Who Gains, Who Loses?

The Impact of Market Liberalisation on Rural Households in Northwestern Kenya

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ABSTRACT

Most countries in Sub-Saharan Africa, including Kenya, liberalised their agricultural commodity markets in the 1980s and 1990s as a strategy to increase marketing efficiency. In this thesis, we provide an account of the impacts of market liberalisation on households in Northwestern Kenya, a maize surplus producing region. We apply several analytical frameworks including descriptive statistics, structure, conduct and performance modeling, cointegration and error correction modeling approaches, double differencing and multinomial probit regression to both primary and secondary data.

A descriptive review of the market liberalisation process indicates that commodity markets are liberalised. This is particularly evidenced by the increased number of traders across the four commodity markets (fertiliser, seed, maize and milk) examined. However, the markets are only partially liberalised since there is still some government active participation in some markets like maize and milk. An analysis of the structure, conduct and performance of the four commodity markets shows that the markets are competitive. This is evidenced by low trader concentration levels and marketing margins. Furthermore, there is no evidence of collusion among traders in terms of pricing or limiting market supply despite financial and structural constraints that limit firm expansion. The ensuing increased private trader participation in commodity markets partly explains the observed marketing integration among maize wholesale markets, and a positive and strong aggregate supply response both in the short- and long-run.

By comparing farming activities of maize producing households in 1992 and 2003 by using panel data, we find that on-farm diversification and commercialisation have increased. In particular, fertiliser use increased dramatically in terms of number of households using fertiliser and the rate of use. Furthermore, the number of households participating in maize marketing increased from 40 percent in 1992 to 70 percent in 2003. Area under maize, distance to the market, rate of basal fertiliser use and household size are the major factors that influence household participation/non-participation in maize markets.

Overall, the study shows that market liberalisation could be beneficial to households if constraints traders face could be eliminated and that the government has lost revenue because of its reduced role in commodity marketing activities.

Keywords: Market liberalisation, rural households, traders, Kenya, market integration, cointegration analysis, difference-in-difference approach, farmer response.

PREFACE

This book is a product of a multi-institutional effort involving many people, which started with my enrolment as a sandwich PhD researcher at Wageningen University on September 9, 2002. While it is impossible to individually mention all institutions and people who in one way or another contributed to this book, I particularly would wish to thank the following:

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Lawrence O. Mose
Wageningen, March 2007.

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CHAPTER 1

INTRODUCTION

1.1 Problem statement

In mid 1980s, the Government of Kenya, with assistance from the World Bank, instituted the Structural Adjustment Programs (SAPs) to address the declining trend in economic growth. At the macro-level, the domestic currency was devalued, exchange rate controls were removed and interest rate was de-regulated in a bid to restore macroeconomic stability (van Wijk & Makokha 2000). At the micro-level, the reforms were sector-specific.

In the agricultural sector, commodity markets such as maize, fertiliser and milk were liberalised. Specifically, commodity prices were decontrolled, trade restrictions such as licensing controls and commodity movement restrictions were reduced or removed altogether and the role of government in commodity marketing was reduced (van Wijk & Makokha 2000). This policy change set the stage for increased participation of private traders in such markets as maize, milk and farm inputs, previously handled by government-controlled marketing agencies like the National Cereals and Produce Board (NCPB), Kenya Cooperative Creameries (KCC), and Kenya Farmers' Association (KFA). Increased entry of private traders in input and output markets has been documented (Omamo and Mose, 2002; Wanzala, 2001; Owango, 1999).

Increased trader participation was expected to usher in competition in the market, which in turn could improve marketing efficiency. In turn, marketing efficiency could result in competitive input and output prices. Competitive input and output prices could lead to increased use of the inputs and subsequently, increase production and marketed surplus, *ceteris paribus*. Therefore, market liberalisation was expected to change domestic trade and household agricultural production.

Thus far, the impact of market liberalisation on input and output prices, crop and livestock production and marketing in Kenya, which have been a focus of many studies (Mukumbu 1994; Mose 1997; Owango *et al.* