABSTRACT

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Degree: MSc Agric (Agricultural economics)
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This study aims to test the performance of agricultural markets in the Democratic Republic of Congo (DRC). Although the DRC is classified as the fifth biggest producer of cassava, nearly 70 percent of its population living mainly in urban areas is suffering from food shortages. Since the markets are poorly integrated, food prices are very volatile. Small agricultural producers obtain low prices for their products, while vulnerable household's consumers experience high prices. Over the last few years, the price of cassava has increased considerably, from US$ 72 per ton in 2007 to US$ 123 per ton in 2009. This dramatic increase in the price of a basic foodstuff has significantly affected poor people in both urban and rural areas. The increase in cassava market prices and the food insecurity level in DRC are an indication that markets have not efficiently performed their fundamental role of connecting producers and consumers. Therefore, understanding the status of value chain development and the degree of market integration is important to improve food security, as well as people's livelihood in rural areas.

Several techniques were identified in the literature for testing agricultural market performance, including: market integration, parity bound analysis, causality, symmetry, error correction mechanisms and value chain analysis. Some studies used mathematical models including deterministic analytical models and stochastic analytical models. For the purpose of this study and because of data limitations, value chain analysis and market integration techniques were applied. The value chain analysis was performed to

identify critical issues and constraints that undermine value chain development, as well as to identify business and technological opportunities that can enhance the performance and competitiveness of the sub-sector.

The prices of cassava products in the DRC were found to be high, due to the high costs of production, processing and marketing of cassava at different levels of the market chain. Poor market linkages lead to low utilisation of value addition technologies, and this contributes directly to poor market opportunities. This results in a wide range of negative aspects for the sector, such as decreasing incentives for the production and consumption of cassava products and lack of sufficient competitiveness to make cassava a significant commercial commodity. Investment in the sector is considered risky by different chain actors, and is limited as a result of the overall non-competitiveness of the sector.

The cassava market in the DRC is organised around Kinshasa in Western Congo, and around Lubumbashi in the South-eastern part of the country. In view of the strategic importance of the two marketplaces, a market integration analysis was conducted to consider whether food policy focusing on those two reference marketplaces would be sufficient to stabilise the cassava supply nationwide, since most of the marketplaces seem to have a strong relationships with these two reference markets. Using co-integration techniques, an error correction mechanism and an index of market connection, the findings established that among the 11 pairs of trading markets, 6 of them were segmented, meaning that price changes in the reference markets were not fully transmitted to the regional markets. Four key factors, including macroeconomic environment, transportation infrastructure, market information flow and distance, played a significant role in price differentials, and caused potential and existing markets to cease to function as efficient generators of wealth and distributors of food. This is apparently one of the most important reasons for increased food insecurity and poverty among food producers and consumers alike.

The results confirm the poor value chain status of cassava, which leads to the stagnation of this crop as a semi-commercial crop, and restrains its absorption into the mainstream market chain in local, national and regional markets. The market integration results showed segmented and moderated integrated markets arising from the 11 pairs of

trading markets, of which 6 were identified as segmented. The results from the error correction mechanism (ECM) suggest that on average about 30% of past deviations from the long run are corrected each month. Among the 11 paired markets, the highest coefficient of price adjustment in the long run was indicated by the paired markets Bukavu–Goma (43%), Mbujimayi–Kananga (38%) and Matadi-Kinshasa (36%); and the lowest was given by the paired market Kisangani–Kinshasa (15%). In the short run, the IMC of 0.85 suggests a strong market connection between Matadi and Kinshasa, which then suggests that price shocks that occur in the market of Kinshasa affect immediately, and partially, the Matadi markets supplying it. This high IMC coefficient was also found between Bukavu and Goma (0.86), and Kananga and Mbujimay (0.81). None of the other markets trading with Kinshasa and Lubumbashi respond in the short run to price changes in these reference markets. This implies that only 3 market pairs out of 11 hav strong intgration which therefore presents clear evidence of weak market integration between production and deficient areas in the DRC as awhole. This weak linear relationship between markets can be postulated as one of major causes of food insercurity in the country. This understanding of cause of food insecurity and various issues surrounding market integration would futher help policy makers to improve efficiency of cassava marketing system, lower farm to retail price spread and consolidate food security accross the country.

Key words: Food insecurity, cassava, value chain, market integration, Democratic Republic of Congo

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Acronyms and Abbreviations

Abbreviation	Meaning
ARS	Agricultural Research System
CEEAC	Central African Economic Community
CIAT	International Centre of Tropical Agriculture
COMESA	Common Market for Eastern and Southern Africa
CPGL	Great Lakes Countries Community
CPI	Consumer Price Index
CRS	Catholic Relief Service
DRC	Democratic Republic of Congo
ECM	Error Correction Mechanism
FAO	Food and Agriculture Organization
FAOSTAT	FAO STATISTICS Database
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute for Tropical Agriculture
IMC	Index of Market Connection
INERA	National Agricultural Research Institute
INS	National Institution of Statistics
MINAGRI	Ministry of Agriculture
NTP	National Trade Policy
SADC	Southern African Development Community
SENASEM	National Seed Service
SNV	National Service of Extension
VAR	Vector Auto Regression
WTO	World Trade Organization

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The Democratic Republic of Congo is the fifth biggest producer of cassava in the world, beside Nigeria, Brazil, Thailand and Indonesia (CIAT, 2000). It produces an annual average of 17000 metric tons. However, food insecurity is still one of the fundamental problems facing the country, with nearly 70 percent of its population being food insecure (FAO, 2009). More importantly, nearly 47 percent of cassava producers live in abject poverty (WFP DRC, 2008).

Cassava (*Manihot esculenta crantz*) is the main national staple food crop, before maize and bananas. In the DRC, cassava takes a significantly larger part of the 2 million hectares used for agriculture. The crop is produced in nearly every province for its carbohydrate rich tuberous roots (Minagri, 2007), but there is a large disparity in cassava production between different provinces. The province of Bandundu produces a yearly average of 5148,7mt, against 425,5mt for North-Kivu province. Five provinces out of eleven (Bandundu, Katanga, Equateur, Province Oriental and Bas-Congo) produce 80 % of the cassava consumed in the country (see Chapter 3 for details). This underlines the importance of inter-provincial trade to supply deficit areas with food. As a basic food product, cassava is the main source of food security for about 20 million of the Congolese population (IRS, 2007). When the crop is sold at the local market, it also provides a valuable source of employment and income for the local population. In terms of export, cassava has huge potential to contribute to the enhancement of the economy.

On average, the national cassava yield is estimated at 8 tonnes per hectare, but an on-farm demonstration field using improved technologies has recorded a yield of 18 tonnes. The low yield is mostly attributed to traditional farming practices, the use of low-yielding varieties, and inappropriate disease and pest control. However, there is still huge potential for yield improvement, through the use of intensification of cassava improved technologies (Tollens, 2004).

The fast population growth in the cities of DRC raises concern about the mechanism of assuring that there is food security via a regular and stable food supply. Considering the high rate of poverty in the major cities, cassava provides half of the calorie intake to the majority of the population daily (IRS, 2007). For this reason, the crop is receiving increased attention in the country's production system. For more than a decade now, the Agricultural Research System (ARS) has put emphasis on development and distribution of a varied range of cassava technologies to help farmers improve production and hence ensure food security and household income to alleviate poverty (INERA, 2008). However, to what extent such efforts have been helpful in improving food security in the deficit areas is still a matter of investigation.

Marketing studies have established that cassava is an important commodity in Central, Western and Eastern Africa trade, particularly between the DRC, Republic of Congo, Republic of Central Africa, Angola, Tanzania, Rwanda, Burundi and Uganda through informal trading (Tollens, 2004; Van der Land, 2007; Mitchell *et al*, 2009; Njingulula, 2010). Their findings indicate enormous demand potential for high quality processed cassava products, with increasing urbanisation and industrial processing opportunities in terms of changing food preferences in favour of value added products. Notwithstanding these opportunities for cassava trade, the existing institutional and technological framework in the country do not favour the optimal exploitation of emerging and potential market opportunities. Consequently, prices of cassava have been found to be very high because of high production and transaction costs, which have negatively affected the profitability and the competitiveness of the crop and limited its absorption into mainstream markets (FAO, 2008). Therefore, there is a need to understand how value chain addition technologies can be introduced to improve the status of cassava commercialisation.

The cassava market in the DRC is structured around Kinshasa and Lubumbashi, the two biggest cities representing two poles of consumption, with about 10 million and 6 million inhabitants respectively. The city of Kinshasa relies entirely on food crops (mainly cassava) from other regions and the city of Lubumbashi is located in a region where cassava is accounted as the second staple foodstuff, after maize. The two cities have the highest per capita income, therefore denoting an effective demand. Following the flow of

trade (Figure1.1) Kinshasa is a focal point of regional markets such as Matadi (Bas-Congo), Kikwit (Bandundu), Mbandaka (Equateur) and Kisangani (Province Orientale). Lubumbashi has Kananga (Kasaï-Occidental) and Mbujimayi (Kasaï-Oriental) as feeder markets. The cities of Kindu, Bukavu and Goma encounter many difficulties in connecting with other provinces because of distance and the failure of transportation infrastructure.

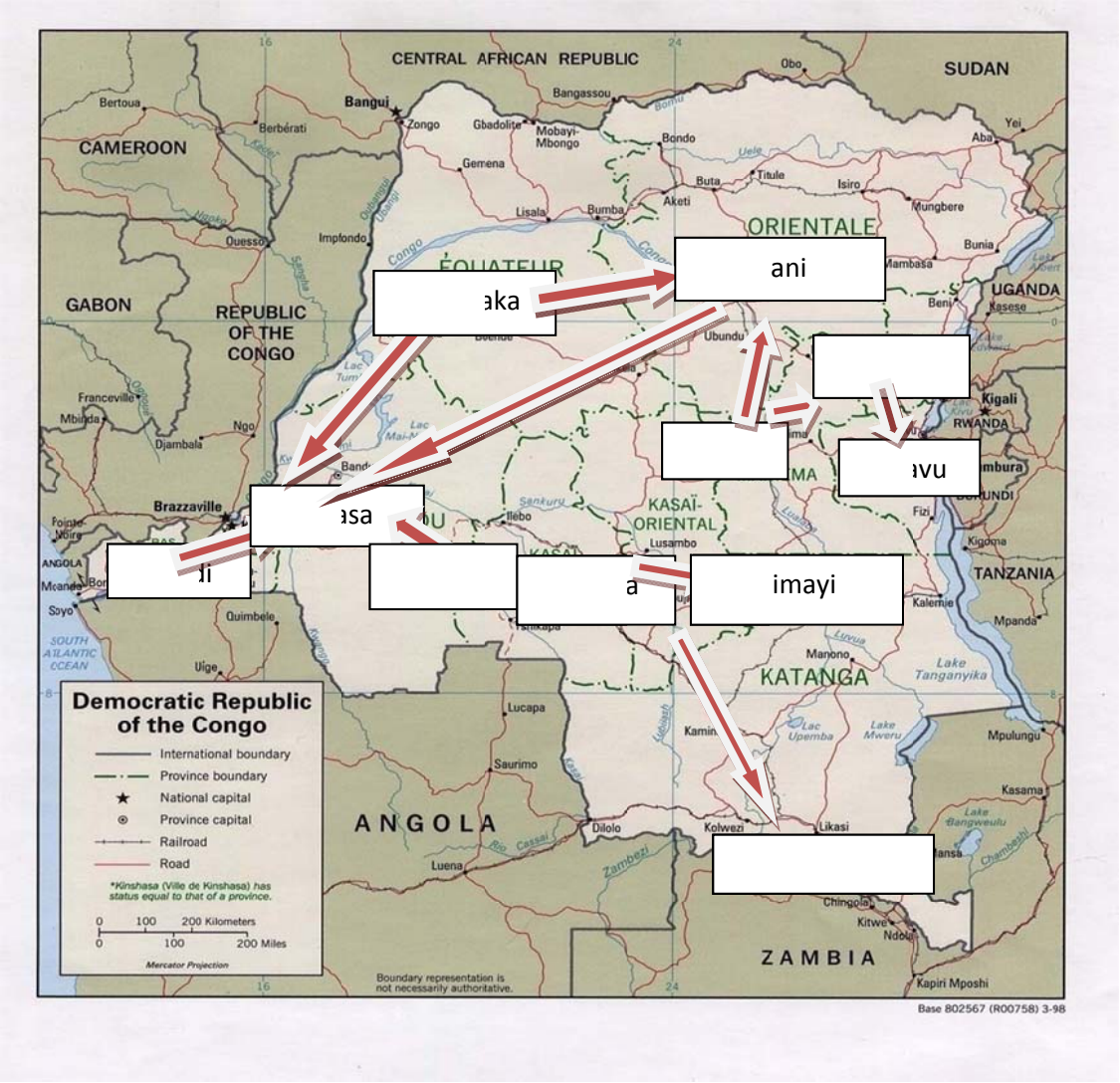


Figure 1.1: Main cassava trade flow in DRC. Source: Tollens (2004)

1.2 PROBLEM STATEMENT

As previously pointed out, the Democratic Republic of Congo is a country with food insecurity in most of its urban centres, measured in terms of weak food availability, accessibility and price stability. High food production disparities between different

provinces have worsened food security in both rural and urban areas (FAO, 2008). A number of studies have been conducted to study the impact of market disparities on food availability and price transmission in Sub-Saharan countries. Some case studies have been conducted for a particular district in the DRC, but none has been conducted recently to estimate the status of cassava value addition that could make cassava products attractive for high value market opportunities, or to establish if markets are integrated in the long and short term to make food available and accessible across the country. To date, there is no empirical evidence of whether, and to what extent, value addition and price transmission can be considered as efficient across different provinces, and how food markets are integrated and contribute to food security. This indicates the need for analysing the efficiency of the role played by markets in the process of food security and poverty alleviation across the country. However, the success of a strategy for achieving food security for the major cities depends on how market forces can transfer price and demand signals to those who supply food in a timely and accurate manner.

Over the last few years, the price of cassava has considerably increased. A ton of cassava sold at US$ 72 in 2007 cost US$ 123 in 2009. A survey conducted in the country in December 2008 shows that the annual food price index in the DRC increased by 31 %, while non-foods prices rose by 15 % (FAO, 2009). In May 2009, the same research paper reported an annual increase of 126 % on cassava prices. This dramatic increase in food prices significantly affects poor people in both urban and rural areas, as their purchasing power erodes as prices rise, in a country where about 49 % of an individual's income is spent on food. Any increase in food prices will push about 15 million people into the ranks of the poorest of the poor living daily on less than one dollar (FAO, 2009)

This increase in cassava market prices constitutes a sign of possible inefficiencies in the food distribution system between surplus and deficient areas, which in turn becomes an important cause of concern. The first concern relates to the consequences of intensification of research efforts undertaken during the last two decades. If domestic markets are not integrated at national level, there are concerns that not all regions and categories of agricultural producers in the DRC have benefitted, and will benefit in the future to the same extent from this research investment. This means that the surplus is not transmitted quickly enough between production areas and consumption centres to make

food available and accessible in deficient areas. Secondly, this case may be evidence of 'market segmentation', in other words an inefficient inter-provincial cassava market. Thirdly, the phenomena of high speculation leading to price volatility, may be an issue, and seems to be related to the cassava value chain status and spatial market integration in the trade operations among provinces.

No market value chain or market integration tests have been undertaken in the DRC to provide an answer to the above questions. In the context of a post-conflict country aiming to design policies to address food security and poverty alleviation, there is very little evidence about the economic implications of value chain management – information that could assist decision-making and stimulate future cooperative research programmes targeted to benefit developing countries. The present study attempts to improve that information base. It is therefore necessary to understand how market chains are functioning to move food from surplus areas to deficient areas. Such refinement makes it possible to identify factors that explain the high level of food insecurity in the country, and specific and practicable intervention objectives.

1.3 STUDY OBJECTIVES

This study aims to assess the dynamics of the cassava value chain in terms of market integration, and factors affecting its growth and competitiveness. The findings are expected to highlight a certain number of important issues related to cassava marketing as well as identifying best marketing practices to solve the problems relating to cassava market failures.

1.3.1 SPECIFIC OBJECTIVES

The study specifically aims to:

(i) Assess the status of value chain development and the degree of market integration in geographically dispersed marketplaces in the DRC, with the focus on the efficiency of price transmission between Kinshasa or Lubumbashi and their feeder markets.

(ii) Characterise the cassava market in the study area. The characterisation of such a market is crucial for understanding how the chain functions, the

limitations stakeholders face today, and the extent to which they affect cassava supply and demand.

(iii) Analyse the short and long-term integration of the cassava market in the DRC. This is important for understanding how market integration has affected food security in this country.

(iv) Identify the factors that constrain or facilitate value chain development and market integration and their implications for food security in the DRC. This will help to explain the cause of the recent increase in cassava prices.

(v) Make relevant recommendations on how to achieve food security in the DRC.

1.4 STUDY HYPOTHESES

To achieve these objectives, the study tests the following assumptions:

H1: The referential markets, Kinshasa and Lubumbashi, are co-integrated with their feeder markets. A change in price occurring in these central markets is quickly transmitted to the feeder markets to stimulate quick movement of cassava from surplus areas to deficit areas.

H2: There is a strong relationship between cassava market structures, cassava price rises and food security: the infrastructure for transportation, poor market information system and long distances between markets play an important role in the speed of price adjustment over peripheral markets. The speed of price transmission determines the food movement from surplus to deficient zones and largely affects the state of food security.

1.5 RESEARCH METHODOLOGY

Cassava market performance was tested in this study by combining value chain and market integration analysis. This combination provides significant advantage as it focuses research on both actors and product sides of cassava commercialisation. The value chain analysis provides valuable information on factors influencing the actor's performance such as access and requirements of final markets, the legal, regulatory

policy environment, and the availability, and quality of support services such as financial services, equipment manufacture and repair, business management service and information technology information technology.

This analysis is completed by the market integration analysis, which provides important information about product movement mechanisms as well as technical information on spatial prices behaviour, in other words: 'how prices are formed and transmitted among different markets in the short and long run'. This global view provides the researcher with the possibility of setting a holistic intervention strategy that can improve both the performance of the actors and the performance of the product and its distribution mechanism in the value chain.

The study used primary and secondary data. Primary data come from a baseline farm survey on cassava market conducted in Southern and Northern Kivu from April to July 2008 by the National Agricultural Research Institute (INERA), in conjunction with the International Institute of Tropical Agriculture (IITA) (INERA, 2008). A total of 126 cassava farmer and 80 traders. Traders and agribusinesses were randomly selected and interviewed by trained enumerators, using structured questionnaires. Specifically, the survey was conducted to collect information that can help to identify opportunities and constraints to cassava value chain development. Secondary data was obtained from the FAO Database and covers 11 provincial markets estimated from July 2005 to December 2009, which gives 54 observations for each market. These data are prices aggregated on a monthly basis. These data were analysed using Eviews software, and appropriate statistical processes. Details on methodology are provided in chapter 3.

1.5 THE IMPORTANCE AND BENEFITS OF THE PROPOSED STUDY

Cassava production plays a crucial role in food security for both the rural and urban contributing to inefficient product movements (Collinson *et al.*, 2000).Understanding the status of the value chain, the extent and the effects of cassava market integration and how it can be corrected are important in improving food security and people's livelihood in rural areas. Evidence about how market integration might influence government

policies is scarce in the DRC. The study findings will provide a better understanding of the role of cassava marketing on food security that is necessary to shape the policy debate on the reform alternative. This study will add scientific value as the findings will be used to identify best marketing practices to solve the problems relating to cassava market failures.

1.7 ORGANISATION OF THE DISSERTATION

This dissertation is outlined as follows: the first chapter is dedicated to the problems and objectives of the study. The second chapter will focus on a survey of the literature on value chain and market integration; a review of definitions and the theories related to value chain and market integration; a discussion on the advantages and limitations of various empirical approaches; and finally, a description of main issues in the recent debate. The third chapter illustrates the methodology used in this dissertation. This empirical study will concern a large set of markets located in 11 different provinces of the DRC. It will consist of two major steps: analysis of value chain development status and the degree of spatial market integration. Chapter 4 provides an overview of cassava sector in the DRC and chapter 5 and 6 report the empirical findings. The seventh chapter contains a conclusion and recommendations.

CHAPTER 2

VALUE CHAIN AND MARKET INTEGRATION: A LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews the literature concerning value chains and market integration in food markets in developing countries. The chapter briefly reviews the existing theories and analytical techniques that are relevant for a better understanding of cassava commercialisation in the DRC. A quick historical look considers how existing literature deals with the problem of market integration over time and space and shows the current situation relating to the DRC. The section that follows provides the framework for the study, which was used to perform a value chain analysis and a market integration analysis of cassava market. The chapter ends with a summary of different factors perceived in the literature as determinants of market performance and important techniques and approaches used in the literature to assess market performance (related to the value chain and spatial integration).

2.2 APPROACHES TO MEASURING MARKET CHAIN PERFORMANCE

In the literature, value chains are synonymously referred to as market chains, supply chains, market channels or value-added chains. At each stage in the market chain, the product changes hands through chain actors and costs are incurred at each transaction. Generally, some form of value is added (Louw *et al*., 2008). A large body of literature on agricultural markets argues that the presence of high transaction costs affect the performance of the market (Smith *et al.*, 2005; Barrett 2008; Kirsten *et al.*, 2002). The empirical literature has focused almost exclusively, however, on one element of the marketing chain, namely, taking distance to the market structure as an indicator of market performance. A number of recent studies examine market performance as a function of: farmers' access to market (Fafchamps & Hill, 2003; Barrett, 2008); profitability for the traders (Minten & Kyle, 1999; Ardeni, 1989); and sufficient focus on customers and

competition (Chan *et al.*, 2003).

A different but related body of literature examines the performance of a market based on the cost components of the market chain, omitting non-cost indicators of market chain performance (De Toni and Tonchia, 2001). A major limitation of these different strands of literature is their lack of connection with the entire market chain as a system. They do not offer a systematic view of market chains, as single indicators cannot adequately measure a market chain, which needs to be measured at multiple levels.

From an alternate perspective, Neely (1999) defines market performance measurement as the process of quantification of the effectiveness and efficiency of the action. Effectiveness is the extent to which a customer's requirements are met, and efficiency measures how a supply chain is economically beneficial to the actors. Performance evaluation is described as an overall set of metrics to quantify both efficiency and effectiveness.

As Neely (1999) observes, performance of a market chain can be measured at three levels: the individual level, the system's level as a whole and the relationship between a supply chain and the internal and external environments in which it operates. Lee (2004) differentiates performance measurement by business process. He distinguishes those processes that are appropriate at the strategic, operational and tactical levels, and between cost and non-cost measures (i.e. time, quality flexibility and innovativeness). This distinction is particularly important, since relying exclusively on cost indicators can produce a misleading picture of market chain performance. Measure of time and quality of supply chains reflect the ability of a market chain to deliver high customer services. Flexibility and innovation indicate the ability to cope with rapid changes in demand and supply. Operational studies develop mathematical models for improvement in performance of supply chains (Lin *et al.*, 2005; Smith *et al.*, 2005), while design studies aim to emphasise performance through redesigning the market chain. The latter include deterministic analytical models (Chen *et al.*, 2005) and stochastic analytical models (Chiang & Monanchan, 2005).

Finally, strategic studies evaluate how to align the market chain with the actor's strategic objectives (e.g. Balasubramanian and Teway, 2005). One of the most important contributions of this wider literature is that it emphasises the need to adopt a systematic approach to performance measurement. For instance, modern manufacturing practices

such as quality management and information technology have all shown the effect of overall market chain performance.

Following the above considerations, the efficiency of the cassava market chain in this study will be assessed by examining how well the cassava market chain meets customers', traders' and producers' demand for services in relation to their preferences. In a properly functioning market, the marketing chain has to guarantee that customers can buy and producers can sell their products at reasonable prices in the marketplace; they have to balance supply and demand in each segment at any time.

In summary, the important limitations of current literature can be summarised as following:

- Lack of connection with the entire strategy (Brorsen *et al*., 1985)
- Focus on cost to detriment of non-cost indicators (De Toni and Tonchia, 2001)
- Lack of a balanced approach (Fafchamps & Hill, 2003)
- Insufficient focus on customers and competition (Chan *et al.*, 2003)
- Loss of supply chain context (Lee, 2004).

Studies combining cost and non-cost aspects have the advantage of leading to statistically significant increases in performance. There are few empirical studies in the literature of factors influencing the success or failure of attempts to influence market chain performance. Furthermore, such a study has not been undertaken on the cassava market chain in the DRC

2.3 VALUE CHAIN: THEORY AND APPLICATION

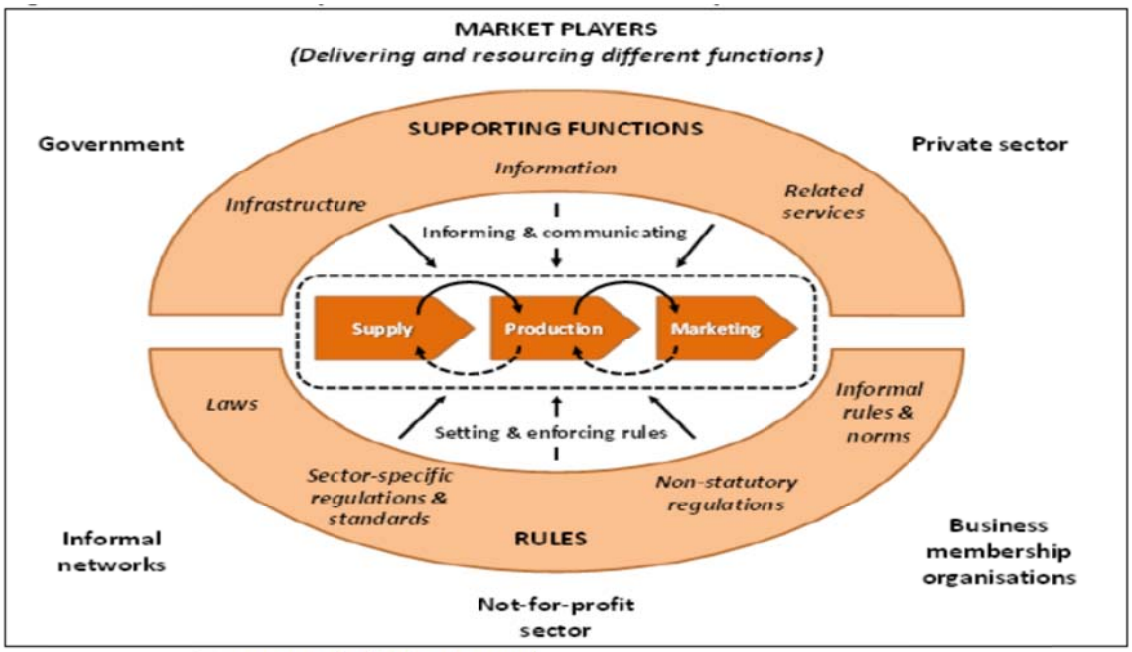
A value chain is defined as a chain of activities required to bring a product or service from production (involving a combination of physical transformation and input of various producer services), through delivery to final consumer and final disposal after use (Kaplinsky and Morris, 2001). It represents an analytical framework that helps to understand how the trade world functions. Depending on the researcher's objectives, a value chain framework can be used to increase commercial profit, improve the

competitiveness of a specific target group in a market or reduce poverty.

The value chain approach was developed by Michael Porter in the 1980s, and described in his book *Competitive Advantage: Creating and Sustaining Superior Performance* (Porter, 1985). The concept of value added in the form of a value chain has been used to build up an industry's sustainable competitive advantage in the business field. The entire industry is formed of activities that link together to develop the value of the business, and together these activities form the industry's value chain. Such activities included product manufacturing, and activities of purchasing, distribution and marketing of the company's products (Lynch, 2003). Since the value chain framework is used as a powerful analytic tool for the strategic planning of an organisation, it aims to maximise value creation while minimising costs.

Figure 2.1 shows the value chain framework used to analyse the cassava industry in a market chain, from input suppliers to final buyers, and the relationships among them. It analyses the factors influencing industry performance, including access to – and the requirements of – end markets; the legal, regulatory and policy environment; coordination between firms in the industry; and the level and quality of support services (see details in chapter five). According to Porter (1990:10), this framework constitutes an interdependent system or network of activities, connected by linkages, showing how the value chain activities are tied together to eventually create value for the consumer. As a result, the linkages become a veritable source of competitive advantage in cases where the system can be carefully managed (Pathania-Jain, 2001). Lynch (2003) postulates that value chain analysis entails the linkages of two areas: linking the value of industry's activities with its main functional parts and assessing the contribution of each part in the overall value added to the business.

In this study, the value chain analytical framework is used to understand various aspects of the cassava supply chain, with focus on the identification of critical issues and blockages that undermine the value chain development. This is followed by the identification of business and technological opportunities that can enhance the performance and competitiveness of actors in the value chain and the linkages among them.



Source: Adapted from www.springfieldcentre.com).

Figure 2.1: Value Chain Analytical Framework

2.4 MARKET INTEGRATION: THEORY AND IMPLICATIONS

Market integration is considered an important determinant of food flow, availability, accessibility and price stability. As Nyange (1999) puts it, the extent to which markets make food available and accessible, and keep prices stable, depends on the degree of market integration across a region. Goletti and Christina-Tsigas (2000) define integrated markets as markets in which prices of comparable goods do not move independently. According to the Law of One Price (LOP), if two markets are integrated, change in price in one market due to excess demand or supply shocks will have an equal impact in the related market price. If this equilibrium condition holds, the two spatially separated markets are said to be integrated. In other words, the Law of One Price prevails between the two markets (Zanias, 1999; Sexton *et al.*, 1991) or the two markets are spatially price efficient (Tomek and Robinson, 1998). Otherwise, markets may have some constraints on efficient arbitrage such as barriers to entry and information asymmetry (Barrett, 2001; Mohr *et al.*, 2008) or imperfect competition in one or more markets (Faminow and Benson, 1990). Hence, the study of spatial market relationships provides the extent to which markets are related and efficient in pricing.

The notion of market integration is often associated with the degree of price

transmission, which measures the speed of traders' response in moving foods to deficit zones when there is an emergency, or some catastrophe that leads to hunger in deficit zones (WFP, 2007). A number of factors that lead to market integration have been identified (Rapsomanikis *et al*., 2005; Timmer, 2009). However, the extent of their contribution to food security has not been fully investigated, especially in sub-Saharan Africa.

Among the key factors, weak infrastructure and large marketing margins that arise due to high transfer costs have been asserted as the main factors that partly insulate domestic market integration. Especially in developing countries, poor infrastructure, transport and communication services give rise to large marketing margins due to high costs of delivering locally produced commodities to the reference market for consumption. High transfer costs and marketing margins hinder the transmission of price signals, as they may prohibit arbitrage (Sexton, *et al.*, 1991; Bernstein and Amin, 1995). As a result, changes in reference market prices are not fully transmitted to local prices, resulting in economic agents adjusting partially to shifts in supply and demand.

2.5 EMPIRICAL STUDIES ON MARKET INTEGRATION

Studies devoted to spatial market integration can be grouped into two main categories. The first group applies the Law of One Price (LOP) to test for perfect price transmission between two markets. According to this technique, if two markets are integrated, price changes in one market are transmitted on a one-for-one basis to another market in the short run or over time in the long run (Ravaillion, 1986). Numerous empirical studies use a Pearson correlation coefficient between market pairs and the co-integration coefficient to test whether prices have a significant linear relationship in the short and long run. A simple bivariate coefficient captures how close price movements of commodities are between different markets. This technique has been criticised for its inability to measure the direction of price integration among different markets, as well as its inability to account for trade reversals, typical in regions of poor infrastructure (Barrett, 1996). These concerns led to the development of the Granger-causality test and co-integration procedures to determine both the direction of price integration and the speed of price adjustments, respectively.

Furthermore, co-integration techniques are focused on identifying factors that determine spatial market integration. An understanding of these factors is required for designing investment policies oriented to the development of commodity markets (Collinson *et al.*, 2000). Following this question, the analysis process starts by identifying the market integration indicator (e.g. price). The second step consists of identifying the factors that determine the degree of integration among markets. Gilletti *et al.* (1995) assert that the extent of market integration depends on trade action and its operational environment, which is determined by transportation and communication infrastructure availability and by the policies affecting the mechanism of the price transmission. In their study, they found that the factors that determine rice market integration in Bangladesh are mainly transportation (paved roads) and telecommunication development. Such findings are similar to those achieved by D'Angela and Codane in Peru (2005).

A second group of studies attempts to take into account the possible sources of asymmetry and discontinuity in the responses of the commodity market price. This group introduces the dynamic transaction costs considered as a major factor that influences arbitrage relations between different markets. Using the price series of a particular commodity, the Law of One Price is adjusted by transaction costs. Following this approach in the transaction costs is the determinant number of the efficiency of price band (parity) for a homogeneous commodity between two special markets (Blauch, 1997; Barrett and Li, 2002). As Blauch (1997) puts it, when transaction costs are equal to the inter-market price differential, prices in the two markets move on a tandem basis and the spatial arbitrage conditions are binding. But if transaction costs go beyond the inter-market price differential, the spatial arbitrage conditions are violated, which results in impediments to trade efficiency that negatively affect market integration.

Alternatively, the advancement in times series models has allowed a wider application of the co-integration approach. According to this approach, if two markets are integrated then the prices of the two markets are considered to be co-integrated (Barrett and Li, 2002). McNew (1996) questioned the validity of the approach in the absence of transfer costs. Blauch (1997) introduced transfer costs in his investigation to determine the parity bounds within which a commodity price in two markets may vary independently. Testing the hypothesis of spatial price differentials equal to, or less or greater than the transfer costs, he found that the higher the incidence of outside parity bounds, the lower the

market integration. Kovenock *et al*. (1998) used the maximum likelihood method to estimate a switching regression system. In their study, prices are predetermined and transfer costs endogenously determined, which allowed for determining the probability of efficient markets arbitrage.

Recently, Barrett and Li (2002) drew attention to the effect of transaction costs, which is considered as a major problem that affects continuous trade and the direction of trade flow. They introduced a mixture distribution model that takes into account both transfer costs and trade flow. This model presents the advantage of distinguishing between market integration and market equilibrium. Based on whether or not trade exists, the model considers the correlation between trade flows; price spread and cost transfer, to explain the four potential market conditions: perfect integration, segmented equilibrium, imperfect integration and segmented disequilibrium. However, most of these studies did not consider seasonal price fluctuation, which is one of the most important factors in agricultural commodities.

Several authors have made use of time series econometric analysis techniques to test for the price transmission between two markets. The expansion of these techniques, which take account of co-integration and error correction models, seems to be the standard tool for analysing spatial market relationships, and replacing earlier empirical tools such as the bivariate correlation coefficient and regressions. Nonetheless, as the recent research criticise time series analysis as unreliable, they focus on switching regime models that incorporate data on prices, volumes traded and transactions costs. (Blauch, 1997; Barrett and Li, 2002)

In this study, we argue that, despite the above criticisms, in particular concerning non-stationary transfer costs, the time series analysis offers a practical insight about the issue of market integration and price transmission, if a relevant testing framework and correct results interpretation are used (Schroeter and Azzam, 1991). Market integration can be formally tested if one follows the definition developed by the standard spatial equilibrium model. On the other hand, the degree of price transmission is an intrinsically unclear concept. Co-integration and error correction models give an analytical tool that can focus not only on the case of market integration or complete price transmission, but also test notions such as short run and long run relationships between prices (Amarender,

2006). For instance, if there is a trade discontinuity in a time series model framework, it implies that the speed of convergence to a long-run relationship is slow, whereas non-linearity possibly will be considered as asymmetric responses to price changes. Compared to other techniques, time series models have small data requirements and rely on price series only, which are the most easily obtainable for developing countries. Furthermore, time series applications play an important role in signalling potential failures in markets. They also contribute to the measurement of the direction, magnitude and distribution of welfare effects of trade policy reforms. Basically, time series applications can also fail to achieve an unachievable goal such as giving a universal measure of the extent of price transmission (Sharma**,** 2002).

Concerning modelling using times series in Sub Saharan Africa, Lele (1967) and Jones (1968) were among the pioneers of using times series data for testing spatial market integration on food prices. They analysed commodity food prices in Nigeria. In their studies, they estimated the co-movement correlations between price series in two markets in different locations. A price correlation greater than 0.7 or 0.8 showed close price movements for the two markets and was an index of spatial integration. As pointed out by Barrett (2001), the studies of Lele and Jones used arbitrage as a cut-off point for deciding whether markets are integrated, without considering whether or not the price series were stationary or non-stationary. However, most econometric models used for testing spatial market integration were based on the same hypothesis of testing how intimately prices moved together. For instance, the model of the Law of One Price (Isard, 1977; Richardson, 1978) and the Ravaillion model (Ravaillion, 1986) are also an expansion of the correlation idea. Many studies also used this technique to test for the co-movement of food prices and long-run market integration (Alexander and Wyeth, 1991; Dawson and Dye, 2002).

This study relies on the time series model including co-integration tests. It uses the co-integration approach, the Error Correction Model (ECM), and the Index of Market Connection (IMC), which are the most useful tools used to estimate market integration, as Nyange (1999), Kinnucan and Forker (1987), Schroeder and Azzam (1991) and Ghoshray (2009) did. This approach has small data requirements and has the advantage of testing market integration both in the short run and in the long run, taking into account the error correction and the speed of price adjustment.

2.6 MARKET STUDIES IN THE DRC

A number of studies were conducted in the DRC to assess the impact of food price instability on Kinshasa's food security (Tollens, 2004). Data on cassava prices stress a strong instability of price in time and in space (FAO, 2008). This instability has been hypothesised to be the major cause of food insecurity in Kinshasa, since consumers are not able to decide how much cassava they will be able to purchase with the unpredictable income for day-to-day consumption (Kankonde and Tollens, 2001).

Motivated by the negative effects of price increases on food security in the urban areas, Tollens (2004) focused on the system of food distribution in the food market chain in Kinshasa, in order to determine the cause of instability and the strategies adopted by economics agents to deal with this instability. His findings sensibly point out that to supply Kinshasa, the systems of food supply and distribution include a series of operations such as collection, handling, transport, processing, storage, wholesaling and retailing, which are reflected in the final price paid by consumers. When these different operations are inefficient, the cost of food will be severely affected, which in turn underlines the need for improving the cassava supply and distribution system.

Aware of the importance of improving food supply and distribution systems in the DRC, some authors have analysed the mechanism of food supply to the cities of Kinshasa and Lubumbashi (INS, 2008), as well as the determinants of prices and price instability (FAO, 2004), and consumption and survival practices and food security (Banea, 2001). The study by Kinkela (1989) stresses the problems of cassava trading in the country and a WFP/EU study (2006) analysed the market profile in the DRC. The main findings of these studies indicate the existence of two categories of markets: one of fresh cassava generally located in rural areas, and the market for dried and processed cassava, generally located in urban areas.

To supply Kinshasa, four markets (Matadi, Kikwit, Mbandaka and Kisangani) play the role of feeder markets. At the same time, the Kisangani market plays the role of feeder to Kinshasa and reference market for Mbandaka and Kindu. For the supply network of Lubumbashi, around 30 % comes from the two provinces of Kasaï (Kananga and Mbujimayi).

Concerning price trends and the factors influencing their instability, the INS (2008) and FAO (2009) reports show that the price series analysed on the Kinshasa and Lubumbashi markets reveals an upward trend, which in theory would translate into a deficit of supply compared to the urban markets' demand. The market volatility was explained by the instability of supply and price volatility, exacerbated by poor equipment and infrastructure. The instability of supply was caused by the deficiency of the distribution system and the socio-economic situation of the economic agents (Tollens, 2004.).

A study on food consumption patterns shows a decrease in per capita cassava consumption since 1994 (Mastaki, 2006). Although cassava consumption decreased, the author has not linked this reduction to Bennett's law (stating: the richer one becomes, the less he or she spends on starchy staples). The author shows that cassava remains the most preferred food and exhibits income elasticity near one. Changes in food consumption behaviour in major cities are mainly caused by a deficient food distribution system, which results in high prices for locally produced food.

The above discussion reveals that food-marketing chains for urban areas in the DRC do not efficiently perform their fundamental role of making food available and accessible in time and in space. According to Njingulula (2010), this has led to a wide disparity in supplies and prices between surplus and deficit areas across the country. The result is that low-income consumers face high food prices in deficit areas, and small producers receive low prices for foods. To this list, FAO (2008) adds that poor marketing efficiency in the DRC has worsened food security in times of food shortage, both in rural and urban areas.

Most of the abovementioned studies are case studies, which focus mostly on one geographical region in estimating price co-movement between rural and central markets. Given the diversity and disparity among different provinces across the country, the present study attempts to expand the extent of market efficiency by assessing the status of value chain development and the degree of market integration nationally, and by estimating related costs and margins. Understanding how different markets are integrated can help policy makers formulate appropriate food security policies to improve food availability and food access in deficit areas. This is because, as De Janvry and Sadoulet (1996) assert, if markets are fully integrated, the effects of stabilisation of one (central)

market are transmitted to related markets. If markets are not integrated, the stabilisation of one market will be inefficient, and each market will need its own stabilisation programme, which is costly.

2.7 FACTORS AFFECTING THE DEGREE OF MARKET INTEGRATION

There are several factors that affect the degree of market integration and lead to low price responses to exogenous shocks (Blauch, 1997; D'Angelo and Cordano, 2005). The first one is the presence of high transaction costs relative to the price differential between two regions, which determines the exercise of autarchy markets. The second set of factors is the presence of barriers to entry, risk aversion and information failures. Some characteristics of agricultural production, commercialisation and consumption, such as unsuitable transportation infrastructure, entry barriers and information failure, may turn the arbitrage process into a less smooth process than assumed by traditional models of market integration (Timmer, 2009). Put together, these factors can be summarised as price transmission, spatial arbitrage conditions, the asymmetric price response and transfer cost, and these can be explained as follows:

2.7.1 Price transmission

Assuming that two spatially separated markets have p_{1t} and p_{2t}, respectively as prices for a commodity, the Law of One Price (LOP) suggests that at all points in time, if a transfer cost c is allowed, to move the commodity from market A to market B, the relationship between the prices is given as follows:

$$p_{1t} = p_{2t} + c \tag{2.1}$$

If such a relationship (2.1) holds between the two prices, the two markets are said to be integrated. However, this extreme case may often be improbable, particularly in the short run. On the other hand, if the movement of the two prices is totally independent, then one might feel secure in thinking that there is no price transmission, and thus no market integration (Barrett, 2001). Following the different ranges of ways in which prices can be related, and according to Balcombe and Morisson (2002), the concept of price

transmission can be seen as being based mainly on three components, including: co-movement and completeness of adjustment: this means that changes in prices in one market are entirely transmitted to the others at all points of time; the dynamics and speed of adjustment refer to the rate at which the price difference in a previous period is corrected to achieve price equilibrium between the market pair and the asymmetry of response, implying that movements in the price (upward and downward) in market 1 are symmetrically or asymmetrically transmitted to market 2. Alternately, the degree of completeness and the speed of the adjustment can both be asymmetric.

An entire price transmission between two markets that are spatially separated is seen as a situation where change in one price is fully and directly transmitted to the other price, according to the Law of One Price presented by relationship (1). In addition, this assertion implies that if price changes are not immediately fully transmitted after some time, price transmission is deficient in the short run, but given the spatial arbitrage condition, the price transmission will be corrected in the long run. Distinguishing short-run from long-run price transmission is imperative and the speed of price adjustments to their long-run relationship is indispensable in understanding the degree to which markets are integrated in the short run. However, various reasons can be found to explain the transmission of changes in the price in one market to other markets. These include the number of stages in marketing, differing policies, and related contractual arrangements between different economic agents. (McNew, 1996).

2.7.2 The spatial arbitrage condition

Following Prakash (1998), the spatial arbitrage condition indicates price relationships that lie between the two extreme cases of the presence (Law of One Price) and the absence of market integration. If two spatially separated price series are co-integrated, there is a tendency for them to co-move in the long run, according to a linear relationship. In the short run, the prices may drift apart, as shocks in one market may not be immediately transmitted to other markets due to delays in transport. However, arbitration opportunities ensure that these divergences from the underlying long-run relationship (equilibrium) are transitory and not permanent. In general, spatial arbitrage is expected to ensure that prices of a commodity will differ by an amount that is at least equal to the transfer costs with the relationship between the prices identified as the

following inequality:

$$P_{2t} = P_{1t} \text{£C} \quad (2.2)$$

According to Fackler and Goodwin (2001) the relationship (2) is the spatial arbitrage condition. The relationship (2.1) stands for the strong form of equality and the relationship (2.2) indicates a weak form of the Law of One Price, representing an equilibrium condition. If observed prices diverge from relationship (1), spatial arbitrage will force back the difference between the two prices towards the transfer cost. The spatial arbitrage condition makes the interpretation of co-integration easier because its presence is evaluated by means of co-integration tests. Co-integration is therefore seen as the empirical counterpart of the theoretical notion of a long-run equilibrium relationship.

2.7.3 Asymmetric price responses

Asymmetry of response implies that movements in the price (upward or downward) in one market are symmetrically or asymmetrically transmitted to the other. It implies non-linear adjustment of price, and this is caused by policies and market power (Abdulai, 2000). Most researchers agree that an asymmetric price response is generally due to concentration and non-competitive pricing behaviours. Within industry concentration or imperfect competitive behaviour beyond the farm gate, middlemen or wholesalers with more power over price can use pricing strategies that cause a slow and incomplete navigation across price increases in reference markets, and a fast and complete transmission of decreases in the price to price upstream, as their margins are squeezed (Abdulai**,** 2000). However, in the short run, asymmetric price transmission may also occur for reasons other than policies and market power. In spatial markets, inventory holding behaviour in domestic markets may lead to asymmetries, as high future price expectations lead to stock accumulation (Maccini, 1978; Blinder, 1982). Other reasons for asymmetric price adjustment include different reactions to increases and decreases of input costs, dependence on whether prices are rising or falling, competition between wholesalers with high fixed costs, and excess capacity that may result in producer prices increasing rapidly when demand for processed products is high, but decreasing at a slower rate when demand is low (Bailey and Brorsen, 1989; Kovenock and Widows,

1998).

2.7.4 Transfer Costs

An important stream of literature on spatial market integration stresses the role of transfer costs. Fundamentally, these costs introduce a wedge between prices in different locations, which results in a non-linear relationship between such pairs of prices. Transfer costs are central for modeling spatial market integration because they involve a potential bias in estimators based on the linear models. The absence of transfer costs between two markets for a given commodity implies that prices in the two markets should be equal. But if there are transfer costs, there is no need to trade between the markets since the transfer costs make trade between two markets unbeneficial, because prices will only adjust when trade is profitable.

To overcome this inconvenience, Kling and Carmel (1991) and Blauch (1997) introduced the parity bounds model to explicitly take into account the non-linear price relationship in spatially distributed markets caused by transfer costs. Furthermore, the focus of recent research is on an explicit modelling of threshold effects when testing the Law of One Price. (Goodwin and Piggott, 2001; Meyer, 2004; Tailor and Chowdhury, 2004; Duo, 2007).

2.8 APPROACHES AND METHODS OF TESTING MARKET INTEGRATION

Empirical research in market integration, both spatially and vertically, has applied a number of different quantitative techniques to test market integration and price transmission between different markets. The most used are the following:

- Co-integration
- Parity bound analysis
- Causality
- Symmetry
- Error correction mechanism.

Each of the above tests is taken to present evidence about the components of transmission, thus providing particular insights into its nature. Combined, these techniques offer a framework for the assessment of price transmission and market integration.

2.8.1 The Co-Integration Method

On the concept of co-integration (Granger, 1981) and the methods for estimating a co-integration relationship, Engle and Granger (1987) and Johansen (1991, 1995, 2000) provide a framework that allows estimating and testing for long-run equilibrium relationships between non-stationary integrated variables. Co-integration has been extensively discussed and applied in the literature; Maddala and Kim (1998) provide a thorough and extensive review of co-integration. Co-integration, as previously seen, implies that prices of two markets move closely together in the long run, although in the short run they may drift apart, and thus are consistent with the concept of market integration. If two prices in spatially separated markets (or different levels of the supply chain) contain stochastic trends, and are integral of the same order, the prices are said to be co-integrated. A potential shortcoming of co-integration in testing for market integration is the implicit assumption that transfer costs are stationary.

However, Barrett (2001), and Fackler and Goodwin (2002) argue that co-integration techniques are considered unreliable if transaction costs are non-stationary. Failure to find co-integration between two price series may be consistent with market integration. Otherwise, the rejection of the co-integration hypothesis may not necessarily mean lack of market integration, which can be an indicator of transfer costs being non-stationary. Several empirical studies based on co-integration, according to Rashid (2004), have concluded in favour of market integration where in fact there was lack of integration. The second criticism against the co-integration method is its inability to distinguish whether there is efficient arbitrage, autarchy or arbitrage failure. Although the abovementioned criticisms are important, there is no best approach that addresses all the shortcomings of the spatial market integration techniques (Sanago, 2007). Co-integration techniques have largely been used, and are used in this study, to estimate the level of market integration.

2.8.2 Parity bound analysis

Blauch (1997) used transfer costs to determine the parity bounds within which commodity prices in two markets may vary independently. Testing the hypothesis of spatial price differentials equal to, or less or greater than transfer costs, he found that the higher the incidence of outside parity bounds, the lower the market integration.

The major drawback of this technique is the lack of series on transaction costs. Basically, these series are generated by the technique of extrapolation that may not reflect the speed of the price adjustment when there are profitable trade opportunities. Furthermore, this framework does not account for trade reversals. According to Barrett (2005), it also relies on distributional assumptions in estimation and typically ignores the time-series properties of the data, not permitting analysis of inter-temporal adjustment to short-run deviations from long-run equilibrium, and potentially important distinctions between short-run and long-run integration, as attempted by price equilibrium approaches.

2.8.3 Causality technique

Another important implication of co-integration is that co-integration between two variables implies the existence of causality between them in at least one direction (Granger, 1988). If two markets are integrated, the price in one market will normally be found to Granger-cause the price in the other market. Lack of co-integration between the two trending price series may indicate that markets are not integrated, as other factors such as transaction costs may determine the movements of one of the price series. Therefore, Granger causality provides additional evidence as to whether, and in which direction, price transmission is occurring between two series. The hypothesis that market price one Granger-causes market price two and vice versa, can be assessed within a Vector Auto Regression (VAR) framework by testing the null hypothesis that the coefficients of a subset of these jointly determined variables, the lagged p_1 terms, are equal to zero. In addition, Granger (1988) proposed a test for long-run Granger causality in which the presence and direction of Granger causality in the long run can be assessed within the context of the error correction representation of a co-integrated system of variables.

It is important to note that Granger causality may exist, indicating that although the two price series drift apart due to other factors such as non-stationary transaction costs, some price signals are passing through from one market to another. On the other hand, lack of Granger causality may not imply an absence of transmission, as price signals may be transmitted instantaneously under special circumstances. However, given the inherent dynamics of markets, it is believed that this is highly improbable.

2.8.4 Symmetry

The literature on symmetry attempts to take into account the possible sources of asymmetry and discontinuity in the responses of commodity market prices. This group introduces the dynamic transaction costs considered as a major factor that influences arbitrage relations between different markets. Using the price series of a particular commodity, the law of one price is adjusted by transaction costs. This approach suggests that transaction costs determine the efficiency of price band (parity) for a homogeneous commodity between two geographical markets (Blauch, 1997; Barrett and Li, 2002). As Blauch (1997) puts it, if transaction costs equal the inter-market price differential, prices in the two markets move on a tandem basis and the spatial arbitrage conditions are binding. However, if transaction costs exceed the inter-market price differential, the spatial arbitrage conditions are violated, which results in impediments to trade efficiency that weaken market integration.

2.8.5 Error Correction Mechanism (ECM)

The error correction coefficient measures the extent of corrections of the errors that the market initiates by adjusting prices in a local market and prices in a reference market towards restoring the long-run equilibrium relationship (Blauch**,** 1997). The speed with which the market returns to its equilibrium depends on the proximity of the error correction coefficient to one. Within this context, short-run adjustments are directed by, and consistent with, the long-run equilibrium relationship, allowing the researcher to assess the speed of adjustment that shapes the relationship between the two prices. The error correction is presented in the literature as an important framework for testing asymmetric and non-linear adjustment to long-run equilibrium (Fackler and Goodwin**,** 2002). The model provides a structure within which gradual, rather than instantaneous

price transmission can be tested, thus taking into account discontinuities in trade and other factors that may impede market integration over time.

Most importantly, the proximity of the error correction coefficient to -1 can be used to assess the extent to which policies, transaction costs and other distortions delay full adjustment to the long-run equilibrium. Sharma (2002), in a paper aiming to assess market integration between several Asian wheat markets and the world market, estimated Error Correction Models (ECMs) and conducted an extensive policy review. His findings suggest that in countries such as Pakistan, India, Sri Lanka and Indonesia, where governments intervene in the domestic market through various policy instruments, the error correction coefficients were estimated to lie between -0.01 and -0.07, indicating a slow adjustment to the long-run relationship.

Granger and Lee (1989) proposed an Asymmetric ECM (AECM) where the speed of the adjustment of the endogenous variable depends on whether the deviation from the long-run equilibrium is positive or negative. Within this context, asymmetry occurs in the event when positive and negative divergences from the long-run equilibrium result in changes that have different magnitudes. In the context of market integration and price transmission studies, the ECM, as well as its further applications, is perhaps the most useful tool as it provides a stylised picture of the relationship between two prices.

2.9 CONCEPTUAL FRAMEWORK

Figure 2.2 presents a conceptual framework used in this study for market integration in the cassava market in DRC. The entire framework operates within a defined value chain to test market chain. The movement in price gives a significant indicator to derive a conclusion as to whether markets are integrated. If prices among different markets move in similar patterns, those markets present a high potential of integration. In case the series are found to have a negative co-movement in price, a tentative no market integration is suggested. This can imply non-functioning markets, non-availability of food and high price volatility. To assess whether prices move in tandem or not, the study uses a Pearson bivariate correlation coefficient. A high correlation coefficient, close to 1, shows that markets are potentially integrated, since the price co-movement can be influenced by other factors. If the series are found to be close to 1, outliers and price stability series

over time are sorted. The stability of prices is analysed by using the error correction mechanism and calculating the average of price difference in different periods. Actual and lag price convergence indicate whether markets are integrated in the short run and long run.

A zero average suggests that markets may not be integrated in the short run. A non-zero average points to relative convergence in price movement. In other words, prices move in tandem in the long run even if they may drift apart in the short run as a result of other factors such as transaction costs and entry barriers. High transaction costs between two markets indicate that there is no incentive for traders to move food from surplus to deficit markets at a given period of time. Other reasons why traders might not move food will also be checked. Among different plausible reasons, these are notably: seasonal food availability, transport hindrances, insecurity and changes in policy. The implication can be drawn for programming and response options. If markets are found to be integrated, there is evidence that food is available in the markets and prices are stable. Cash transfer may be a good option for food accessibility. This conceptual framework provides a qualitative assessment of market integration and different actions to determine the efficiency in the analysis. This is complemented and detailed by statistical and econometrics analyses presented in the methodological section.

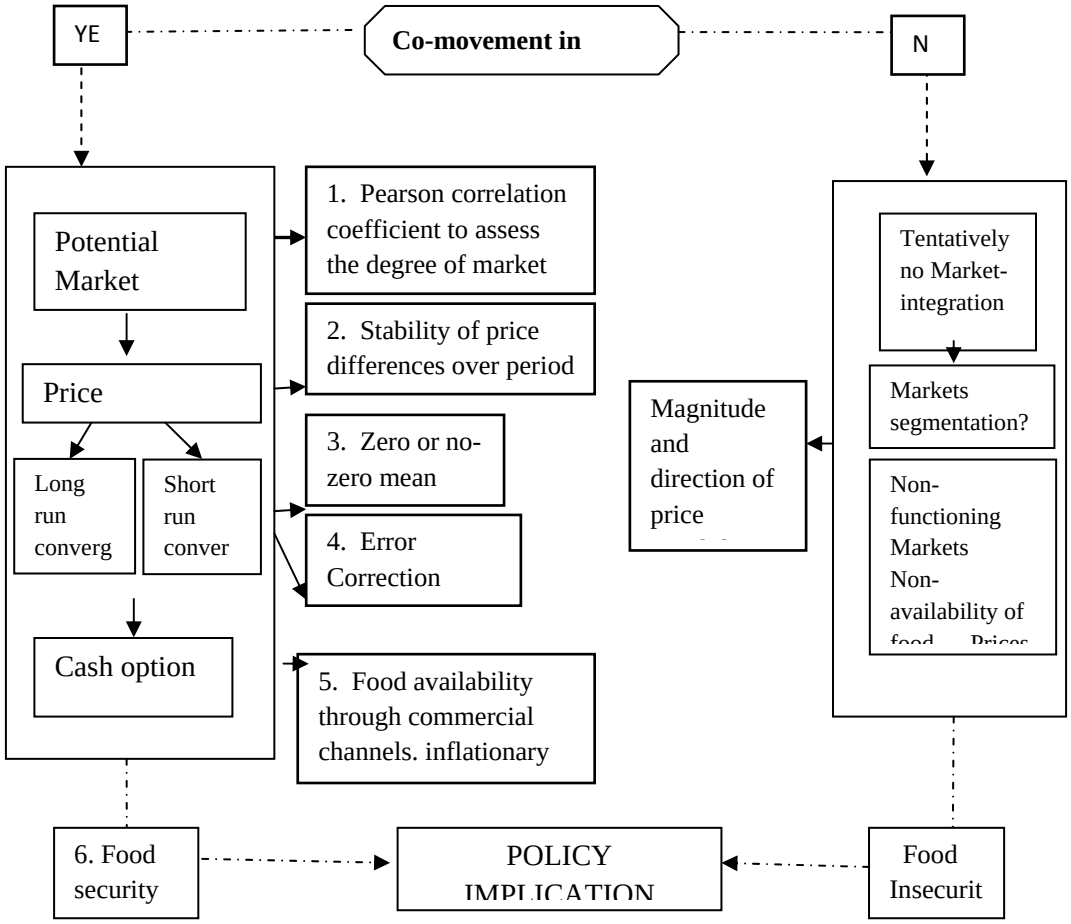


Figure 2.2: Conceptual framework for market integration analysis

S*ource*: Adapted from WFP/PDPE (2007)

2.10 SUMMARY

The literature review reveals that the value chain framework has been used since 1980 as an important tool for identifying and understanding crucial aspects of market performance, and to achieving competitive strengths and core competencies in a commodity market. For other aspects of markets performance analysis, many studies used a co-integration approach. Based on the law of one price, co-integration suggests that if two markets are integrated, price changes in one market are transmitted on a one-for-one basis to the other market in the short run, or over time in the long run. To test the assumption, several techniques were identified in the literature, including co-integration; parity bound analysis, causality; symmetry; and an error correction mechanism. Each technique has shown its limits, and framework for this study combined several techniques to better understand the degree of market integration.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter provides information on different techniques used for data collection and data analysis: Most of data used for the market integration analysis are secondary data, prices aggregated on a monthly basis, obtained from the FAO database and estimated from July 2005 to December 2009. However primary data were needed to assess the status of the cassava value chain t. The sampling procedure discussed in section 3.2 below is therefore specifically discussed to illustrate the sampling process in obtaining primary data for the value chain analysis (see questionnaire in appendix E). It also indicates how data were analysed and presented. The next section focuses on the methodology used for value chain analysis. This analysis is based on four areas including: chain logic and power relationship; enabling environment; business support services; and chain bottlenecks, barriers and leverages. The third section presents the methodology for cassava market integration analysis. It includes: bivariate correlation; error correction mechanism and the index of market integration. A brief summary concludes the chapter.

3.2 SAMPLING PROCEDURE

The sampling refers to the process followed during the selection of subjects to be included in the research. Sampling theory distinguishes between probabilistic sampling and non-probabilistic sampling. Probabilistic sampling occurs when the probability of including each element of the population can be determined. Non-probabilistic sampling refers to the case where the probability of including each element of the population in the sample is unknown (Bless *et al*., 2000:86). Thus, the study used probabilistic sampling, as different categories of participants in cassava market chain were known, their division into subgroups exists, and the researcher could not make an artificial subdivision of samples.

The absence of reliable statistical information about small-scale farmers in the country as well as the difficulties in obtaining an exact number of market participants necessitated an adapted approach. Sometimes it was difficult to distinguish farmers from traders, as both produce and trade in the same market. This obstacle was overcome during the data collection process by using the official traders' corporation recognition. The selection of study participants (i.e., farmers, traders, researchers, extension agents) was drawn from the cassava supply chain operating between South and North Kivu provinces, the most illustrative cassava marketing system in the DRC. Three sites were selected per province: (high, medium and low cassava production), 3 villages were selected within each site and 7 households were surveyed in each village. A total of 126 farmers were interviewed in 18 villages covering key cassava areas in North-Kivu and South-Kivu provinces.

The villages surveyed had already been determined beforehand, based on representativeness, to cover all the 3 agro-ecological zones. The methodology adopted for the choice of households was random, according to principles defined by the INERA and IITA, i.e. with 3 locations by site and 7 households by location. For others market categories, due to the lack of official statistics and high mobility of traders and the change of numbers from a season to another, the participants to this study were chosen based on the importance of information to be collected. The methodology adopted was a random selection of 5 people by category and by district based on a trading corporation list. The participants were chosen based on a minimum experience of 5 years, their availability and their willingness to participate in the survey. In total, those interviewed comprised 126 farmers, 10 rural assemblers, 10 travelling traders, 10 districts wholesalers, 10 urban wholesalers, 10 millers, 10 retailers, 10 extension agents and 10 researchers. Prior to the survey, a training workshop on the methodology of data collection was organised at the Research Centre. It involved twelve enumerators and supervisors who were involved in the survey. The training was based on the use of the survey tool such as questionnaire and GPS. The enumeration team was multidisciplinary, involving agronomists and socio-economists. After the training, three teams of four members each were constituted for the survey. At each site, members of the Development Associations previously contacted introduced the team to the Chief. A local guide from local development associations was in charge of introducing enumerators to households.

3.3 DATA ANALYSIS AND PRESENTATION

Data were analysed using Eviews software, and statistical processes were employed in order to achieve an appropriate analysis. To deal with national currency fluctuation, which, according to Alderman (1993), may cause prices to look as though they are integrated; all prices were quoted in US dollars per kilogram (US$/kg) and the series of prices were all deflated by using the consumer price index (CPI). The real prices obtained were then used for the market integration analyses.

3.4 METHODOLOGY FOR CASSAVA VALUE CHAIN ANALYSIS

The value chain analysis is based on collected primary data and interviews with farmers, distributors, processors and traders regarding their operations, costing and competitiveness across a range of cassava products, including fresh cassava, 'chikwange', dried chips and cassava flour. The aim of the analysis is to shed light on current practices and reveal clear opportunities for improvement. It focuses on four areas, considered as main indicators of value chain performance (Van der Land, H. 2007) including:

1) Assessment of chain logic and power relations to outline organisation and the sphere of nfluence of the value chain participants.
2) Assessment of enabling environment built up, existing laws, rules, regulations, institutions and norms, and their role in supporting cassava value chain.
3) Assessment of business support services (BSS) to identify different services providers, their relevance and adequacy in cassava value chain development.
4) Assessment of bottlenecks, barriers and leverages to highlight the constraints and threats to value chain development.

The study used the value chain framework (figure 2.1) developed by ACDI/VOCAS' (Campbell, 2010). This approach analyses the operators in the market chain from input suppliers to the final consumer and the dynamics of the relationships among them. It examines inter-firm relationships to determine the way they can be used to facilitate production and marketing efficiencies and enable the flow of information, learning, resources and benefits. It also goes through some other factors influencing the chain

performance, such as access and the requirements of final market, the legal, regulatory and policy environment, and the availability and quality of support services such as financial services, equipment manufacture and repair, business management services and information technology.

3.5 METHODOLOGY FOR MARKET INTEGRATION ANALYSIS

Market integration analysis combines bivariate correlation analysis, co-integration technique, error correction mechanisms and the index of market connection. Such combination is necessary as it helps to overcome the limitations attributed to different single methods. This section shows how these techniques were used to analyse data and how their limitations were dealt with in the study.

3.5.1 Bivariate correlation

According to Blyn (1973), a pioneer of the bivariate correlation method, high price correlations between markets are assumed to indicate market integration and the reverse stands for market segmentation. In his discussion, Harry (1979) found that the model suffered from a number of shortfalls. For instance, the prices in different markets might be highly correlated even if markets do not trade with each other. This can be caused by the common destination market or common factors influencing prices such as similar climate patterns. The bivariate correlation method also fails to capture the time lag in price transmission (Nyange, 1999). Despite its shortcomings, the model has been largely used in preliminary analysis in conjunction with other methods.

3.5.2 Market Co-Integration Analysis

The co-integration model (Ghoshray, 2009; Ravaillion, 1986) in market integration literature is usually performed to determine whether a change in price of a commodity in a local market is related to the change in the central market. This approach develops a structural price formation in the local market by assuming that local market prices ($P_i,...P_n)$ are influenced by one central market (R). The structural form of the model according to (Ravaillion, 1986): is represented as follows

$$R_i = f_i(P_i \ldots P_i, X_i) \tag{3.1}$$

$$P_i = f_i(R_j, X_i) \text{ for i=1,n and j=1,2} \tag{3.2}$$

Where the vector $\boldsymbol{X_i}$ market specific seasonal and others exogenous variables that affect price formation; $\boldsymbol{R_j}$ is related to each central market price: Kinshasa (1) and Lubumbashi (2).

The long-run equation is given by:

$$P_t = \beta_0 + \beta_1 R_t + \varepsilon_t \tag{3.3}$$

The dynamic structure of the equation (3.3) is specified as a function of the lag price on the general structure of *i* lag, as follows:

$$P_{it} = \alpha_0 + \alpha_i P_{it-1} + \beta_{i0} R_{jt} + \beta_{it} R_{jt-1} + \gamma_t X_{it} + \varepsilon_t \tag{3.4}$$

The estimated equation (3.4) is susceptible to multicollinearity where the two markets prices are highly correlated; it also presents potential problems of common trend (i.e. spurious correlation). The equation also loses information about the long-run equilibrium and is not suitable for forecasting. To solve this problem, Timmer (1986) suggests the adoption of the Error Correction Mechanism (ECM) formulation of the dynamic structure. If we assume that P_t and R_t are co-integrated, the ECM will contain both short-run and long-run effects.

Following Sanago (2007), the ECM formulation of the dynamic model can be obtained as follows:

- subtract P_{t-1} from both sides;

$$P_t - P_{t-1} = \alpha_0 + (\alpha_1 - 1)P_{t-1} + \beta_0 R_t + \beta_1 R_{t-1} + \gamma_t X_t + e_t \tag{3.5}$$

- add and subtract $\beta_0 R_{t-1}$ on the right hand side of the equation; and

$$P_t - P_{t-1} = \alpha_0 + (\alpha_1 - 1)P_{t-1} + \beta_0 (R_t - R_{t-1}) + (\beta_0 + \beta_1) R_{t-1} + \gamma_t X_t + e_t \tag{3.6}$$

- add and subtract $(\alpha_1 - 1)R_{t-1}$ on the right hand side of the equation.

$$P_t - P_{t-1} = \alpha_0 + (\alpha_1 - 1)(P_{t-1} - R_{t-1}) + \beta_0(R_t - R_{t-1}) + (\beta_0 + \beta_1 + \alpha_1 - 1)R_{t-1} + \gamma_t X_t +$$

The model can be written as first difference, as follows:

$$P_t - P_{t-1} = d_0 + d_1(P_{t-1} - R_{t-1}) + d_2(R_t - R_{t-1}) + d_3 R_{t-1} + d_4 X_t + e_t \quad (3.7)$$

Where $d_0 = \alpha_0, d_1 = \alpha_1 - 1, d_2 = \beta_0, d_3 = \beta_0 + \beta_1 + \alpha_1 - 1, d_4 = \gamma_t$

The following hypotheses can be tested:

- Market segmentation: B_0=B_1=0
- Market integration in short run: B_0=1, B_1=α_1=0
- Market integration in long run: α_1+B_0+B_1-1=0

The long-run equilibrium is incorporated in $\varepsilon_{t-1} = P_{t-1} - \beta R_{t-1}$, which is the lagged residual. Since $\varepsilon_{t-1} = P_{t-1} - \beta R_{t-1}$ represents the long-run equilibrium, when the equilibrium condition holds, ε_{t-1} is equal to zero but during the period of disequilibrium ε_{t-1} measures the distance away from equilibrium. If P_{t-1} has moved below the steady-state growth path then ε_{t-1} is less than zero. But since $-(1-\alpha_1)$ is negative its effect forces *Pt* back toward its long-run equilibrium, as shown in Figure 4.2.

- $-(1 - \alpha_1) = -1$

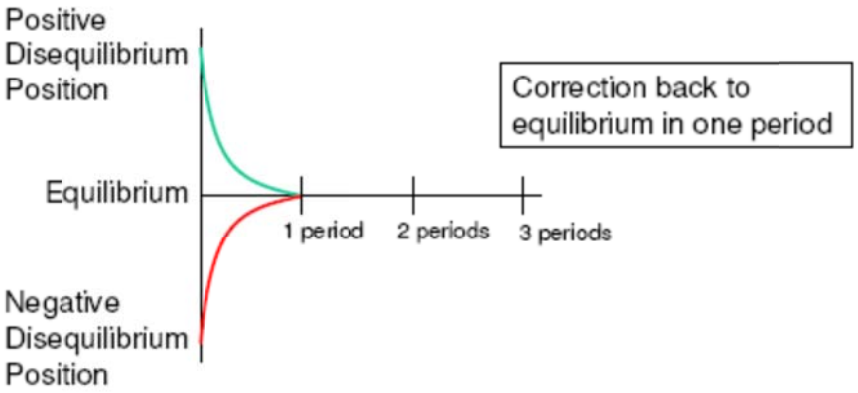


Figure 3.1: Long-run equilibrium

Source: De Waal (2010)

The size of the coefficient $-(1 - \alpha_1)$ is an indication of the speed of adjustment towards

equilibrium. The small value of$-(1-\alpha_1)$, tending to -1, indicates that the economic agents remove a large percentage of disequilibrium each period. The larger values, tending to 0, indicate that adjustment is slow. Extremely small values, tending to -2, indicate an overshooting of economic equilibrium. A value of zero (insignificant), is indicative of no adjustment, in other words, not an error correction mechanism.

The positive value would imply the P_{t-1} diverges from the long-run equilibrium path. This is inconsistent with the entire notion of economic equilibrium and short-run adjustment.

3.5.3 The Index of Markets Connection (IMC)

In short-run, the ECM provides only a measure of the rate of price change that results from an increase in the rate of change in the reference market price. Therefore one cannot directly interpret the sign and size of that coefficient, as we are using first differenced form. In practice, the literature advises that one concentrates only on discussing whether the explanatory variables are significant or not in explaining the variation in the dependent variable (De Waal, 2010). Otherwise, one needs to apply a temporary shock to the explanatory variable (i.e. a 10 % increase) and analyse the effects of the shock on the dependent variable. To overcome this problem, Timmer (1986) proposed a dynamic model to calculate the Index of Market Connection (IMC), which investigates the extent of market integration in the short run. We therefore preferred to use IMC because it better shows the provincial market response to price change in reference market in the short-run.

The IMC is used to measure the relationship between the prices of different markets and is mathematically estimates as follows:

$$P_{it}= \beta_0 +\beta_1 P_{it-1}+\beta_2(R_{jt}-R_{jt-1})+\beta_3 R_{jt-1}+\varepsilon_t \tag{3.8}$$

Which can be written as follows:

$$P_{it} = d_0 + d_1 P_{t-1} + d_2(R_t - R_{t-1}) + d_3 R_{t-1} + e_t$$

Where $d_0 = \beta_0, d_1 = \beta_1, d_2 = \beta_2 - 1, d_3 = \beta_0 + \beta_1 + \beta_2 - 1, d_4 = e_t$

Where R_{jt} if the reference market price *j* for the month *t*, P_{it} the provincial market price *i* for the month *t*, R_{jt-1} is the lagged price for the reference market *j* for the month *t-1*; R_{jt}-R_{jt-1} is the difference between the reference market *j* for the month *t* and its lagged prices *t-1*; ε_t represents unexplained variables or errors related to time *t*; β_0 is the intercept term; β_1 is the coefficient of provincial market lagged price; $\beta_2$is the coefficient of R_{jt}-R_{jt-1}; and β_3 is the coefficient of reference market lagged price. The IMC is defined as the ratio of the coefficient of the provincial market lagged price divided by the coefficient of the reference market price:

$$IMC = \frac{\beta_2}{\beta_o+\beta_1} \quad because \quad d_2 = 1 - \beta_2, \text{thus} \tag{3.9}$$

$$\beta_{2=\,1+\,d_2} \quad since \;\; d_3 \;=\; \beta_o+\beta_1 + \beta_2 - 1 \;\; and \;\; d_2 = \beta_2 - \tag{3.10}$$

Therefore

$$d_3 = \beta_0 + \beta_1 + d_2 \quad \text{and} \quad \beta_0 + \beta_1 = d_3 - d_2 \tag{3.11}$$

Thus $IMC = \frac{1+d_2}{d_3-d_2}$. (3.12)

The IMC shows the effect of the regional market and the past reference market price on current regional prices. IMC at less than 1 indicates short run integration, and when it trends to the infinite it indicates that markets are segmented or provincial market prices do not respond to change in the reference market in the short run.

3.6 SUMMARY

Cassava market performance can be tested by the existing methodologies, combining value chain analysis and market integration analysis. This combination provides significant advantage as it focuses research on both actors and product sides of cassava commercialisation. The value chain analysis provides valuable information on factors influencing the actor's performance such as access and requirements of final markets, the legal, regulatory policy environment, and the availability and quality of support services such as financial services, equipment manufacture and repair, business management services and information technology. This analysis is completed by the market integration analysis, which provides important information about product movement

mechanisms as well as technical information on spatial prices behaviour, in other words: 'how prices are formed and transmitted among different markets in the short and long run'. This global view provides the researcher with the possibility of setting a holistic intervention strategy that can improve both the performance of the actors and the performance of the product and its distribution mechanism in the value chain. The following chapters, five and six, show the application of this methodology and the related results.

CHAPTER 4

AN OVERVIEW OF THE CONGOLESE CASSAVA VALUE CHAIN

4.1 INTRODUCTION

This chapter presents an overview of the Congolese agricultural sector with particular emphasis on the cassava supply chain. The chapter is divided into four main sections. The first one describes the macroeconomic environment, which also integrates socioeconomic environment and physical infrastructure, which constitutes the deciding factors of any economic sector efficiency. The second part attempts to characterise the status of the cassava value chain. It presents food consumption patterns, and the framework of cassava production and commercialisation. The third section deals with different actors and their features in the cassava market. The last section presents different institutions governing transactions in the cassava value chain in the DRC.

4.2 MACROECONOMIC ENVIRONMENT

A better understanding of the political environment in which the wider economy operates can provide a sound understanding of marketing behaviour of producers, traders and consumers in the cassava value chain in DRC. This section illustrates the way some factors of the macroeconomic environment, such as socioeconomic environment and physical infrastructure have significantly influenced the performance of the cassava market in the country. It particularly brings to policy makers' attention the necessity of intensifying effort to stabilise the macroeconomic environment in the process of bringing about food security and poverty alleviation.

4.2.1 Socioeconomic Environment

Since 1991, the socioeconomic environment in DRC has been characterised by a constant decline of the macroeconomic system as well as the living standard of the population. The weakened internal condition has resulted in basic infrastructure collapse, use of obsolete production facilities, lack of funds, extinction of institutional and human

resources necessary to ensure public sector efficiency, national treasury revenue growth, high inflation, a significant slowing down of productive activities and a reduction in exports (Clément, 2004). Following social unrest and looting of property in 1991 and 1992, many formal enterprises have ceased to exist because the investors left the country and workers lost their formal jobs. The whole situation was exacerbated by alleged non-payment of wages in the public sector, and the increase of rural-to-urban migration has resulted in enormous pressure on the marketing system and food distribution: each year, 5 to 7 % more food is demanded to keep the balance, and consequently the need for more markets and other marketing infrastructure increase. In order to cope with this, the formal sector has been replaced by a multitude of small informal businesses, which leads to high poverty index in the country as illustrated in the figure below.

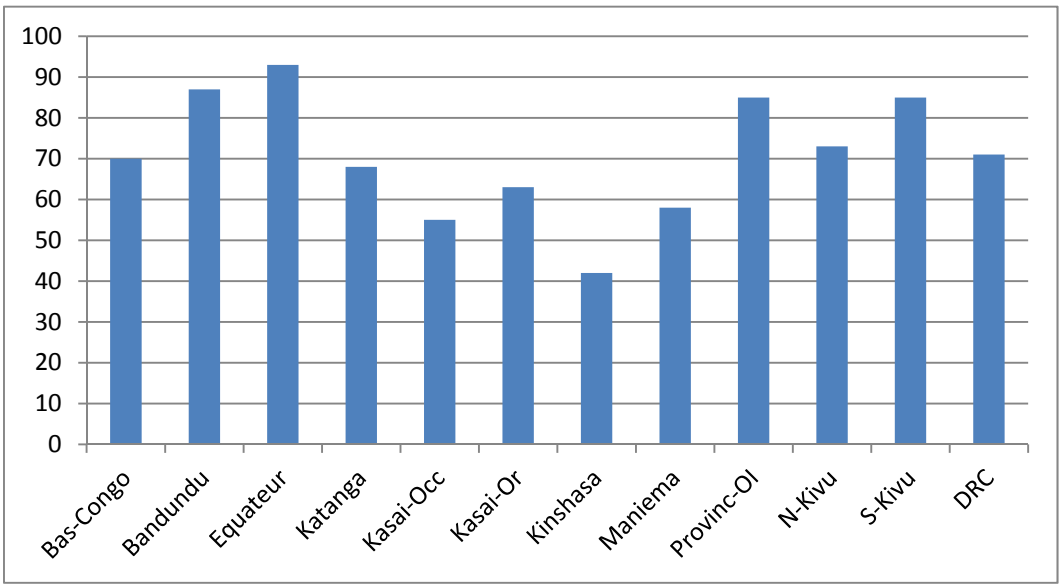


Figure 4.1: Provincial Poverty Index

Source: Adapted from UNDP, 2009

According to figure 4.1 different provinces are differently affected by the incidence of poverty. The provinces of Equator, Bandundu and South-Kivu present the highest poverty index in the country while the provinces of Kinshasa, Kasaï-Occidental and Maniema seem to be less poor than the others.

4.2.2 Physical Infrastructure

The process of macroeconomic decline has accelerated the degradation of physical infrastructure. Considering the present advanced state of decay, there has been no maintenance of basic infrastructure. Formal systems of collection, transportation and distribution of food are quite absent because of the non-existent macroeconomic framework to facilitate investment, i.e., non-maintenance of roads and bridges, lack of fuel, spare parts, credits, telecommunication infrastructure, effective and reliable administration and an inefficient judicial system (Chinamula, 2005). However, since 2003 the government has embarked on a programme of rehabilitation of basic infrastructure, which has started showing a positive effect on food marketing and supply (Infosec, 2004). This study wishes to reveal to what extent such a programme has impacted the cassava market integration among different regions across the country.

4.3 THE IMPORTANCE OF CASSAVA WITHIN FARM HOUSEHOLDS

4.3.1 Contribution of Cassava to Household Food Security and Cash Income

The potential of cassava's contribution to the achievement of food security and poverty alleviation is demonstrated in the role of cassava in the livelihood of the farm households, and justifies the need for subsidised production and commercialisation of the crop as both a food and cash crop. Cassava appears to play a relevant role in generating food and income in the household. Farmers in the study area ranked it foremost for food security and income generation during the survey. The survey revealed a high tendency to move from cassava subsistence farming to commercial farming in some production areas. The most remarkable fact is the presence of male farmers in cassava production; it is no longer a matter of women only. Table 4.1 provides information on farmers' evaluation of the most common crops for food and cash income. Cassava followed by bean and maize have been singled out by more than 60% of interviewed to be the main source of food security and income.

Table 4.1: Crops' contribution to Food security and income

Crop	Food Security		Incomes		Food Security & Income	
	Number of respondent	%	Number of respondents	%	Number of respondents	%
Bean	45	30	2	4	44	25
Cassava	66	44	1	2	48	27
Maize	23	15	20	38	46	21
Banana	3	2	7	13	13	7
Potato	1	1	1	2	2	1
Peanut	0	0	9	17	11	6
Rice	0	0	1	2	9	5
Yam	1	1	0	0	0	0
Sorghum	1	1	1	2	3	2
Vegetable	10	7	11	21	9	5
Total	150*	100	53	100	175*	100

*N is much greater than the study sample size due to multiple responses.

Source: survey data

4.4 THE CONGOLESE CASSAVA VALUE CHAIN

Figure 4.2 illustrates the main cassava supply chain in the DRC, an illustration of how cassava products change hands from production to consumption. This section indicates the product flow and actors' interaction and provides further details about market chain functioning, constraints and opportunities for value chain improvement.

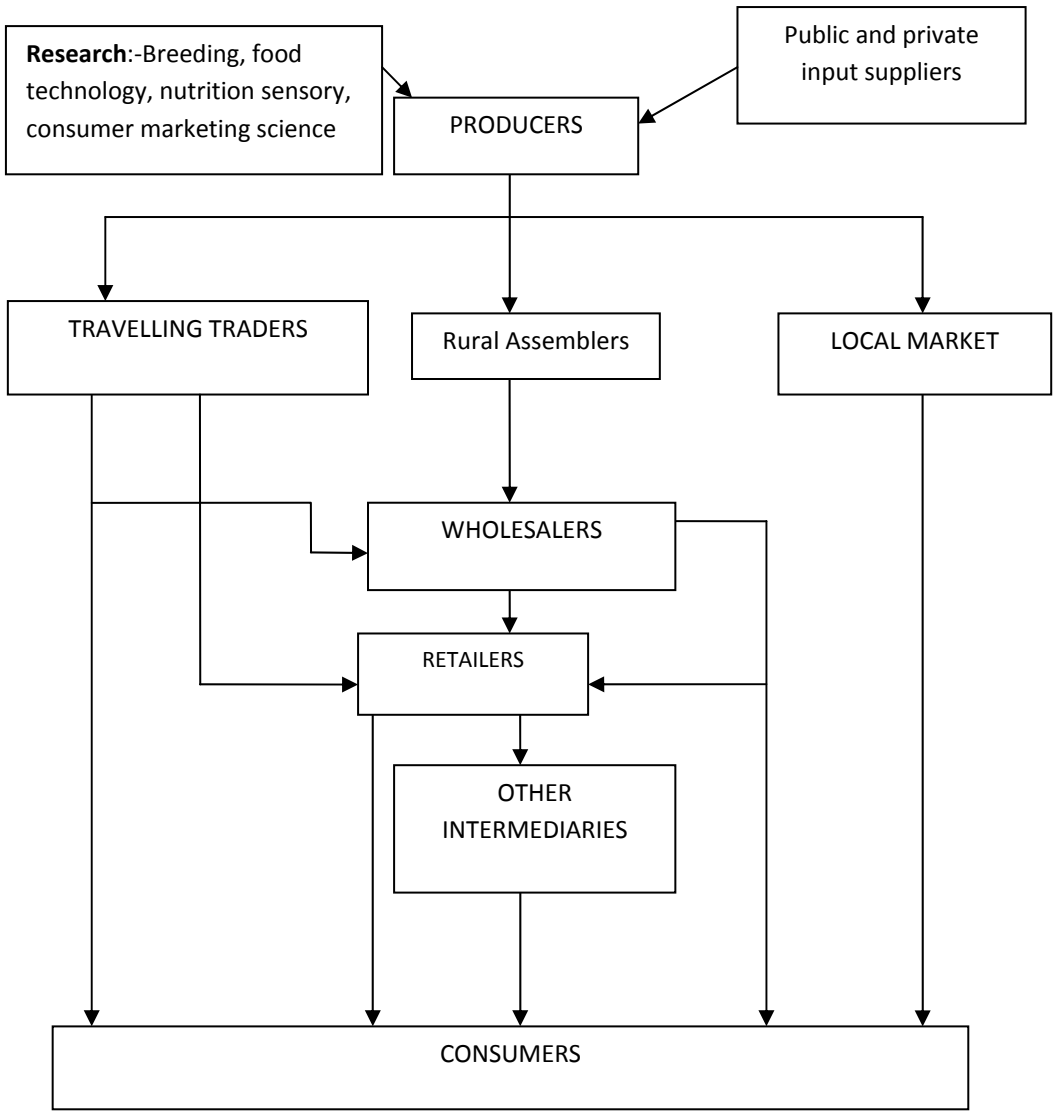


Figure 4.2: Product flow and Actors interaction diagram

Source: drawn from survey data

4.4.1 Input Supply

In most cases, farmers plant local varieties sourced from their own farm or neighbours. More than 35% of interviewed farmers have access to improved material from INERA, SENASEM, IITA and CRS. The system of inputs supply in the rural areas is weak; most inputs suppliers are hardware shop owners selling farming inputs that include hoes, slashers, axes, manual sprays, ox ploughs, rakes and fertilisers. The inputs are sold on cash terms while farmers are mostly concerned with price, quality and transportation of inputs (Tollens, 2004). This constraint has required the involvement of NGOs in the farming inputs supply sector.

4.4.2 Cassava Production

Congolese cassava is mainly produced by largely dispersed small-scale farmers, who often own less than 1 hectare (INERA, 2008). Figure 4.3 provides statistics of the main crops produced in the DRC. Cassava clearly appears to supersede most popular crops such as plantains, maize, rice and beans.

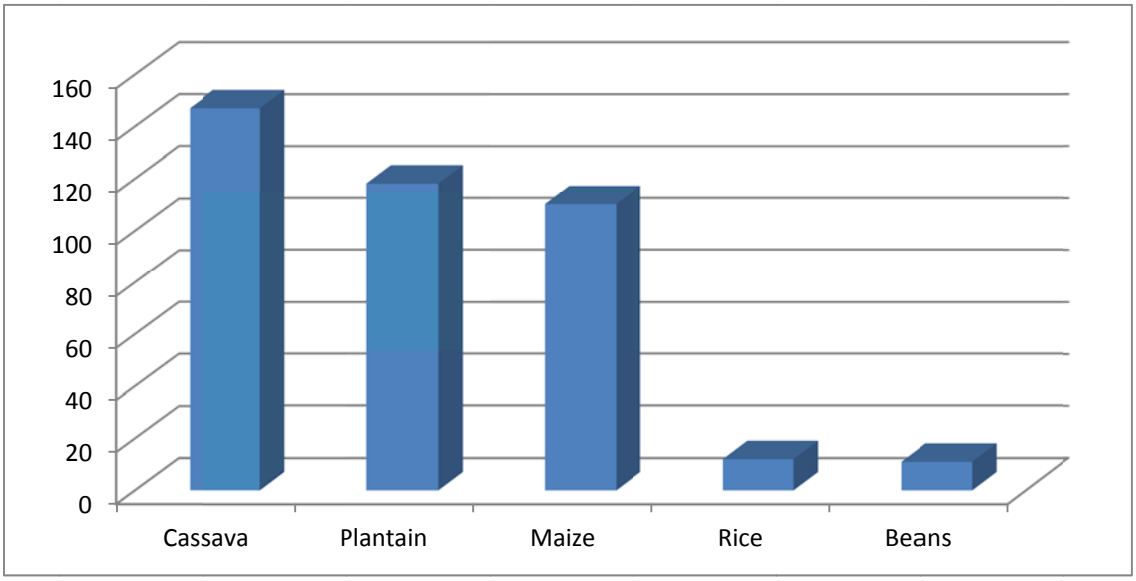


Figure 4.3: Annual Production of main crops in the DRC (t/year)

Source: FAO (2009)

Cassava is produced in each province, but there is a large disparity in its production over different provinces, as indicated in Table 4.2. According to this table, five provinces out of eleven (Bandundu, Katanga, Equateur, Province Oriental and Bas-Congo) produce 80 % of the cassava consumed in the country.

Table 4.2: Annual provincial cassava production

Province	Production(T)
Bandundu	5 148 688
Katanga	3 331 495
Equateur	3 028 665
Province Orientale	2 670 662
Bas Congo	2 407 766
Kasaï Occidental	1 592 001
Kasaï Oriental	1 305 334
Maniema	1 027 706
South-Kivu	786 879
North-Kivu	425 417
Kinshasa	15 143

Source: Minagri (2006)

However, official data (Minagri, 2006; FAO, 2007; IRS 2007) show that cassava production and consumption have significantly decreased over the last two decades in both urban and rural areas. This is shown in Figure 4.4. Cassava production has been decreasing since 1994 with the 1996 lootings and armed conflict as a structural breaking point. In 1996, when the war started many producers had to move from their villages to more secured cities. As result, agricultural activities were deserted for about 1year before farmer reinstallation in 1997.This is the reason of the spectacular production fall observed during 1996 in the figure 4.4

According to cassava production trends in the DRC (Figure 4.4), from 1990 to 2006 the highest decrease in the cassava production rate is shown in the province of Katanga. A large amount is produced in Bandundu, Katanga and Province Oriental, while South-Kivu, North-Kivu and Maniema, have the lowest production rates. The average cassava yield varies from 12 tonnes to 6 tonnes. Low application of input and the recurrence of infection by the African cassava mosaic virus (CMV) have been pointed out to be the major cause of yield reduction (FAO, 2008). Farmers have few value addition options, and the major value addition processes for the product, at the production level, include the use of improved planting material, packaging and transportation.

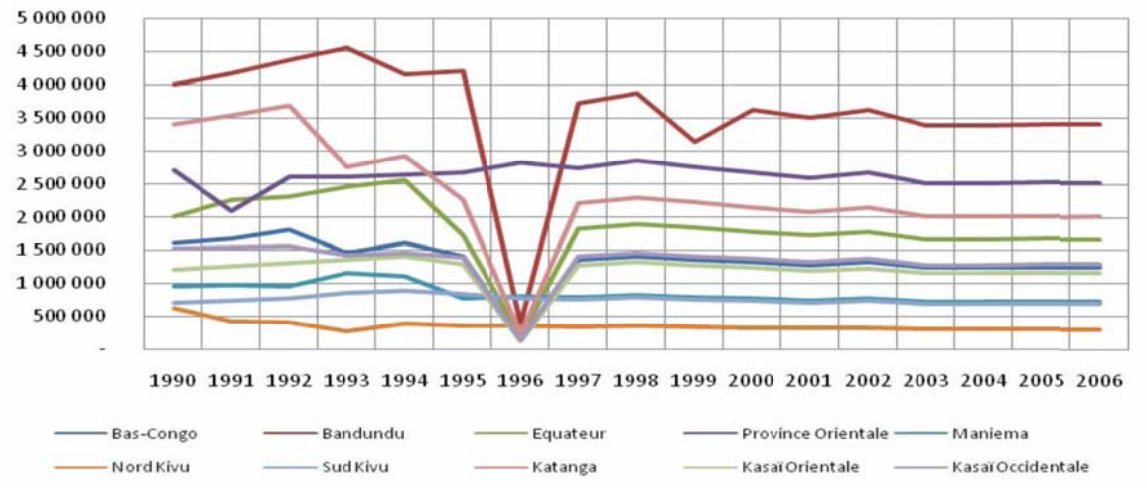


Figure 4.4: Cassava Production Trend 1990-2006 (kg)

Source: adapted from FAO (2008)

4.4.3 Cassava Processing

Cassava has the potential to be processed into a range of sub-products from food products to industrial sub-products. Table 4.2 lists the different sub-products derived from cassava.

Table 4.3: Sub-Products Derived from Cassava

From roots	From traditional starch	From modified starch
Food (fresh root boiled, chikwange, chips, pellets, gari, fufu flour, tapioca meal and lafun)	Alcohol	Biodegradable products (plastic bags, soup bowls, lunch boxes and cups)
Flour (mostly used for baking as it is gluten free)	Glue	Pharmaceuticals (used in pills and tablets, syrups and body creams)
Animal feed (processed into chips and pellets)	Plywood	Prepared food (used in sausages and prepared meats)
Starch	Paper	Sweeteners (glucose syrup)
	Textile	Monosodium glutamate (used in soups, sauces and gravies)

Source: adapted from Ruramai (2010)

However, the use of cassava products in the industrial sector is still at an experimental stage and it is hoped that it will develop steadily with the improvement of the country's political environment. To date, cassava is mainly processed into fries, flour, 'Chikwange', traditional alcohol drinks and starch. Fresh roots in many areas are generally processed on-farm as an individual activity, shortly after harvest. The processed product is transformed into 'Chikwange' (or dried chips) and sold to local

markets or traders. The dried chips are processed into cassava flour at the farmer level or by traders using modern milling to improve product quality. The greatest value addition in this chain occurs via farmers and micro bulk carriers.

4.5 MAIN CASSAVA SUB-PRODUCTS TRADED IN THE DRC

Trading in cassava is largely informal and private. The demand for cassava is mostly for food. Opportunities for commercial development are still underdeveloped, in contrast to other cassava cultivation areas of Asia and South America. The absence of an agro-industrial market remains the major constraint to the future development of the crop. The cassava market has four major sub-products, beside the leaves, which are a very important commercial vegetable. Different sub-products traded are the following:

4.5.1 Fresh roots

Fresh roots are consumed mostly at the farm level in various forms: boiled, crisps, roasted or fried, and the production surplus of fresh roots is sold to nearby markets. Overall, fresh root sales account for about 3 % of total production (Mastaki, 2006). As cassava roots contain about 70 % of water, and the root quality degrades within 72 hours after harvesting, most of fresh sales travel only 50 to 100 km from field. For this reason, the fresh roots supply chain is not well established in the country. The demand is decreasing in the market, due to the fact that it does not have characteristics that are demanded by modern customers, such as shelf life, ease of transport and storage. The fresh cassava market price fluctuates seasonally; it records high prices during the rainy season when supply of other staple foodstuffs is scarce and falls off during the dry season. The future development of the fresh cassava market depends largely on improvement of transportation conditions

Figure 4.5: Cassava plant and fresh roots Source: Ruramai (2010)

4.5.1 Dried chips

Farmers use a dry-fermenting process or a wet fermentation process to make dried chips. In the first process after uprooting, the roots are peeled, washed and sun-dried for 2 days, then the cassava is covered with bags or leaves for about another three days. After removing any moulds, they are pounded into chips. In the wet fermentation process, the cassava is soaked in water for several days to remove poisonous cyanogens, and thereafter it is dried and pounded into chips.

In terms of the level of commercialisation, dried chips make up a large proportion of the cassava traded within the country, and because dried cassava is easier to store and to transport than fresh cassava, it offers a better alternative for cassava commercialisation. Trading in dried cassava, which accounts for about 80 % of marketed bulk, originates predominantly in rural areas. Significant intra-provincial trade exists, as deficient provinces and urban areas depend on regular purchase of dried cassava. There are several intermediaries operating in the cassava market, processing and delivery to the final market.

Figure 4.6: Men holding Bags of Dried Cassava

Source: Mnenwa (2009)

There is an important network of intermediary traders who purchase cassava directly from the farmers. Direct interaction between producers and customers is virtually non-existent. Cassava trade is highly seasonal because farmers and processors depend primarily on sun drying, and the dried cassava trade flourishes during the dry season. Data from the Bukavu Office of the National Agricultural Research Institute (INERA, 2008) indicate that the seasonal volume traded ranges from 50 to 100 tonnes per month in the rainy season, to over 300 tonnes per month during the dry season. Cassava prices follow the same seasonal profiles like Maize, reaching the peak in the rainy season when dried cassava and maize become scarce, and reaching their lowest level during the dry season when the supply of both staples is abundant. This study mainly focuses on this sub-product to make inference of cassava market integration in the DRC.

4.5.2 Chikwange

This is a fresh cassava-based product consumed in the DRC and most of Western and Central African countries. Fresh roots are soaked for three days, then pounded and packaged in fresh leaves or plastic. Thereafter, the product is boiled for one hour.

'Chikwange' is in constant demand in all local and export markets, representing a good alternative for future cassava market-development in the country. However, its demand is not enough to absorb an increasing supply. Effort must focus on organisation of the market in order to stimulate demand.

4.5.3 Cassava flour

Derived from dried cassava, cassava flour is a form of cassava sub-product that currently predominates among Congolese staple foodstuffs. However, cassava flour is currently facing decreased demand because the traditional processing method does not give the quality required by modern consumers. On the contrary, there is an increased demand for processed products for human consumption and animal feed in the country. 'Fufu', a main cassava-based food, and blended flour for products such as biscuits, breads, fritters and local alcohols offer the advantage of access to a large existing milling infrastructure and hence potentially rapid uptake, although they will require some product improvement and marketing effort to win consumer acceptance.

Figure 4.7: Cassava flour

Source: Mnenwa, 2009

4.6 CASSAVA CONSUMPTION

Although the country is one of the world's major producers of cassava, the DRC is not self-sufficient. There is a large daily per capita deficit in the consumption of both calories and proteins. Table 4.4 indicates that the per capita daily calorie and protein levels are below the United Nations standard of 2,300 calories and 29 grams of protein. Table4.4 also exhibits a large disparity in calories and proteins consumed within different provinces. Since the 1990s, food imports have increased by 20 % per annum, starkly underlining the country's vulnerability.

Table 4.4: Per Capita Consumption of Food (Calories and Proteins) in the DRC

Provinces	Calories	Proteins	Calories Discrepancy	Proteins Discrepancy	% agricultural population
Kinshasa	1988	35	-13.57	-30	7.8
Bas-Congo	1765	24	-23.26	-52	73.3
Bandundu	1941	23	-15.61	-54	76.4
Equator	1816	19	-21.04	-62	58.9
Provincial Oriental	1758	25	-23.57	-50	89.8
Maniema	1903	31	-17.26	-38	89.7
North-Kivu	1741	33	-24.30	-34	79.2
South-Kivu	1560	27	-32.17	-46	83.9
Katanga	2007	43	-12.74	-14	64.9
Kasaï-Oriental	1826	30	-20.61	-40	65.8
Kasaï-Occidental	1816	31	-21.04	-38	75.6
DRC	**1829**	**29**	**-20.48**	**-42**	**63.8**

Source: Mastaki, 2006

4.5.4 Food consumption patterns

The main dish for the average Congolese household is generally composed of cassava flour, commonly referred to as 'fufu', or cooked, roasted, fried, or raw cassava, varying from one province to another. It is served with fish, meat, cassava leaves or other vegetables. A survey conducted by the National Institute of Statistics (INS) in 2005 indicates that 46.2% of household expenditure is devoted to food, 23.5% to housing, 6.7% to transport and 4.2% to schooling. For household consumption, 95.1% of food purchases are made in the informal sector. In addition, 80.8% of the amount of consumption is made in the informal sector. To maintain the level of consumption at the household and individual level, the more expensive products are replaced by other foods. First, lower purchasing power is usually reflected in the diminution of both calories and

protein intake as shown in Table3.4, and an increase in the share of food calories (cereals, tubers, cassava, etc.), which replace foods high in protein (meat, soya, beans, poultry, fish, etc.). The following table shows the decrease of calorie and protein intake over time.

Table 4.5: Per capita consumption of calories and proteins in Kinshasa 1975- 2009

Years	*Calories*	*Proteins*
1975	1,797	59.8
1986	1,506	46.8
1990	1,471	46.3
1995	1,438	44.0
2000	1,368	38.5
2003	1,594	47.1
2005	1,675	47.2
2009	1,677	46.1

Sources: Drawn from data from Nkwembe (2002) and INFOSEC No. 61, 25.11.2009

Second, changes between the components of each product group are involved, between different categories of cereals, meat, fish, vegetables, etc. More expensive foodstuffs are replaced by less costly food. As a result, cassava products, which are relatively expensive, are being replaced by processed and imported food such as rice, bread and maize. This tendency is shown in Table 4.5, where rice and maize consumption has relatively increased at the expense of cassava.

Table 4.6: Annual per capita consumption of food (kg per capita) in Kinshasa

Product	*Years*				
	1975	*1990*	*1995*	*2000*	*2009*
Cassava	176.71	165.39	161.84	156.52	145.31
Wheat (flour)	37.92	32.08	30.37	28.36	26.48
Rice	8.41	12.81	15.41	19.43	21.51
Maize grains	2.84	4 4.02	4.64	5.57	6.68

Sources: PNUD - UNOPS (2006), Nkwembe (2002), Infosec No. 61, 25.11.2009

4.6 CASSAVA VALUE CHAIN ACTORS

The performance and the efficiency of a value chain is a result of its market structure, of how well the actors are organised, and how well the chain is supported by a range of business development services (Barrett, 2008). Business services include research

entities, input suppliers, communication support, transporters, local administration, information services and financial services. A market analysis aims, therefore, to assess both goods and services along the chain and virtual strength of market signals. Cassava marketing chains have evolved to cope with the perishability of the root. Speedy marketing is ensured through a wide range of operators, including producers, travelling traders, transporters, wholesalers and retailers. The research and extension services (INERA, SENAEM and SENAFIC) influence the market chain by facilitating development and dissemination of new technologies, farmers' training and providing technical backstopping. Operators such as farmers, traders and consumers are often connected through complex systems of information flow, credit, and transport. The actors are at various stages of the cassava value chain, and their function and outputs are summarised in the following table:

Table 4.7: Summary of market chain actors and their functions

Stage of Chain	Agent	Function	Output
Input supply	Research	Technology development	New and improved technologies
Input supply	Extension service (Senasem, Senafic, SNV),	Technology transfer,farmers traning	(Fertiliser,seed, equipment)
Production	Farmer	Farming	Raw cassava
Processing	Farmer	Processing	Processed chip
	Wholesaler	Processing raw chip	Cassava flour
Marketing	Rural Assembler	collect and supply	Cassava chips
	Travelling Trader	Purchase and selling	Cassava chips
	Wholesaler	Purchase and selling	Cassava chip and flour
	Retailer	Purchase and selling	Cassava chip and flour

Source: Survey data, 2008

From Table 4.6 the role played by various actors in the cassava value chain can be explained as follows:

4.6.1 Farmers

Cassava is mainly produced by smallholder farmers owning less than 1 ha of land. Large farmers and commercial firms are more involved in cereal production than cassava (Mastaki, 2006). Farmers produce raw cassava, peels and dry roots. Depending on the

available carrier mode, they may decide whether to sell directly to rural retailers, local markets or to wholesalers if they are near a major district level town (Tollens, 2004). Farmers can also sell to rural assemblers or travelling traders**.**

4.6.2 Rural Assemblers

These are usually intermediaries who buy mainly farm products from small and scattered producers and prepare them for shipment in economical quantities to the city. They typically have access to more resources than other village members do. They use these capital and social networks to collect cassava from neighbouring areas, purchasing products in markets or in rural villages from door to door, moving on foot, by bike, bus, etc. (Kalonji, 2003), over a distance of several kilometres. Many customers prefer buying from rural assemblers to spare their time and money assembling sufficient quantities of cassava chips, at the same time reducing the cost of transport in the marketing channel. Rural assemblers act as quality controllers of small quantities of typical chips offered by farmers (Collinson *et al*., 2000). They basically sort chips into a high quality, white and well dried grade, and a discoloured and lower quality grade. In order to mitigate market uncertainty, collectors like to customise their business relationships with identified producers and buyers. Usually, they receive cash in advance from wholesalers or travelling traders.

The lack of a formal trade system has resulted in the non-existence of market entry requirements. About 60 % of collectors operate without official trading licenses (Tollens, 2004). They only pay taxes on parking, and exercise the profession for some time. This explains the sharp increase in the number of collectors in recent years. Often, they get agricultural credit in their village, and they pay others fees until they sell their products in town. In conclusion, the chain of collectors emerged as a local response to the constraints of the system of collection, transportation and distribution in large semi-perishable food products. This marketing system operates without well-organised contracts for delivery and has no credits, no distribution infrastructure, but manages to feed the main cities throughout the year.

4.6.3 Travelling Traders

These are usually urban-based traders supplying the greater part of chips or cassava flour to urban consumer markets (Tollens, 2004). By reducing the time between purchasing and selling, travelling traders quickly turn over their working capital. Most of the time, they avoid cassava storage as a means to reduce risk of significant overhead costs and of prices moving against them. Basically, travelling traders purchase products from several rural assemblers per journey and hire trucks to transport the products to the urban centres, where they mill the chips and sell flour to wholesalers. They have the particularity of being sellers of virtually all food products.

4.6.4 District Level Wholesalers

The district level wholesalers buy a certain number of bags, arrange transportation to their depots and sell them in small units or single units to retailers and consumers. Approximately half of these wholesalers are tenants of their warehouses and the others, owners. They have no means of transportation. As the main purpose of these warehouses is to supply to retailers, they are located around the major retail markets. Some of them are located along the route of products supplied by boats along the rivers or at main lorry parking places. The district level wholesalers generally belong to the informal sector. Their weaknesses are the lack of account books or individual ledgers; no reinvestment and even depreciation of products; and that their profit is currently used to meet the immediate consumption needs of the owners and their families. The use of working capital to solve family problems is common, which keeps them from long-term planning.

Mixing family and business funds poses a serious challenge to the stability and financial soundness of many companies. Roughly speaking, the strength and survival potential of this sector lie in its dynamism. The value of a transaction to purchase food is on average of $US 550 (INS, 2007). This quantity is sold within 8 days (average) resulting on an average turnover of $US 60 per day, which is very high because there is little cost and they generally add little or no value. The structure of trade in district level wholesale is atomistic, but there are barriers to entry. Potential district level wholesalers face the challenge of finding initial working money. About 80 % of them renew stocks by themselves. People who find themselves in a situation of food insecurity, lack access to

such trade. Thus, the number of district level wholesalers fluctuates with economic conditions: there are families with financial resources who would wish to invest in district level wholesale ventures but have no investment opportunities. Those in possession of capital are oriented towards the retail sector or become hawkers.

4.6.5 Urban Wholesalers

These are located in urban areas and operate on a large scale. The feature of urban wholesalers is that they are still vertically integrated, with branches and representative offices around the country and parent companies in Europe, the Middle East or Asia. Some are also horizontally integrated; they have nothing more than one product within the same industry or related industries. This integration can partly escape the tax on turnover (3 to 20 %, depending on the product) for each sale of products when a sales invoice is prepared. Thus, the price of a product imported by the parent company in Europe and sold to a customer in a city within that country can be increased by several institutions of the same company, but ultimately the tax will be paid twice, when import duties and import taxes are paid and when the final sale to customers is finalised. Thus, the import and export of food products is always done by wholesalers. Wholesalers are also active in local products that do not require processing or conditioning specialisation, such as maize, peanuts, rice, palm oil and export products like coffee, cocoa, rubber, tea and cinchona. They also own and control the production, collection, processing and export of cassava.

4.6.6 Millers

The millers are organised as independent service providers, serving both traders and consumers. As such they are not directly involved in product selling or buying. However, there are numbers of millers who sometimes combine milling with wholesaling (Collinson *et al.,* 2000). They purchase cassava chips directly from rural assemblers or from travelling traders, transform the chips into flour, and organise selling and storage service. Sixty-seven percent of millers interviewed indicated that their weekly turnover ranges from 8 to 10 tonnes. In small agglomerations, where electricy is not supplied, they run small petrol or diesel powered mills.

4.6.7 Retailers

There is a large number of retailers in the cassava market with small businesses, selling small quantities of products. Retail in cassava products is mainly undertaken by women (over 95 % of retailers are women), who practice it for survival (Tollens, 2004). Chips are purchased broadly at the 'truck station' where trucks from the interior stop, from wholesalers' stores or directly from others traders. Then they are milled into flour and sold in markets or along the roads. Most of these retailers (84 percent interviewed), sell on average a daily quantity of 50 to 100 kg. Their profit margins are not large enough to ensure a minimum income. The main causes of these low returns, according to Nkwebe (2002), are a large number of middlemen, the low quantity used by each, lack of effective competition, unnecessary comings and goings, lack of standardisation of weights, measures and packaging, requiring an exhaustive control at each exchange, the loss of many products, and lack of objective information on the markets. The decrease in the quantity sold by the retailers, which inflates the cost per unit of product, is in turn due to:

- A poor economic situation that leads to a decrease in purchasing power and quantities purchased by consumers;
- Increase in the number of vendors caused by an economic crisis and the social role of the market, causing a decrease in the quantity sold by each vendor;
- A reduced demand for services in the retail market for certain products that people buy, (half-fat or low-fat products being preferred). The poorest people suffer from lack of efficiency in distribution, because their meagre income cannot allow them to afford semi-wholesale markets.

4.7 PRICING AT DISTRICT MARKETS

Figure 3.8 presents the average market price of a kilogram of dried cassava for the eleven provinces in the DRC. The price of cassava varies from one market outlet to another due to discrepancies in market environment and series. The price is very high in Kinshasa followed by the Lubumbashi market. The two metropolises represent a large demand

centre, being the largest cities in the DRC.

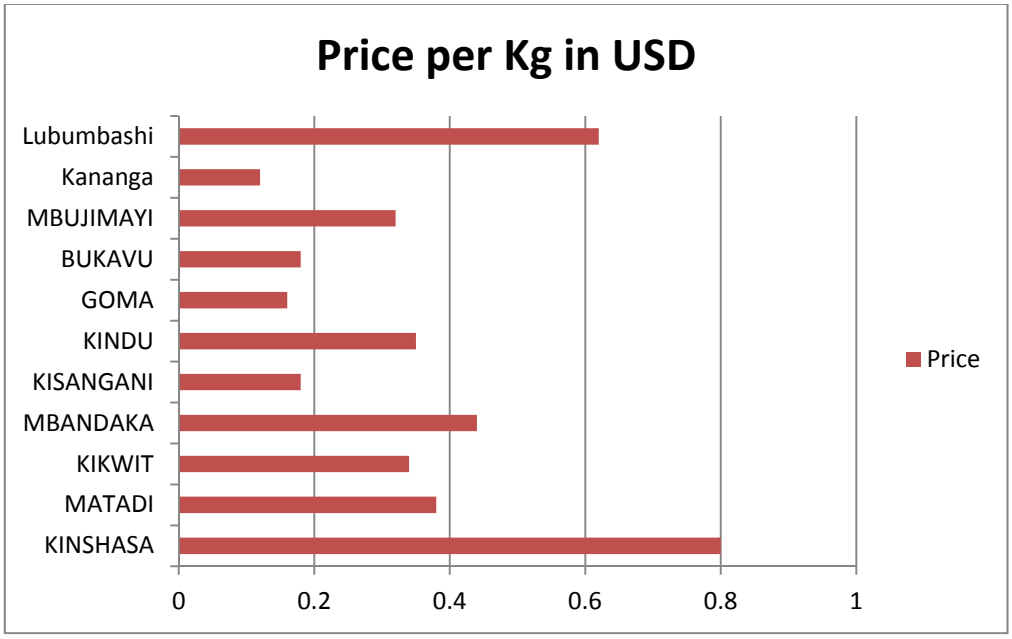


Figure 4.8: Average provincial price of 1 kg of cassava chips.

Source: Survey data, 2008

Market prices seem to be high in areas where supply is low against a high demand, and vice-versa in areas like Kananga, Goma and Kisangani. The cassava price in Mbandaka and Matadi is relatively high on average, at $US 0.44 and 0.38 respectively compared to an average of 0.34 in Kikwit, which also trades directly with Kinshasa. In the Eastern Province, the high market price in Lubumbashi may be the result of limited production in the two provinces of Kasaï as well as the high transaction costs associated with marketing cassava in these provinces. Although the market prices might vary across the provinces in the country, the reference market prices seem to be much higher than the provincial prices. For instance, in Matadi, the nearest provincial market linked to Kinshasa, the price is less than half the price on the market in Kinshasa. The high market prices relative to the provincial prices reflect high transaction costs along the marketing channel, which are detrimental and reflect welfare losses to both consumers in terms of high consumer prices and to producers in terms of low producer prices. The market channel is also relatively long and since the middlemen insist on high returns, the final price to the consumer is high and producer prices are low.

4.9 FARM TO RETAIL PRICE SPREAD (COMMERCIAL MARGINS)

In Chapter one, section 1.2 it was shown that cassava retail price increased by 123% from 2007 to 2009. Such price increase has negatively affected both the production and the consumption of cassava products. This section intends to highlight a specific stage in the marketing system and identify factors that are important in determining that price increase. Average prices of cassava at the farm gate (farm value), the processing and refining stage (Wholesale) and retail stage are used to calculate three price spread: farm-to-wholesale, wholesale-to-retail and farm-to-retail. Price spread, according to Khol and Uhl (1998) is the difference between the price paid by consumer (retail price) and the value of the equivalent amount received by the farmer (Farm value). It indicates the price of all value-adding activities and function performed by different middlemen such us: Millers, Transporters, Wholesalers and Retailers. As it was noted above, consumers, in most of the time, do not buy food directly from farmers. Before the food reaches consumers it changes hands and goes through different stages. Price spread is then seen as an aggregate of cost and profits of the marketing system that moves food from farm to retail and process it into its final form. All these costs and profits are embedded in the price change of cassava which are fully transmitted through the whole chain to the consumer.

High price spread has led both to lower farm price and higher consumer price, which is seen as the most important reason for decrease of cassava production and consumption reported in section 4.4.2. A better understanding of the issues surrounding cassava price spread, would further help in determining the dynamics of price adjustment in the long and short run (Sections 6.3.4 and 6.4.5). In other words, if the price changes at one stage of the marketing system, how long should other stages take to adjust to that change? This price adjustment mechanism has been referred to as price transmission mechanism in section 2.7.1. This section simply captures a price spread figure for a given period of time, e.i. January 2008. It does not focus on how price spread changes year after year, which is the main focus of chapter 6.

Table 4.8: Recent value and spread of cassava product (Congolese Franc / kg)

Product	Month	Value			Spread				
		Retail	Wholesale	Farm	Farm to retail	Farm to wholesale	%	Wholesale to retail	%
Dry cassava	Jan 08	180	96	65	115	31	17.2	84	46.6

Source: drawn from survey data

Table 4.8 shows the January 2008 price spread figures for dry cassava from producer to consumer. A kilogram of dry cassava is sold at 180FC at the retail stage. At the farm gate level it costs 65FC and reached 96 FC at the wholesale stage. The farm share is made of 36,1 percent of retail price. Farm-to- wholesale spread is (96- 65/ 180 x 100) = 17.2 percent and the wholesale to retail price spread (180-96/180 x 100)= 46.6 percent. The total price spread is the sum of the two prices spread (17.2 + 46.6) = 63.9 percent. Results from Table 4.8 indicate that the main price spread embedded in price change occurs in the segment wholesale –to-retail. With 46.6 percent of retail price, wholesale-to-retail is likely the marketing segment driving change.

Several activities are involved in this phase including handling, packaging, transportation, storage and tax. Figure 4.9 below provides a broad overview of the structure of cost and related margin of trading a 50 kg bag of dried cassava from a provincial market to a reference market. It shows the transport cost, related tax, storage and handling cost for each category of trader. From this figure it seems that the marketing cost structure is considerably dominated by the transport cost (more than 60%) and tax (more than 15%). These two factors can be postulated as the most important cost items that significantly contributed to the price increase during this period. Due to data limitation, it was not possible to assess, whether or not, increasing the profit margin, if any, has contributed to this increase. Policy makers need to understand and find out mechanisms of increasing economic efficiency of cassava marketing by either reducing the cost of transportation and/or lowering the level of tax.

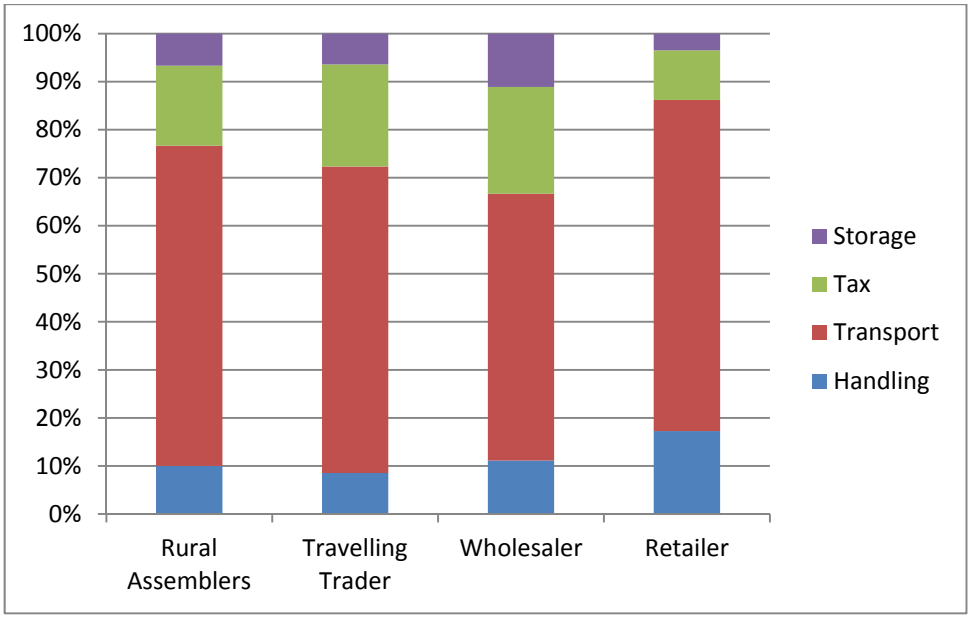


Figure 4.9 Marketing costs and margins of a 50 kg bag of cassava chips

Source: drawn from survey data

4.10 SUMMARY

This chapter has provided an overview of the Congolese cassava value chain for a better understanding of different issues facing the industry. It was found that cassava is an important staple foodstuff produced and consumed all over the country. Cassava is processed and has potential to be processed into various food and industrial products. The most traded forms in the DRC are fresh roots, 'Chikwange', dry chips and cassava flour. Each of them has a specific market segment in countrywide trade. Several actors are involved in the cassava value chain, including farmers, rural assemblers, travelling traders, district and urban wholesalers, millers, retailers and input suppliers. At each stage, products change hands and involve costs and margins. The difficult socioeconomic environment and physical infrastructure have negatively affected cassava production and transaction costs. As a result, cassava products seem relatively expensive, and are being replaced by cheaply processed and imported foods such as rice, bread and maize flour. The level of production and consumption rates has decreased noticeably over the past two decades as a consequence of high production and transaction costs. The situation has negatively affected the profitability of the crop and limited its absorption into the mainstream market chain, which probably explains the low use of inputs by farmers and the lack of traders' incentives to make significant investments in value adding technologies. The following chapters aim to find a mechanism that can help cassava

products to enter the high value market and that could allow actors to improve their income and competitiveness and move into high-value activities.

CHAPTER 5

VALUE CHAIN ANALYSIS: RESULTS AND DISCUSSION

5.1 INTRODUCTION

In chapter 4 above, we described how the cassava trade operates in the DRC, the nature of transaction along the chain, actors and the relationship between them. The overall prices of cassava products in the DRC were found high, as result of high production, processing and marketing cost of Congolese cassava at different levels of the market chain. This results in a wide range of negative aspects for the sector, such as decreasing incentives of producing and consuming cassava products while increasing consumption of imported product such as maize flour and rice, and the lack of sufficient competitiveness to consider cassava as a significant export commodity. Investment in the sector is considered risky by different chain actors and is also limited as a result of the overall non-competitiveness of the sector. Poor market linkages lead to low utilisation of value-addition technologies that contribute directly to poor market opportunities. In order to address this over-riding issue, this chapter attempts to carry out a market oriented value chain analysis of cassava products to identify technological and marketing approaches and strategies that can enhance processing and demand for cassava product commercialisation.

5.2. Mapping of the Cassava Supply Chains

Figure 5.1 provides an overview of four supply chains for cassava, each with different end markets. Using the logical sequence of activities in the chain as described by different interviewed individuals, the different cassava supply chains identified in the country can be represented as follows:

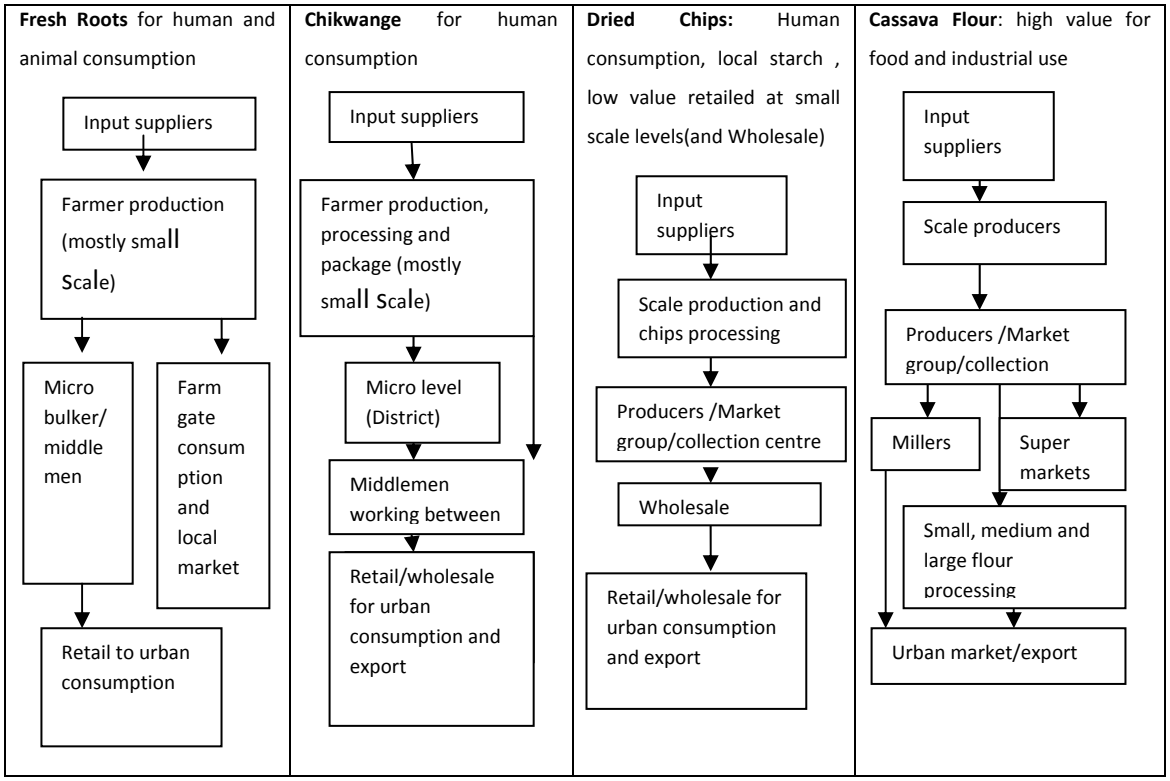


Figure 5.1: Cassava Supply Chain Mapping

Source: Drawn from survey data /focus group meeting

In order to find new industrial market development opportunities in the country that could drive the sub-sector, the above described supply chain presents the following status:

5.2.1 Fresh Cassava Supply Chain

The fresh cassava supply chain is negligible in the country due to limited cultivation of sweet varieties and traditional preference for dried cassava flour. It is therefore not expected that the fresh cassava supply chain would grow and may not really warrant further development as far as we could expect in the short run (Tollens, 2004). During the season when cassava is abundant, fresh cassava is sold in the market, but not much during periods of scarcity. Fresh cassava has a very low value/bulk ratio and is perishable, so marketing is strictly local.

5.2.2 Chikwange Supply Chain

This chain presents a good alternative for future cassava market development in the country. However its demand is not enough to absorb an increasing supply (Mastaki, 2006). Chikwange constitutes niche marketing, difficult to expand in the short term because of the preference for dry cassava flour by the majority of cassava consumers. Any effort must focus on organising the market to stimulate demand

5.2.3 Dried Cassava Supply Chain

Including the product consumed at the farm level, dried cassava is probably the largest segment of the cassava market in the DRC. The country has a growing urban market for improved dried cassava. This market should be developed further as the market conditionality is less stringent. But, inappropriate technology used by farmers and processors, weak private sector development that could link producers and processors with the final user industries, and the volatility of prices and markets, all threaten the dry cassava value chain development (FAO, 2004). If cassava can be more efficiently processed to meet consumer requirements, it stands to gain greater domestic demand as well as potential export.

5.2.4 Processed Cassava Flour Supply Chain

This segment of the market is small compared to the dried cassava supply chain. It has recently emerged as an attractive high value cassava product chain where food-processing companies become involved and more value adding occurs (Mitchell *et al.*, 2009). It offers a range of opportunities to expand production through export sales if growers can meet buyers' quality and quantity requirements. This implies the adoption of a high-quality processing regime, producing a quality and value-added product at competitive pricing, hence penetrating the more refined markets for medium and high bracket income earners in the country, and elsewhere in neighbouring countries. Here food safety standards and packaging requirements may become apparent.

5.3 PROFITABILITY ANALYSIS

The analysis of profitability presented in Table 5.1 shows that, in current marketing conditions, it is more profitable for farmers to trade fresh cassava (with $US 0.08 gross margin per kg) than dried chips ($US 0.029 gross margin per kg). The value per kg was calculated from the production and marketing cost of a bag of 100kg of fresh or dried cassava according to traders estimation. Selling cassava chips and cassava flour at current prices is still not profitable, which probably explains why most farmers do not participate in chip production ventures to any great extent. Cassava flour could be more profitable if milling technologies were more accessible and efficiently utilised by farmers to cut down milling costs. This calls for the identification of more viable market opportunities. Cassava producers need to be trained in commercial farming for better exploitation of identified market opportunities, and they need access, production and value additing technologies that are market led.

Table 5.1 also presents the cost structure in processing cassava meal. This value chain breakdown indicates an average of the aggregate industry structure of value addition cost to cassava as it moves from one stage to another. The production cost is calculated on the basis of cost and price estimations by key farmers' discussion groups during the survey, and has been crosschecked against other independent sources such as local government official data and the FAO database, where possible. The production cost average (total cost of producing 1 kg of chips) of $US 0.114 seems to be very high compared to the farm gate price of $US 0.143 and does not accurately reflect the attractiveness of the crop for the producer (gross margin of $US 0.029/kg).

The enthusiasm of the farmer for producing a marketable supply of cassava is greatly constrained by his fear of potential low prices. Market circumstances strongly influence the production strategies of the farmers, and in addition, the market risk constrains the area planted with cassava and reduces the role of the crop in many farms to a semi-subsistence crop, primary produced for home consumption (Nkwembe, 2002). The marketable surplus depends on what is left after home consumption has been satisfied. In such a situation, improved technology is of doubtful value, if higher input levels and higher monetary costs would increase losses in years with bad prices. As a consequence of the above situation, the income-gaining potential of the small farm is not fully realised

Table 5.1: Production Cost of cassava fresh root and chips

Production cost	Unit	Cost in US$
Production: average 4.000kg/acre	Kg/acre	
Land (owned)	US$/acre	0,0
Plugging (1 and 2)	US$/acre	6,0
Panting material (8 bags)	US$/acre	2,3
Planting	US$/acre	4,0
Gap filling and thinning	US$/acre	2,9
Weeding (twice)	US$/acre	4,8
Harvesting and transport	US$/acre	5,2
Total production cost per acre		25,2
Cost of product of 1 kg of fresh cassava	US$/kg	0,06
Average selling price of 1 kg of fresh cassava	US$/kg	0, 14
Gross margin	US$/kg	0,054
Ratio of tubers/chips		3/01
Cost required to produce fresh tuber to make 1 kg of chips (63 x3)	US$/kg	0,108
Chipping expense per kg (labour)	US$/kg	0,006
Total cost of producing 1 kg of chips	US$/kg	0,114
Current selling price for 1 kg of chips	US$/kg	0,143
Gross margin	US$/kg	0.029
Other costs		
Packaging material per kg of fresh tuber (0.2/0kg bag)	US$/kg	0,004
Packaging material per kg of dried chips (0.2/0kg bag)	US$/kg	0,004
Transport to collection centre per kg of chips/four (0./0kg bag)	US$/kg	0,011

Source: focus group Discussion, 2008

Further to the above discussion, information about the product cycle, market costs and price was used to identify the value chain that the government and other investors can focus on. Based on market size and profitability of the value chain, potential for value addition and its potential to empower smallholder farmers, the dry cassava value chain and the cassava flour value chain seem to be the most recommended for cassava industry development in the DRC. The following section performs a more elaborate analysis on the two selected cassava supply chains.

5.3.1 Dried Cassava for local and cross border market

Figure 5.2 indicates the strategic collaboration framework for the dried cassava value chain in the country: This is an indication of how the value chain functions in normal conditions, in contrast with the reality on ground as described in chapter three.

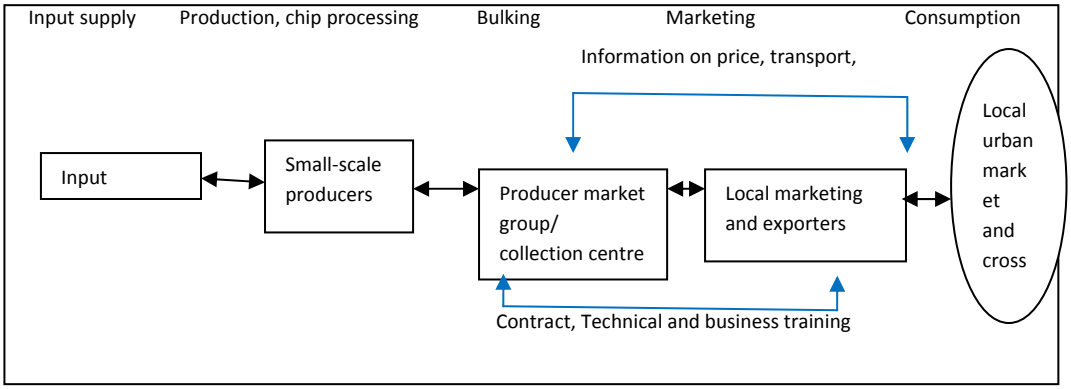


Figure 5.2: Strategic collaboration frameworks for dried chip value chain

Source: Adapted from Van der Land (2007)

The advantage of this chain is that a dry cassava market already exists in the country and in neighbouring countries as well. The value chain arrangement will strive to upgrade the product to market requirements. However, today, the dried cassava chip market is not profitable for most market participants. They face high transaction costs and margins (as described in the following section on cost and margin analysis). If farmers are organised it will make the economies of scale more attractive for output and input markets, and possibly reduce transaction costs. Information sharing about price and transport, contract, technical and managerial training on both improved agronomic practices and processing technologies are feasible because of availability of many service providers on the ground.

5.3.1.1 Marketing Costs and Margin Analysis of the Dried Cassava Value Chain

Marketing agents within each area gave remarkable and consistent estimates of farm-gate prices, transport costs and taxation between various production and consumption points and the wholesale prices for different marketplaces. Table 5.2 indicates the costs of trading a 50 kg bag of dried cassava. Following the data, transport is the most important marketing cost component. It is high for the assembler agent who brings cassava from production to consumption areas. Another high cost is related to the transportation of cassava from the wholesale market to the retail outlet. The retailers are often responsible for this. The bulky nature of cassava causes high transportation costs, aggravated by the fact that only small quantities are distributed at a time. On average, the total marketing costs of cassava wholesalers are US$ 280 per tonne. The important cost items also include the taxes that cassava traders have to pay for handling and storage.

Table 5.2: Marketing Cost of One Bag of Cassava ($US/50 kg)

No.	Actors	Handling	Transport	Taxes	Storage	Total
1	Rural Assemblers	0.1	3.0	0.5	0.2	3.3
2	Travelling traders	0.4	1.0	1.0	0.3	2.7
3	Wholesalers	1.0	1.0	2.0	1.0	5.0
4	Retailers	0.5	2.0	0.5	0.5	3.5
	Total	**2**	**7**	**4**	**2**	**14.5**

Source: survey data, 2008

Table 5.3 shows the average margins (value-added) in dried cassava supply chains, from producers in rural areas to consumers in urban areas. A marketing margin is the price difference between the one paid to the farmer and that paid by the consumer, and it is a commonly used measure of market system performance (Purcell, 1979). The information used to calculate margins covers the time before the principal harvest (July to September). This approach provides accurate information, and has shown that even when there is price variation throughout the year at all market levels, market margins remain relatively stable in the DRC. This is because some of the cost components such as transport, labour and tax do not change for a week or a month in relative terms, as the price of cassava does.

The marketing margin analysis in the last column of the table indicates that trade captures a high proportion of consumer price, especially the wholesalers (43.4 %). The lowest percentage is obtained by cassava retailers (13.0 %). Regarding the return accruing to various participants, the supply chain analysis reflects that farmers, assemblers, traders and retailers have very low returns. The estimation of net benefit indicates: US$ 0.7 to the assembler agent, US$ 1.3 to the travelling trader, US$ 5 to the wholesaler and US$ 1.5 to retailers for a 50 kg bag of cassava. At the same time, transaction costs and asymmetric information are of more advantage to the wholesaler, probably because they have a strong informal market information network.

The low returns are attributable firstly to the low volume handled by the various actors, which consequently refers to high uncertainty and risk taking. This implies that for small-scale farmers to get better revenue they have to organise themselves into a collective market; a form of collective action or cooperatives. Mobilising large volumes of cassava is thus a problem because the emergent commercial cassava farmers are not consistent

producers and do not know what the market really requires.

Table 5.3: Actor's Cost and Margin of Trading a 50kg Bag of Dried Cassava

No	Actors	Buying Price	Marketing Costs	Selling Price	Gross Margin	% of consumer price
1	Rural Assembler	5	3.3	9	0,7	17.3
2	Ambulant Traders	6	2.7	10	1.3	17.3
3	Wholesaler	10	5	20	5	43.4
4	Retailers	20	1.5	23	1.5	13.0

Source: Survey data, 2008

5.3.2 High quality cassava flour value chain for food and industry use

The Figure 5.3 below shows the strategic collaboration framework for high quality cassava flour value chain in the country:

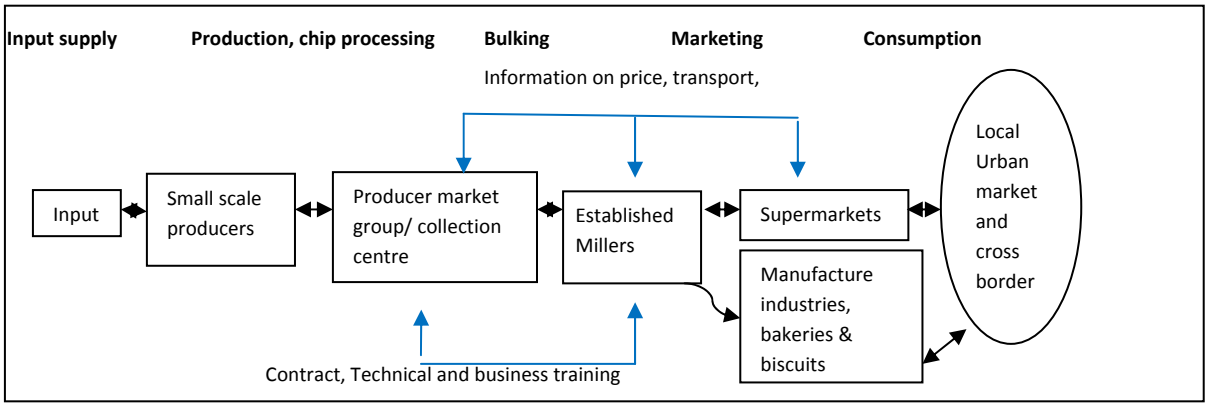


Figure 5.3:Strategic collaboration frameworks for high quality cassava flour

Source: Adapted from Van der Land (2007)

The main advantage of this value chain is the involvement of supermarkets and industrial millers. This could sensibly increase producer margins as prices in this segment are much higher. Prices of high quality processed chips could go up to two or three times more than the average prices presently offered to farmers by rural traders.

5.4 POWER RELATIONSHIPS BETWEEN SUPPLY CHAIN ACTORS

The relationship between the chain participants is an important factor for sustainable development of the chain. It implies a collaborative system in which different actors can benefit from each other's activities. Furthermore, the efficiency of a chain relies on a power relation between the chain participants. Power relations refer to chain vision based on the need to collaborate, joint action, trust and negotiation. It also includes factors such as information sharing, quality and innovation management. In this study, power relations were assessed on the basis of who controls the information, quality and innovation.

The findings demonstrate that cooperation between farmers and other chain market participants is obviously inadequate. The relationship between various actors appears to be informal and changes occasionally. Assembers and wholesalers seem to have a trustworthy relationship, as each wholesaler works with specific rural assembers. The market's law (selling to highest bidders) dictates the relationship of other agent groups. The participants do not have a common vision, trust, joint action and negotiation. Information sharing between actors demonstrates that, in general, poor farmers are merely price takers, as they are not well informed of prices and quality requirements in different markets.

The survey shows that the value chain was demand driven. The traders (small and wholesaler) are the true power holders in the value chain. They have a set of informal information networks regarding market, price and quality. Traders are in charge of quality control of cassava before it is sold to retailers. They control product quality by sorting and hardening during harvest period in the field. They leave to the farmers the products that do not meet their requirements. The poor power sharing is also seen as a lack of commitment to quality and consistency of product at the farmer level, thereby jeopardising their position in the chain

5.5 ASSESSMENT OF BUSINESS ENABLING ENVIRONMENT

International trade agreements and standards tremendously affect the constraints and opportunities for industry growth. They present opportunities for market expansion but can be extremely expensive for firms, especially MSEs (Medium and small enterprises), and can easily preclude a developing country from being competitive. The DRC is a member of the Economic Community of Central African States (CEEAC), the Southern African Development Community (SADC), Common Market for Eastern and Southern Africa (COMESA) and the Great Lakes Countries Community (CPGL), both aiming at building a region of free trade and a harmonised and rationalised system of good people circulation. The country's link position between several free trade zones is seen to be a significant advantage for economic prosperity through regional integration. This offers high potential for cassava market development.

The national policy and regulatory environment is critical to the functioning of markets and enterprises; it should create incentives for private sector growth and involvement in the policy process. Moreover, more conducive local and regional policies can provide opportunities for rapid improvement of the enabling environment.

5.6 POLICY FRAMEWORK

Policies concerning production and trade of an agricultural product in the DRC are mainly described in the following documents:

- Stratégie de Réduction de Pauvreté (DSRP),
- Programme Multisectoriel de Partenariat pour la Transition et la Relance (PMPTR),
- Programme Economique du Gouvernement (PEG),
- Facilite pour a Réduction de la Pauvreté et la Croissance (PMUUR).

In 2001, a post-conflict government agricultural policy was formulated with emphasis on crop food production. To achieve this objective, the policy encouraged increasing production through adoption of high and improved technology, including improved

varieties and improving yield and disease control.

The second main policy focus was on the development of government and private sector cooperation. This includes promoting Small and Medium Enterprises (SMEs) by supporting and promoting new and existing institutions, improving their competencies and increasing their contribution to the national economy. The issue of marketing locally produced and processed products also attracted the government's attention to national trade policy (NTP). An "Investment Code" and "Land Laws" were implemented to stimulate and secure foreign investment and trade process development, and thereby encourage high performance and intensify competition in the domestic market.

Other international and regional trade agreements reinforce the vision of national products trade development. All these policies and laws are designed to improve food availability, accessibility and market access.

As many of them are macroeconomic policies, the challenge in value chain development is to find an appropriate way to convert them into a practical solution at local level and ensure effective agricultural sector development in the country. This requires the implementation of strongly functioning regulatory and administrative systems at local level, which can play a linkage role between the sectoral and operational function in the agricultural production system. To date, poor local government operations and poor enforcement of legal and regulatory regimes explain the transaction costs and risks increase, restricting investment relationships and upgrading for cassava market participants.

The current administrative reform committed to by the government needs to be achieved and correctly implemented so that the agricultural sector can efficiently play its role.

5.7 ASSESSMENT OF BUSINESS SUPPORT SERVICES

Service and marketing institutions are crucial for the overall development of a commodity chain. Access to low cost and high quality services such as transport, distribution, communication and finance, market and information is a major determinant of farmers' competitiveness in the market (Mnenwa, 2009). While the country has

realised a large implementation of service providers, accessing these services is still a major challenge for farmers. In chapter 3, we saw that farmers continue to face inadequate access to transport and communication services, as well as difficulty in accessing financial and institutional services. Among the relevant services operating to support value chain development in the country, there are:

5.7.1 Government Departments

The government plays an important role in creating an enabling environment for sustainable growth and development. The Ministry of Agriculture operates in different areas (crop protection, analysis and planning, inspection, market, price and credit, technologies dissemination) to promote sustainable agriculture and agribusiness through efficient policies and coordination, and monitoring and evaluation of the sector (Minagri, 2004). But the governmental system has inbuilt structural weaknesses; the agents face difficulties in operation as a result of limited resources, although the government services influence and outreach are still vital for the functioning of the sector, and although activities related to fieldwork are implemented with the coordination, monitoring and evaluation of a government officer. Therefore decentralised government structures need to be strengthened and efficiently funded to help them increase their role as service providers.

5.7.2 Agricultural research and extension service

This service is responsible for technology development for farmers to improve their productivity: Seed breeding is done by INERA, seed certification, multiplication and development are carried out by SENASEM, and seed dissemination and training is provided by SNV. Various public services work jointly with local and international NGOs, research institutes and the universities.

5.7.3 NGOs and Research Institution (International and Local):

International NGOs and Research institutions use their expertise in agriculture and relief management to facilitate the development process in the country. They provide training, extension relief services and input provision. The most popular and active services

providers in the cassava sub-sector are IITA, FAO, Caritas and CRS. The local NGOs provide services related to community resource mobilisation and management, coordination, identification and preparation of target groups, training, monitoring and evaluation. Notwithstanding the importance of their services to farmers, the scope of their mission and resources restrains the action extended to a few groups of farmers, which makes visibility of their actions very low.

5.7.4 Financial Institutions

Private, large, medium and small enterprises offer their expertise in financial issues, micro-credit implementation and promotion. However, given the insecurity created by the war, the services of these providers are not quite remarkable on the ground. Only one of the farmers interviewed recognised receiving micro-credit from the Mutual Saving Cooperative. The most important access to finance came from intermediary buyers (traders and brokers) who, in exchange, required that all production be sold to them. This arrangement gives to the intermediaries a great deal of control over pricing and limites the grower's flexibility to adapt new approaches to their cassava farming. There is also a form of technical assistance already being provided by NGOs in the country, which, once fully applied, would enable cassava growers to meet buyers' requirements for exports and thus gain a better price. There is a need to involve the private industrial sector as service providers. They could offer services to farmers in term of inputs distribution, technical advisory service, market information, financial/credit services and quality control.

During focus group discussions, the following services were reported to be essential to farmers: Technology search, transfer and adoption, technical training, advice and extension, business entrepreneur advisory service and training, market and legal services, commercial credit services, money transfer services and credit and saving schemes support.

5.8 ASSESSMENT OF BOTTLENECKS, BARRIERS AND LEVERAGES

5.8.1 Cassava Production Constraints

The following aspects were pointed out by interviewed as the major constraints related to cassava production:

- Input access, which scored the highest percentage response of 34 %
- Pests, diseases, soil exhaustion; drought and water logging, lack of manure and scarcity of land respectively.
- Other mentioned constraints with low percentage responses included access to credit and lack of good crop varieties.
- Cassava Mosaic Virus was reported to be one of the most damaging constraints to cassava production.

However, farmers are advised to come up with improved technologies such as virus resistant varieties, reinforced with timely planting practices and to reduce the risks of extending their production in the drought season. Utilising early yielding varieties may also improve land utilisation. Some farmers reported that they lack information about improved production techniques, and this calls for more farmer awareness on improved cassava production techniques and how to reduce pests and other disease attacks.

Table 5.4: Cassava Production Constraints

Production Constraint	Frequency	Percent
Soil infertility	16	9.8
Land tenure regime	3	2.5
Difficult access to inputs	56	34
Diseases and pests	14	8.5
Drought	9	5.5
Flooding	9	5.5
Difficult access to credit	7	4.5
High interest rate	7	4.5
Input availability	7	4.5
Credit offered late	3	2.5
Insufficient land	4	3.0
Availability of renting land	3	2.5
Total	138	100

Source: Survey data

5.8.2 Cassava Marketing Constraints

During the field survey, it was found that the cassava market chain faces a number of bottlenecks and barriers. The most important, as noted down by discussion groups, are the following:

- Inadequate technical capacity and training, restraining the adoption of new technology, productivity and competitiveness;
- Inefficient marketing systems, unfair competition, unreliable prices, unreliable market demand;
- Unfair policy environment and regulatory risk: excessive requirement or lack of enforcement of regulation, hindering the viability of business and financial operation;
- Poor producers' organisation and poor coordination;
- Inadequate use of appropriate technology for value adding;
- Low investment and assets which provide limited collateral options;
- Inadequate use of financial services;
- Lack of clear guidelines on standards and policy issues from the public sector.

Several authors have indicated that there are some opportunities and strengths in the cassava sector, which can be used to overcome these bottlenecks and barriers (Tollens, 2004; Minagri, 2007; INS, 2008). These leverages include:

- The potential to develop a strong value chain partnership between farmers and other market participants;
- Availability and increased demand of improved cassava product in the country and cross-border markets;
- The current programme of infrastructure building (road and communication technology), presents high potential for establishing an effective information system and capacity building for market development;
- Potential for lobbying with religious leaders, communities, politicians and government authorities;
- Existence of research institutes such as INERA, IITA, CIALCA and other extension services;
- The presence of various international and local NGOs to facilitate farmers' organisations;
- Potential to promote microfinance credit with the assistance of banks and other financial services.

The above group discussion observation and view of several authors show that hindering roles and barriers disrupt the development of the cassava sector in the country, pushing people into poverty. It is therefore important to save the existing opportunities and strengths of the value chain, to address the constraints and help the cassava sector to play an efficient role in poverty reduction.

5.9 SUMMARY

This chapter discussed the results of cassava value chain analysis. Four major supply chains were identified: the fresh cassava supply chain, the Chikwangwe supply chain, the dried cassava supply chain and the processed cassava flour supply chain. Following the profitability analysis, market size and potential for value addition criteria, two sub-

products have been identified by the study to be the most recommended for future cassava value chain development in the country. Dried cassava chips and processed cassava flour were seen to be well positioned to enter the high value market easily. However, the marketing cost and margin analysis showed that cassava market participants face high production costs, high transaction costs and margins because of high transportation costs and poor market institutions. The supply chain efficiency is undermined by poor information sharing, and lack of power among various market participants. The assessment regarding an enabling environment has shown that the country has designed a large number of international and national policies to sustain the vision of national product trade development. Poor local government function and poor policy implementation have resulted in restricting investment and upgrading for cassava value chain development. In order to focus better on these ideas, the study performed a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis showing the strengths, weaknesses, opportunities and threats for the future cassava value chain development in the country.

CHAPTER 6

CASSAVA MARKET INTEGRATION: RESULTS AND DISCUSSION

6.1 INTRODUCTION

This chapter discusses the results of the cassava market integration analysis using co-integration, error correction mechanisms and the index of market connection. The use of these techniques permits a good understanding of the extent of market integration, the short-run dynamic and the speed of adjustment in the long run. The chapter discusses the results of the test of unit root, market co-integration test, error correction mechanism and the index of market connection. Again it is important to note that this study only considers price transmission in market integration analysis.

6.2 AVERAGE PRICES FOR CASSAVA AT DISTRICT LEVEL

Table 6.1 displays the means of real prices for cassava in 11 selected markets across the and the country. For the period of the study, the highest average cassava price is noted in Kinshasa and Lubumbashi. Distance seems to play an important role in the spatial prices differential. It was noted that the greater the distance from these highest priced reference markets, the more prices dropped proportionally. For instance, the average price of cassava per kilogram in Kinshasa is US$ 0.80, whereas Matadi, the nearest market located about 350 km away, has an average price of US$ 0.38. However, as the distance increases, in Kikwit (522 km) and Kisangani (1,525 km) the price drops to $US 0.34 and $US 0.18 per kilogram, respectively. The same scenario is observed in Lubumbashi with its trading markets Kananga and Mbuji-Mayi. Such price patterns confirm the hypothesis that Kinshasa in the western region and Lubumbashi in the south-east are the focal points of cassava price formation in the DRC. The lowest average price is observed in the Kananga market. This can be explained by other reasons, as Kananga is located in a deficient zone. The most probable reason could be the lack of effective demand. In the Kasaï province, where Kananga is located, cassava is ranked second after maize in terms of consumption. Maize is always used as a cassava substitute during periods of shortage.

Table 6.1: Average, monthly and real price differentials between markets

Market Channel	Linkage Mode	Distance (Km)	Mean prices difference	Coefficient of variation
Matadi–Kinshasa	Road	365	0.32	1.300
Kikwit–Kinshasa	Road	520	0.46	1.020
Mbandaka–Kinshasa	River	753	0.36	0.492
Kisangani–Kinshasa	River	1,525	0.62	0.340
Kananga–Lubumbashi	Railway	1,000	0.50	0.252
Mbujimayi–Lubumbashi	Railway	857	0.30	0.360
Mbamdaka–Kisangani	River	772	0.26	0.558
Kindu–Kisangani	Road	587	0.17	0.434
Kananga–Mbujimayi	Road	200	0.20	1.650
Bukavu–Goma	River	208	0.02	1.250

Source: Calculated from FAO data (2009)

The coefficient of variation for the spatial prices differential in the fourth column can shed some light on the extent of market integration, as it shows some stability of margins. The spatial prices differentials (margins) for integrated markets are expected to move together since the local market is influenced by the central market price. For instance, the market pair Kananga–Mbujimayi shows a large coefficient of variation suggesting that they may not be integrated. This market pairs experience linkage problems in terms of poor transportation infrastructure, as roads are not paved. One may notice at this stage that, besides the distance factor, several variables may also explain the special differential between two markets.

Alternatively, according to the bivariate correlation model (Table 6.2), high price correlations between markets are assumed to be an indication of market integration and the reverse stands for market segmentation. The results in Table 6.2 below show three market pairs with high price relationships: Bukavu–Goma (0.95), Kinshasa–Matadi (0.93) and Kananga–Mbujimayi (0.90).

These results corroborate quite well with the real situation in these markets, since cassava flows are observed from Matadi to Kinshasa, from Kananga to Mbuji Mayi and from Goma to Bukavu. These markets present similar characteristics of being linked by small distances and intense traffic (high congestion). However, the high correlation coefficient between Kindu– Matadi, Goma–Mbandaka, Kananga–Bukavu (where this pair of markets do no trade with each other), particularly appears to be causing inconsistent

results in the preliminary estimation. This might be caused by the presence of serial multicollinearity in the estimation. Therefore, other appropriate methods for resolving the problem of multicollinearity are applied.

Table 6.2: Bivariate correlation coefficients matrix for cassava price

MARKET	KIN	MAT	KIK	MBD	KIS	KIND	GOM	BUK	MBUJ	KAN	LUB
KINSHASA	1.00										
MATADI	**0.93**	1.00									
KIKWIT	0.52	0.55	1.00								
MBANDAKA	0.60	0.71	0.60	1.00							
KISANGANI	0.68	0.76	0.22	0.84	1.00						
KINDU	0.63	0.62	0.21	0.24	0.36	1.00					
GOMA	0.77	0.77	0.52	0.81	0.76	0.27	1.00				
BUKAVU	0.63	0.68	0.51	0.80	0.72	0.20	**0.95**	1.00			
MBUJIMAYI	0.73	0.66	0.37	0.66	0.62	0.23	0.76	0.72	1.00		
KANANGA	0.65	0.56	0.44	0.81	0.69	0.17	0.80	0.75	**0.90**	1.00	
LUBUMBASHI	0.66	0.74	0.49	0.77	0.65	0.35	0.61	0.53	0.77	0.74	1.00

Source: Calculate from FAO monthly price data(2009)

6.3 APPLICATION OF THE CO-INTEGRATION MODEL AND RESULTS

Before performing the co-integration analysis, the order of the integration of the different series of prices used was tested. An Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) was first applied. The non-stationary assumes the presence of the Unit Root in the series, which implies that the series are not integrated in the same order. This would lead to spurious regression problems (de Waal, 2010), since the regression of price levels requires price series to be stationary. If the series are non-stationary, the first difference transformation is assessed to derive a stationary series. In cases where the series of prices are found to have the same order of integration (1), the null hypothesis of non-co-integration is then tested against the alternative hypothesis of co-integration, using the co-integration approach. If the evidence shows that there is a co-movement of prices, then the error correction mechanism will be applied to examine the short -run integration and the speed of price adjustment in the long-run relationship between different markets.

6.3.1 UNIT ROOT TEST

The test of the unit root or the first order of stationary of the variable in the price series was conducted using the ADF test with trends as the determining component. The number of lags is chosen using the Schwarz information criterion.
Given the estimation:

$$Y_t = \beta X_{t-1} + \varepsilon_t$$

As shown by de Waal (2010), the model to test for co-integration is given by:

$$\Delta\varepsilon_t = \rho^* \varepsilon_{t-1} + \sum_{i=1}^{\rho-1} \rho^* \Delta\varepsilon_{t-1} + \omega_t$$

Where ω_t is white noise and $\rho^* = (\rho_1 + \rho_2 + ... + \rho_\rho) - 1$

The tested hypotheses tested were:

- H0: $\rho^* = 0$ (has a unit root) no cointegrated
- H1: $\rho^* < 0$ (has no unit root) cointegrated

The first difference was then included in the initial test to see the first order of integration. Table 6.3 shows the results of the unit root in the level and the first difference of each price series using the ADF test.The ADF level critical values are: -3.51 (1 %), -2.91 (5 %) and -2.63 (10 %), respectively, for the H0: Unit root with drift and H1: Linear trend stationary. For the first differences, 1 %, 5 % and 10 % critical values are -2.59,-2.04 and -1.72 respectively for H0: Unit root, H1: stationary around the mean.

Table 6.3: Results of ADF test on the monthly price series

SERIES	ADF TEST	FIRST DIFFERENCE
KINSHASA	-1.56	-3.075
MATADI	-2.21	-4.725
KIKWIT	-2.34	-3.550
MBANDAKA	-1.22	-4.002
KISANGANI	-1.89	-5.642
KINDU	-2.52	-7.356
LUBUMBASHI	-2.02	-3.664
GOMA	-2.48	-4.657
BUKAVU	-2.32	-3.784
MBUJIM	-2.22	-4.456
KANANGA	-2.36	-3.576

Source: Estimated from survey data

All price series have unit roots in the level, showing that they are not non-stationary. When using the first difference, the null hypothesis of unit roots is rejected for the first difference of the price series. It can therefore be concluded that all the price series are integrated to order 1.

6.3.2 Markets co-integration test

In this study, the extent of market integration and price transmission is assessed on the basis of the error correction mechanism and speed of price adjustment in the long run. The null hypothesis of no co-integration is tested against an alternative hypothesis of co-integration.

The purpose of this test is also to show the direction and the strength of the relationship between various prices (Table 6.4). The Durbin-Watson statistics are significant in all equations, which indicates that there is no serial correlation in the model. All the estimated coefficients on the co-integration regression residual are negative, as needed for the dynamics to adjust towards the long-run equilibrium path. Thus, the coefficients of the lagged residual are acceptable. All the regression coefficients prove to be statistically significant at a 10% level of significance. Considering the estimated equation from a purely statistical point of view, it appears as though there is a good relationship ranging between 0.50 and 0.90 of the variation and the dependent variables are explained by the regressors. According to the adjusted R-squared, the local price variable is explained by the reference market prices. It can be concluded that the variables in the

long-run equation are indeed co-integrated since the null hypothesis of non-stationarity at the 10% level of significance can be rejected using the MacKinnon critical values.

6.3.3 Error Correction Mechanism

Equation 3.7 incorporating the short-run effect in P*t*, is estimated to correct the stochastic residuals from long-run co-integration regressions of the estimated equation 3.5. When the estimated coefficient is insignificant, it shows that markets are not integrated, meaning the price change in the central market ($R_{jt} - R_{jt-1}$) observed in the past (one lag) was not fully reflected in the current local price change ($P_t - P_{t-1}$).

Table 6.4 summarises the test results for all the market pairs. The study used the Ordinary Least Squares (OLS) method to estimate the coefficients and to test the significance of the relationship between different price series. Thus, Table 6.4 shows the coefficient of co-integration between different price series. The numbers in brackets are the t-statistic. According to these results, there is a relative price adjustment between Kinshasa–Matadi, Kinshasa–Kikwit, and Bukavu–Goma. The rest of the markets seem to have the weakest prices in long-term relationships with other markets as their t-statistic coefficient turns out to be either positive or negligible.

Table 6.4: Regression Coefficients for Testing Market Integration

Market channel	Intercept	$P_{it} - P_{it-1}$	$R_{jt} - R_{jt-1}$	R_{jt-1}	Adj R^2	DW
Matadi–Kinshasa	-0.04 (-2.028)	-0.324 (-3.514)	0.317 (2.030)	-0.044* (-0.675)	0.8563	1.816***
Kikwit–Kinshasa	-0.038 (-2.229)	-0.350 (-2.979)	0.216 (2.123)	-0.020 ** (-0.126)	0.9124	1.701***
Mbandaka–Kinshasa	-0.030 (-1.7.41)	-0.315 (-3.654)	0.328 (2.675)	0.213 (2.164)	0.7883	1.631***
Kisangani–Kinshasa	-0.210 (-3.765)	-0.406 (-4.120)	0.295 (1.955)	0.095*** (0.842)	0.7237	1.452***
Kananga–Lubumbashi	-0.049 (-1.548)	-0.226 (-2608)	0.193** (3.032)	-0.116 (-1.535)	0.8761	1.603***
Mbujimayi–Lubumbashi	-2.307 (1.567)	-0.225 (-2.093)	0.155 (0.697)	0.113 (0.077)	07.037	1.872***
Mbandaka–Kisangani	0.065 (1.448)	-0.303 (-3.704)	0.175 (1.983)	0.025 (0.298)	0.5198	1.965***
Kindu–Kisangani	0.017 (-0.928)	-0.164 (-2.734)	-0.041 (-0.350)	-0.116 (-0.271)	0.7123	1.635***
Kananga–Mbujimayi	0.018 (2.052)	-0.254 (-3.015)	0.274 (2.789)	-0.125 (-0.365)	0.8182	1.775***
Bukavu–Goma	-0.094 (-3.134)	-0.529 (-5.237)	0.285 (1.876)	-0.050** (-0.781)	0.6361	1.967***

Source: estimated from FAO data , ***, ** and * denote the statistical significance of the price adjustment at 10 %, 5 % and 1 % level, respectively

6.3.4 The Short-Run Dynamic Adjustment

In Table 6.5 below, the short-run dynamic adjustment is measured by the IMC, which signifies the local market to central market ratio. It clearly reflects the immediate response of the provincial market to shocks in the reference market, or in other words 'short-run elasticity'. The IMC of 0.85 shows a strong market connection between Matadi and Kinshasa, suggesting that price shocks occurring in the market of Kinshasa affect immediately and partially the provincial markets which supply them. When prices in Kinshasa increase by 1 % in the period 't-1' it leads to a 0.85 % increase in the Matadi price at 't'. The same table shows a strong short-run integration between Kananga and Mbujimayi (0.81) and between Bukavu and Goma (0.86). None of the other markets trading with Kinshasa respond in the short run to price changes in Kinshasa.

From the results, it was found that provincial markets trading with Lubumbashi present an IMC far from 1, revealing that the price adjustment in the short run is relatively weak. Distance, low demand and infrastructure quality are probably the most plausible explanations for observed variation in the degree of market integration.

Table 6.5: IMC regression analysis for Cassava Markets in DRC.

Source: Analysis of Data: 2005-2009. Figures in parentheses are t-value calculated

MARKETS		Constant	Coefficients			IMC
LOCAL	**REFERENCE**	β_0	β_1	β_2	β_3	
Matadi	Kinshasa	-0.183 (-0,677)	0.237 (2.286)	0.433 (7.766)	0.745 (5.743)	0.85
Kikwit	Kinshasa	0.786 (0.432)	0.278 (0.386)	0.976 (15.987)	0.683 (.8795)	2.72
Mbandaka	Kinshasa	0.234 (1.121)	1.543 (1.567)	0.621 (10.586)	0.599 (2.567)	1.69
Kisangani	Kinshasa	0.369 (0.465)	4.567 (1.779)	0.923 (11.767)	0.336 (2,54()	2.25
Kananga	Lubumbashi	0.788 (1.124)	6.756 (0.655)	0.869 (14.579)	0.884 (8.026)	3.67
Mbujimayi	Lubumbashi	0.279 (2.335)	0.697 (1.458)	0.775 (17.213)	0.871 (0.699)	4.25
Mbandaka	Kisangani	0.391 (1.076)	2.480 (0.342)	0.925 (16.136)	0.974 (9.154)	2.14
Kindu	Kisangani	0.765 (1.216)	3.867 (0.676)	0.567 (14.974)	0.569 (7.984)	3.54
Mbujimayi	Kananga	0.965 (1.673)	0.132 (1.246)	0.865 (10.767)	0.789 (2,657)	0.81
Bukavu	Goma	0.897 (1.798)	0.243 (1.569)	0.877 (11.345)	0.978 (2.335)	0.86

6.3.5 Speed of Price Adjustment in the Long Run

The residuals from the ECM were regressed on the variables included in the long-run equation, multiplied by the non-negative coefficient of the residuals from the co-integrating equation retrieved from the ECM. These new adjusted coefficients are then used in calculating the adjusted t-statistic, which is used for statistical inference. The results displayed in Table 6.6 indicate the speed at which prices adjust in the long run relationship. The coefficient d_1 is expected to be close or equal to 1, in the long-run relationship between two markets, meaning 100 % of long-run deviation corrected each month, and faster adjustment of local markets to the previous period deviation from long-run equilibrium. In contrast, the very small d_1 value implies that the provincial market is unresponsive to the last period equilibrium error.

Among all estimated equations, none have a d_1 close to 1. All pair-wise correlation coefficients are below 50%. The high coefficient of price adjustment in the long run is indicated by the pair-wise markets Bukavu–Goma (43%), Mbujimayi–Kananga (38%) and Matadi–Kinshasa (36%), suggesting that only 43% of the total deviation from the long-run equilibrium was adjusted each month between Kinshasa and Matadi, 38% between Mbujimayi and Kananga and 43% between Goma and Bukavu. This indicates that markets are not perfectly integrated in the long run, and variations of price in the reference market are partly transmitted to the domestic markets. It takes more than one month for long-run price changes in reference markets to be reflected in the provincial markets. In other words, markets are not efficient in transferring all price changes from the central market to the regional market. That is, the price adjustment between the two central markets and their feeder markets is very slow.

The pair markets that perform moderately well in both the long run and short run are Matadi–Kinshasa and Bukavu–Goma. Poorly performing markets in both the short run and the long run are Kindu–Kisangani, Mbujimayi–Lubumbashi and Kananga–Lubumbashi. Other markets do not show strong relationships between the short and long-run.

The results for the selected markets indicate 4 market pairs with statistically insignificant d_1: Kikwit–Kinshasa seems to be segmented, despite paved roads. The great distance between the two towns can certainly explain the segmentation between these markets.

Kananga–Lubumbashi and Mbujimayi and Lubumbashi seem to be segmented, despite their direct connection by railway. The irregularity of the train service and the great distance may contribute to such a weak price co-movement. Another segmented pair of markets is Kisangani and Mbandaka. The direct connection to the Kinshasa market may have attracted the attention and impacted cassava trading between the two markets. Moreover, the two markets may have the problem of a low local demand since the two are situated in a surplus zone.

Table 6.6: Integration of Cassava Markets in DRC. From Analysis of Data: 2005- 2009

Markets		Market Integration Indicators	
Local	**Reference**	**Speed of long-run adjustment d1**	**Short-run integration IMC**
Matadi	Kinshasa	0.36	0.85
Kikwit	Kinshasa	0.25	2.72
Mbandaka	Kinshasa	0.28	1.69
Kisangani	Kinshasa	0.15	2.25
Kananga	Lubumbashi	0.20	3.67
Mbujimayi	Lubumbashi	0.23	4.25
Mbandaka	Kisangani	0.17	2.14
Kindu	Kisangani	0.16	3.54
Mbujimayi	Kananga	0.38	0.81
Bukavu	Goma	0.43	0.86

Source: Estimated from survey data, *** and ** indicate statistical significance at the 10 % and 5 % levels

Once observed in a broad way, the test for market integration indicates little evidence of market integration between production and deficient areas. The price spread is below 50 %; the extent and the speed of price transmission is moderatly faster in the markets linked by short distances and relatively good transportation infrastructure .

6.4 SUMMARY

The error correction mechanism and speed of price adjustment based on co-integration approach, was performed to test the degree of cassava market integration. All the price series were first checked and differentiated using the ADF test for the first order of integration. The ECM was used to measure the speed of the stochastic residual adjustment from long-run equilibrium, and the short-run dynamic adjustment was measured by the IMC. Under the hypothetical equilibrium condition, the short-run fluctuations of provincial prices were expected to regularly correct past deviations from long-run relations. This correction reflects price convergence, and serves as a key dynamic measure of market integration. The result from the ECM suggests that on average about 30% of past deviations from the long run are corrected each month. Among the 11 market pairs, the highest coefficient of price adjustment in the long run was indicated by the pair-wise markets Bukavu–Goma (43%), Mbujimayi–Kananga (38%) and Matadi–Kinshasa (36%); and the lowest was given by the pair-wise market Kisangani–Kinshasa (15%).

In the short run, the IMC of 0.85 suggests a strong market connection between Matadi and Kinshasa, which suggests that price shocks in the market of Kinshasa immediately and partially affect the Matadi market supplying it. A high IMC coefficient was also found between Bukavu and Goma (0.86), and Kananga and Mbujimay (0.81). None of the other markets trading with Kinshasa and Lubumbashi respond in the short run to price changes in these reference markets. These findings constitute clear evidence of weak market integration between production and deficient areas in the DRC. This weak linear relationship between markets can be postulated as one of major causes of food insercurity in the country.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSION

This study aimed to understand the causes of the increasing food insecurity in the DRC in spite of the fact that the country is held to be the second largest producer of cassava in Africa. Cassava is the staple foodstuff of many Congolese, providing about half of the population's dietary calories. Out of 11 provinces (regions), only 5 are regular cassava surplus producers; thus the inter-regional trade from surplus to deficient areas is of great importance. The cassava market is organised around Kinshasa in western Congo, and Lubumbashi in the south-eastern part of the country. During the last two decades, the dramatic increase of cassava prices has worsened food security in the deficient areas.

This study a combined value chain analysis and co-integration analysis to test the performance of cassava markets in the DRC and to assess the possibility of reducing the cost of food policy intervention by focusing on two major markets, Kinshasa and Lubumbashi. As these two markets bear strategic importance, the study was performed to check if food policy focusing on those two reference markets would be sufficient to stabilise the cassava supply nationwide, since most of the markets seem to have strong relationships with them. If there were a strong linear relationship between these markets, price changes in the reference markets would be transmitted to their feeder markets and would also lead the cassava supply in inter-regional trade to adjust quickly. Otherwise, it would necessitate a separate regional intervention.

The results indicated segmented and moderated integrated markets. Four main factors were identified as influencing the degree of market integration: macroeconomic environment; transportation infrastructure; information flow; and distance – the most important of these factors being transportation infrastructure. Out of the 11 pairs of trading markets, 6 were identified as segmented. Three of them, Kindu–Kisangani, Kananga–Lubumbashi, and Mbujimayi–Lubumbashi, are poorly linked, with poor roads or irregular train services. Other segmented pairs of markets are Kinshasa–Kisangani,

Mbandaka–Kinshasa, and Kisangani–Mbandaka, and this could be due to the great distances between these pairs of markets.

The segmented markets show a statistically insignificant coefficient of the long-run markets integration 'd_1', indicating that price changes in the reference markets are not fully transmitted to the regional markets. From these findings, hypothesis 1 stating that the referential markets, Kinshasa and Lubumbashi, are co-integrated with their feeder markets is rejected. In other words, the cassava price changes in the outlying regions are independent of price changes in the reference markets.

The market connection index (IMC) indicated that markets were integrated in the short run where there was moderate distances and good quality transportation infrastructure. Following this indicator, a strong connection is represented by the market pair, Goma–Bukavu. Other moderately connected markets are Kinshasa–Matadi and Kananga–Mbujimayi. It was additionally found that poor transportation infrastructure and long distances between production and consumption points play a significant role in price differentials, since they cause potential and existing markets to cease to function as efficient generators of wealth and distributors of foods. This is apparently one of the most important reasons for increased food insecurity and poverty among food producers and consumers. The result from IMC, confirm the second hypothesis which states that there is a strong relationship between cassava market structures, cassava price increases and food security.The infrastructure for transportation, poor market information system and long distances between markets play an important role in the speed of price adjustment over peripheral markets. The speed of price transmission determines the food movement from surplus to deficient zones and largely affects the state of food security

The results also confirm the moderate importance of Kinshasa and Lubumbashi as focal points in the western and south-eastern regions, respectively. The magnitude of d_1 and IMC seem to change with the distance between the markets. High demand for cassava in the reference markets, that is not followed by an increase in cassava supply, leads to high cassava prices, which in turn results in a large price difference in the regional markets.

These findings imply that food market policy focusing on Kinshasa and Lubumbashi

would not be sufficient in establishing a nationwide cassava supply or inter-regional scale, as most of the markets have weak integration.

7.2 RECOMMENDATIONS

7.2.1 Recommendations for improving cassava value chain development

As it was noted in chapter 4 that poor productivity and poor market linkages led to low utilisation of value-addition technologies; and had directly contributed to poor market opportunities. In section 5.9.2 the main constraints that delayed the development of cassava market were identified and some opportunities to overcome these constraints were proposed by some authors. Figures 7.1 and 7.2 below show how these opportunities can be applied to enhance the commercialisation of dried cassava chips and high quality cassava flour in DRC. Firstly, marketing and export companies working closely with the producers in the dried cassava chip value chain and the millers for high quality cassava flour value chain should be empowered and be actively involved in playing the role of interface for market identification, access, high quality control and insurance. Enhancing the commercialisation of cassava product will need as well as a holistic approach, combining productivity enhancement, post-harvest measures and market development linkages, as follows:

1) **Farmer Production Enhancement**: This requires actions that increase farmers' productivity and adoption of new and improved technologies, a market-driven and sustainable supply of improved seed, provision of information to current and potential investors of unmet demand to encourage investment and stimulate outcome. Farmers should be able to produce enough quality cassava to attract investors.

2) **Post Harvest Measures that Reduce Loss and Improve Product Quality:** Farmer capacity building and improvement in handling, storage methods and facilities could result in positive benefits.

3) **Market Development Linkages:** More private sector linkages and involvement. This principle requires empowerment and partnership with companies working

closely with small-scale farmers.

This strategy is described in the following Figure 7.1 and figure 7.2

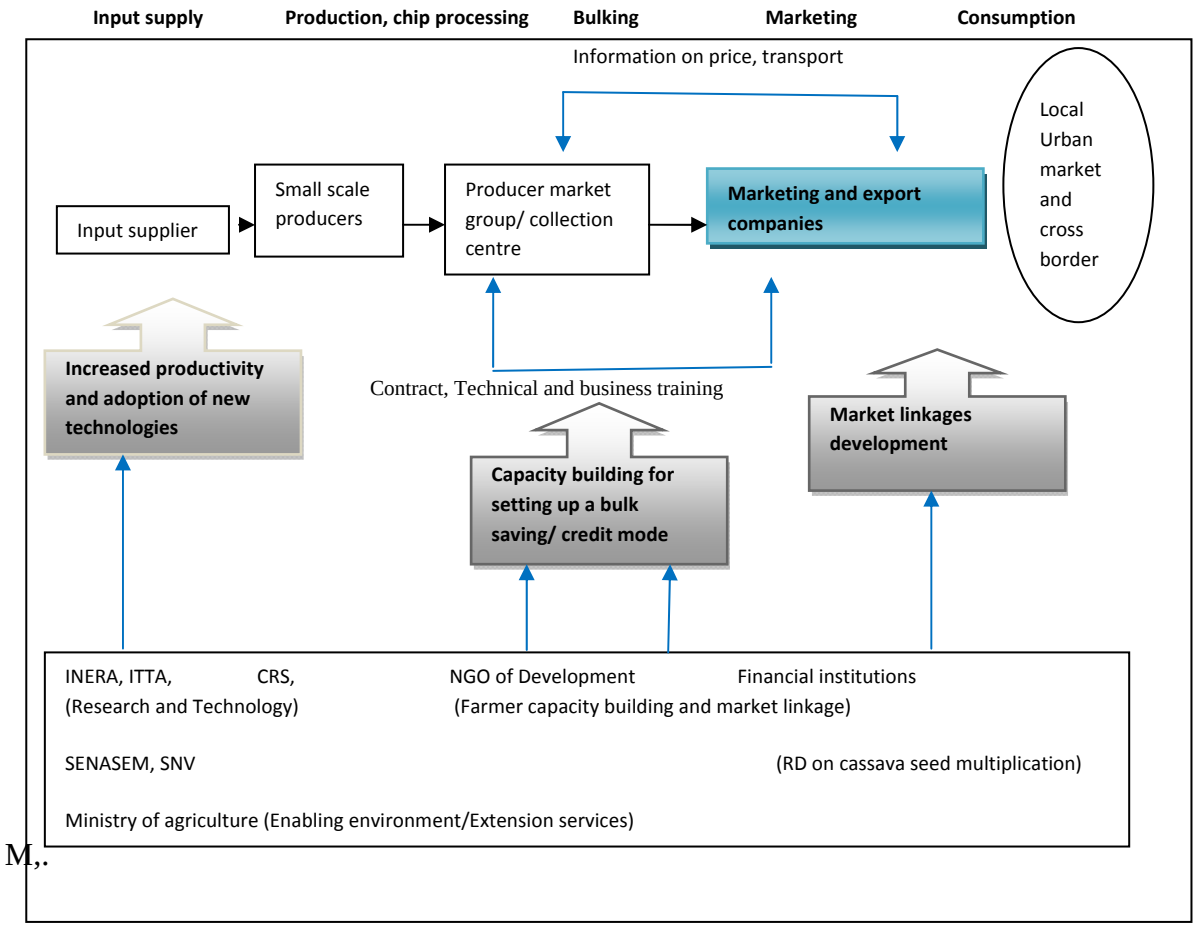


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Figure 7.1: Dried cassava value chain development strategy

Source: Adapted from Van der Land (2007)

Efforts should be taken to help farmers to actively participate in the management of the cassava value chain. The key sector of farmer empowerment should be: information management, quality management, innovation management and facilitation of effective partnership between all market participants. There is the need to train farmers to collect, interpret and utilise available information to forecast market prices and demand, to identify quality planting material, quality control and upgrading, and to use available improved technology. Value chain development will need a leading partner. This role could be appropriately played by wholesalers. They would be responsible for identification of markets, and through them organised producers and other

businesspeople would indirectly access the market at a lower cost than the individual small-scale producers would.

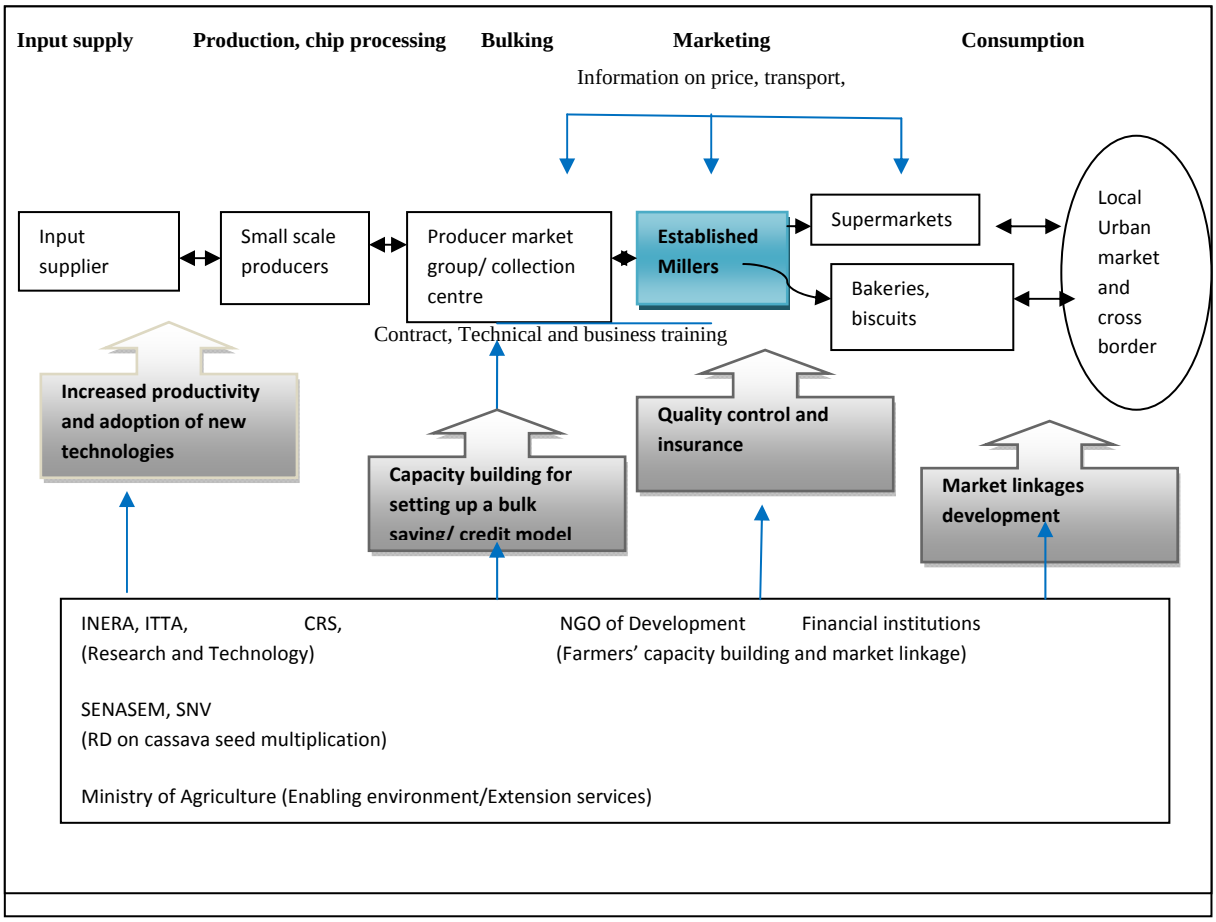

Figure 7.2: High Quality Cassava Flour Value Chain Development Strategy. *Source:* Adapted from Van der Land (2007)

7.2.2 Recommendations for improving market integration

In order to improve the integration of the cassava market a number of policy interventions are required:

- A specific regional intervention for a group of traders would reduce supply stabilisation costs. Such intervention requires a sound and stable macroeconomic framework that leads to long-term investment. More directly, it means improving the means of communication and evacuation infrastructure and transport equipment associated with efficient control and supervision services. Providing good transportation infrastructure would reduce transport and storage cost, and hence

increases the degree of market integration.

- Where the distances are great, improving the economies of scale may partially reduce transport costs. The state needs to implement an efficient market information system (MIS) all over the country.

- A way forward might be sustaining cassava development in the country to speed up regional integration in a free trade zone. By joining Eastern, Central and Southern African free trade zones, most of the national cassava producers and consumers would be exposed to more stable prices, and the entire cassava market would also be more stable. Perhaps the country, with its large production potential will be an engine of food production in the entire region.

- The structure of food marketing implies the need for formal trading in order to organise rapid collection and distribution. The state needs to invest in the cassava production and distribution system in order to increase the volume and the quality of the product. This will help the country gain a more competitive advantage in the regional market for Congolese cassava products.

7.3 Study limitations

Although this research has reached its aims of understanding the role played by markets in increasing food insecurity in the country and various issues surrounding market integration, there are still some unavoidable shortcomings and limitations.

Because of data limitation the study has applied only Co-integration method and value chain analysis. However, these methods alone are not enough for researcher to observe all issues explaining cassava market performance in a country. It would be usefull for future analysis to apply powerful technical tools such as regime switching models or threshold models which are more suitable for this kind of study.

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Appendix A

Diagnostic Tests

Equation 1

Purpose of the test	Test	Test Statistic	P-value	Decision
Normality	Jarque-Bera	19.44	0.00	Residuals not normally distribute
Heteroskedasticity	White	38.39	0.008	Heteroskedasticity present
Heteroskedasticity	ARCH LM	0.98	0.613	No Heteroskedasticity detected
Autocorrelation	Breuch-Godfrey	2.39	0.302	No Autocorrelation present
Autocorrelation	Ljung-Box Q	5.03	0.540	No Autocorrelation present at 6
Stability	CUSUM	-	-	Stable
Stability	Cusum Square	-	-	Stable
Stability	Ramsey RESET	6.2	0.45	Stable
Normality	Jarque-Bera	18.67	0.00	Not normally distributed residua

Appendix B:

Univariate characteristics, decision rule procedure

Find the longest significant differenced lag by starting T ¼. Check the p-value of the lag, and if it is significant (<0.1) then the lag is significant and we could begin testing the procedure.

H0: non-stationarity. Reject H0 if the ADF statistic is less than the DF distribution (provided by-reviews). Now check status of underlying data by testing the Ho trend: reject if F-statistic is greater than ϕ_3. Rejection of H0 implies that the first unit root test above was based on incorrect data; there we redo it (if H0 above was not rejected then the first unit root test was correct and we stopped there. H0: non-stationarity. Reject H0 if ADF less than normal distribution. We repeat the same procedure of finding the longest significant differenced lag for the τ_μ and τ (stop, and don't need to check underlying data)

Appendix C:

McKinnon Responses

MacKinnon Response: critical values (Nominal Exchange Rates) (n=3) total number of variables excluding dummy variables)

$C(P) = \phi\infty + \phi T^{-1} + \phi T^{-2}$

10 %: $-3.4518 + (-6.241)*(34^{-1}) + (-2.79)*(34^{-2}) = -3.63777$

5 %: $-3.7429 + (-8.352)*(34^{-1}) + (-13.41)*(34^{-2}) = -4.00015$

1 %: $-4.2981 + (-13.79)*(34^{-1}) + (-46.37)*(34^{-2}) = -4.7438$

MacKinnon Response: critical values

$C(p) = \Phi\infty + \Phi 1T^{-1} + \Phi 2T^{-2}$

T = 33(1970-2003)

N = 3

10 %: $C(10) = -3.45 + (-6.24)(34^{-1}) + (-2.79)(34^{-2}) = -3.636$

5 %: $C(5) = -3.74 + (-8.35)(34^{-1}) + (-13.41)(34^{-2}) = -3.997$

1 %: $C(1) = -4.30 + (-17.19)(34^{-1}) + (-59.2)(34^{-2}) = -4.857$.

Appendix D:

Calculation of adjusted coefficients and t-statistics

Variable	Adjusted Coefficients	Standard Error	Adjusted t-Statistic
LKin	0.891873 + 0.0000125 = 0.8918855	0.000974	0.8918855/0.000974 = 915.69353

Appendix: E

RESEARCH QUESTIONNAIRE

Cost, margin and problem of cassava commercialisation in the Eastern part of the DRC

DEMOGRAPHIC AND GENERAL INTERVIEWED INFORMATION

1. **Interviewed type**

   Farmer ☐ Rural assembler ☐ Trader ☐ Agribusiness person ☐

2. Name of interviewed…….

3. Age: Below 18 years ☐ 19-25 years ☐ 26-35 years ☐
   36-45 years ☐ above 45 years ☐

4. Education: Primary & below ☐ Secondary ☐
   Tertiary ☐ University ☐

5. **Gender:** **Male** ☐ **Female** ☐

6. Income: Below FC. 5,000pm ☐ FC. 6,000-15,000pm ☐
   FC. 16,000-25,000pm ☐ FC. 26,000-50,000pm ☐
   Above FC. 50,000pm ☐

7. **Place of residence**…….

QUESTION TO FARMER

8. What are the most consumed foods locally?

	January – March	**April-June**	**July-September**	**October -December**
Most consumed food				
Rice				
Maize				
Millet				
Sorghum				
cassava				
Sweet Potatoes				
Plantain				
Beans				
Banana				

8. Did you produce cassava during the last two years?

a) If yes, fill in the table below.

Name of Variety	Mixed or Pure	Area Cassava	Quantity Produced (kg)	Quantity Consumed (kg)	Quantity Sold	Price per kg

B) Inflow,

……

……

……

……

9. What are the main cassava production constraints?

Socioeconomic Constraints of Producing Cassava			
List of constraints	**Ranking of the Constraints**		**Observation**
Land	**Season A**	**Season B**	
Insufficient Land			
Land Regime Problem			
Availability Of Renting Land			
Climate Constraints			
Drought			

Flout			
Credit			
Difficult Access To Credit			
High Interest Rate			
Input Availability			
Credit Offered Late			
Post-harvesting Constraints	**Ranking of the Constraints**		**Observation**
	Season A	**Season B**	
Storage			
Transport			
Product Market			
Market not Available			
Low Price			
Multiple Taxation			
Long Distance to the Market			
Extension Services			
No-Availability ff Extension Services			
Long Distance from Extension Service			
Other			

10. What is the main purpose of producing cassava?

Consumption

Selling

Both

Other- specify

QUESTION TO TRADERS

11. Trader origin

Urban area ☐

Local area ☐

Other: specify ☐

12. Means of transport used from residential place to the market:

Private Car

Public Transport

Car Hire

Walking

Other: specify

13. Do you trade cassava? If yes fill in the table below.

	Buying Market	Selling Market	Quantity Bought	Commercial Cost	Unitary Buying Price	Unitar Price
SEASON a						
SEASON b						

14. What kind of problem do you face in the cassava trade

Market facilities

Market access

Market storage facilities

Market transport mean

15. What are buying behaviours? Are they changing or constant?

……

……

……

16. Provincial production level

Auto-sufficient area

Deficit area

Surplus area

17. Product demand from other markets

Decreasing

Increasing

Stationary

18. **Seasonal supply to others markets**.

Decreasing ☐ ☐

Increasing

Stationary

19. Seasonal price variation in the region

High

Low

Negligible

20. Commercial problem that may affect cassava trade in the region

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21. Source of information on market (price, law, quantity)

Official source

Private source

Other, specify

QUESTIONS TO RESEARCHER AND EXTENSION AGENT

22. What aspect of cassava are you working on?

Variety improvement

Marketing aspect

Training aspect ☐

Farmer structure

Input supply

Other: specify

23. Do you work with cassava producers?

Very often

Often

Not often

24. Do you also discuss market constraints with cassava traders?

Yes

No ☐

a. If yes list the main cassava production and trade constraints

.....

.....

.....

NOTES

Appendix E

STUDY DATA SET

Appendix F: Study data set

Monthly average cassava retail price 2005

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
KINSHASA	0.45	0.42	0.41	0.41	0.41	0.42	0.42	0.42	0.43	0.41	0.45	0.45
MATADI	0.15	0.15	0.15	0.16	0.15	0.15	0.17	0.15	0.16	0.15	0.15	0.15
KIKWIT	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
MBANDAKA	0.15	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.17	0.17	0.17	0.15
KISANGANI	0.12	0.12	0.13	0.12	0.14	0.13	0.12	0.14	0.12	0.15	0.14	0.12
KINDU	0.12	0.12	0.12	0.14	0.14	0.15	0.13	0.13	0.12	0.15	0.15	0.12
GOMA	0.06	0.06	0.06	0.07	0.06	0.06	0.08	0.06	0.06	0.07	0.06	0.06
BUKAVU	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
MBUJIMAYI	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
KANANGA	0.10	0.1	0.11	0.1	0.12	0.11	0.1	0.12	0.1	0.13	0.12	0.1
LUBUMBASHI	0.35	0.35	0.55	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36	0.35

Monthly average cassava retail price 2006

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
KINSHASA	0.51	0.51	0.51	0.52	0.52	0.52	0.52	0.52	0.53	0.51	0.54	0.52
MATADI	0.15	0.15	0.15	0.16	0.15	0.15	0.17	0.15	0.16	0.15	0.15	0.15
KIKWIT	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
MBANDAKA	0.15	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.17	0.17	0.17	0.15
KISANGANI	0.12	0.12	0.13	0.12	0.14	0.13	0.12	0.14	0.12	0.15	0.14	0.12
KINDU	0.12	0.12	0.12	0.14	0.14	0.15	0.13	0.13	0.12	0.15	0.15	0.12
GOMA	0.06	0.06	0.06	0.07	0.06	0.06	0.08	0.06	0.06	0.07	0.06	0.06
BUKAVU	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
MBUJIMAYI	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
KANANGA	0.10	0.1	0.11	0.1	0.12	0.11	0.1	0.12	0.1	0.13	0.12	0.1
LUBUMBASHI	0.37	0.37	0.37	0.37	0.38	0.38	0.36	0.36	0.37	0.37	0.37	0.37

Monthly average cassava retail price 2007

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
KINSHASA	0.53	0.52	0.51	0.5	0.5	0.52	0.52	0.52	0.53	0.51	0.55	0.55
MATADI	0.15	0.15	0.15	0.16	0.15	0.15	0.17	0.15	0.16	0.15	0.15	0.15
KIKWIT	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
MBANDAKA	0.15	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.17	0.17	0.17	0.15
KISANGANI	0.12	0.12	0.13	0.12	0.14	0.13	0.12	0.14	0.12	0.15	0.14	0.12
KINDU	0.12	0.12	0.12	0.14	0.14	0.15	0.13	0.13	0.12	0.15	0.15	0.12
GOMA	0.06	0.06	0.06	0.07	0.06	0.06	0.08	0.06	0.06	0.07	0.06	0.06
BUKAVU	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
MBUJIMAYI	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
KANANGA	0.10	0.1	0.11	0.1	0.12	0.11	0.1	0.12	0.1	0.13	0.12	0.1
LUBUMBASHI	0.45	0.45	0.45	0.47	0.47	0.48	0.46	0.46	0.46	0.46	0.46	0.45

Monthly average cassava retail price 2008

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
KINSHASA	0.73	0.72	0.66	0.67	0.65	0.70	0.69	0.70	0.71	0.72	0.71	0.70
MATADI	0.25	0.22	0.20	0.21	0.23	0.23	0.20	0.23	0.24	0.26	0.25	0.26
KIKWIT	0.20	0.18	0.17	0.17	0.16	0.20	0.18	0.19	0.20	0.23	0.23	0.22
MBANDAKA	0.30	0.28	0.25	0.29	0.30	0.30	0.33	0.30	0.30	0.31	0.32	0.32
KISANGANI	0.12	0.08	0.09	0.10	0.12	0.10	0.12	0.13	0.13	0.15	0.17	0.18
KINDU	0.30	0.30	0.32	0.33	0.35	0.35	0.34	0.35	0.35	0.38	0.39	0.38
GOMA	0.08	0.06	0.05	0.05	0.07	0.08	0.07	0.09	0.09	0.12	0.14	0.14
BUKAVU	0.10	0.09	0.08	0.09	0.11	0.13	0.12	0.15	0.16	0.18	0.20	0.19
MBUJIMAYI	0.25	0.23	0.22	0.20	0.22	0.24	0.27	0.28	0.28	0.30	0.32	0.31
KANANGA	0.10	0.05	0.04	0.03	0.5	0.17	0.08	0.09	0.09	0.11	0.12	0.11
LUBUMBASHI	0.47	0.45	0.45	0.48	0.51	0.50	0.52	0.50	0.53	0.53	0.57	0.58

Monthly average cassava retail price 2009

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
KINSHASA	0.80	0.75	0.68	0.70	0.64	0.68	0.65	0.66	0.70	0.75	0.82	0.81
MATADI	0.38	0.37	0.33	0.35	0.32	0.33	0.30	0.32	0.33	0.35	0.38	0.40
KIKWIT	0.34	0.33	0.34	0.34	0.35	0.34	0.32	0.33	0.30	0.28	0.35	0.34
MBANDAKA	0.44	0.40	0.37	0.39	0.38	0.38	0.36	0.40	0.44	0.45	0.47	0.46
KISANGANI	0.18	0.17	0.19	0.22	0.20	0.22	0.19	0.21	0.20	0.20	0.20	0.22
KINDU	0.35	0.32	0.32	0.33	0.35	0.35	0.36	0.37	0.37	0.39	0.38	0.38
GOMA	0.16	0.14	0.12	0.14	0.13	0.14	0.15	0.17	0.17	0.19	0.20	0.20
BUKAVU	0.18	0.16	0.14	0.16	0.13	0.15	0.17	0.18	0.20	0.21	0.22	0.24
MBUJIMAYI	0.32	0.30	0.27	0.30	0.35	0.37	0.40	0.40	0.39	0.38	0.39	0.40
KANANGA	0.12	0.08	0.07	0.10	0.13	0.15	0.17	0.17	0.17	0.16	0.17	0.18
LUBUMBASHI	0.62	0.60	0.57	0.58	0.62	0.60	0.62	0.65	0.63	0.65	0.67	0.67

Commodities price in Kinshasa

Market(USD/kg)

Year	Maize	cassava	rice
1999	0.85	0.31	0.47
2000	0.58	0.27	0.50
2001	0.63	0.35	0.51
2002	0.40	0.27	0.43
2003	0.64	0.52	0.53
2004	0.76	0.77	0.59
2005	0.58	0.58	0.45
2006	0.54	0.52	0.44
2007	1.01	0.73	0.58
2008	1.38	0.80	0.63

source" coordination des oprération agricoles d'urgence et réhabilitation ,FAO N0 6, 2017

Per Capita annual Food consumption in DRC (Source: IRS, basic survey 2008)

Products	kg/pers	Gram/day
Banana	40.2	110.14
maize	23.0	63.01
beans	3.3	9.04
Sweet patatos	6.2	16.99
cassava	145.0	397.26
Rice	8.7	23.84

Exchange Rate evolution (Source:BCC,Annual report 2009)

Period	Rate
2000	21.82
2001	206.82
2002	346.48
2003	405.00
2004	399.73
2005	470.00
2006	490.00
2007	625.00
2008	825.00

Prix moyen (en FC) par province au 10 avril 2009													
Produits	Unités	CTR OUEST				CTR NORD		CTR EST		CTR SUD OUEST		CTR SUD	Moyenne
		KIN	BC	BDD	EQ	P. OR	MAN	NK	SK	KOC	KOR	KTG	RDC
Local Rice	Kilo	837	780	500	600	700	380	771	550	825	993	588	684
Imported Rice	Kilo	1047	1 008	1 046	952	822	1 500	294	467	1 000	1 373	894	946
Maize grain	Kilo	458	500	278	569	295	1 000	378	367	775	149	1 124	536
Maize flour	Kilo	517	450	488	600	465	500	567	383	1 200	372	1 166	610
Wheat flour	Kilo	2 576	1 455	833	1 358	975	2 500	783	875	1 100	2 663	1 103	1 475
Cassava flour	Kilo	1 722	967	750	1 050	525	860	346	586	800	367	1 243	838
Cassava chips	Kilo	833	1 950	400	750	350	333	236	400	625	1 293	1 273	768
Chikwangue	Kilo	1 042	500	625	375	500	714	433	1 750	163	569	1 000	697
Banana Plantain	Kilo	1 138	982	467	800	2 786	2 850	633	1 250	1 254	635	1 307	1 282
Bean	Kilo	1 931	1 307	1 593	1 219	899	439	987	450	786	1 345	1 550	1 137
Chiken	Kilo	2 993	2 771	3 950	2 285	5 677	5 000	5 450	6 150	3 333	3 386	3 479	4 043
Goat	Kilo	8 350	4 800	2 500	2 400	2 300	1 000	2 867	5 975	3 950	4 500	3 508	3 832
Beef	Kilo	3 383	4 150	3 750	4 450	5 500	4 000	2 800	3 625	5 900	6 250	3 809	4 329
fish	Kilo	1 783	1 900	1 750	2 100	3 750	1 500	3 209	3 150	2 750	2 925	1 968	2 435
Palm oil	Litre	622	581	500	507	653	556	719	953	750	849	1 273	724
Essence à la pompe	Litre	800	825	1 150	1 300	1 025	1 800	900	975	1 325	1 475	1 125	1 155
Transport	Course	275	225	500	600	2 250	300	342	375	500	250	213	530
Taux du dollar	FC	835	810	833	820	825	820	850	850	790	823	815	825

Annual cassava retail price by province (Source, Minagri , annual report, 2009)

	KINSHASA	MATADI	KIKWIT	BANDAKA	KISANGANI	KINDU	GOMA	BUKAVU	MBUJIM	KANANGA	LUBUSHI
2000	0.27	0.04	0.03	0.1	0.008	0.16	0.07	0.09	0.23	0.08	0.48
2001	0.35	0.07	0.4	0.27	0.009	0.15	0.1	0.12	0.20	0.10	0.50
2002	0.27	0.05	0.08	0.32	0.12	0.17	0.08	0.1	0.22	0.11	0.52
2003	0.52	0.12	0.10	0.24	0.08	0.26	0.12	0.11	0.24	0.11	0.53
2004	0.77	0.22	0.25	0.27	0.10	0.26	0.12	0.12	0.35	0.13	0.55
2005	0.58	0.18	0.17	0.27	0.12	0.29	0.14	0.17	0.22	0.10	0.45
2006	0.52	0.16	0.22	0.39	0.14	0	0.17	0.20	0.35	0.14	0.55
2007	0.73	0.25	0.30	0.44	0.15	0.35	0.18	0.22	0.42	0.16	0.60
2008	0.80	0.38	0.34	0.44	0.18	0.35	0.16	0.18	0.32	0.12	0.62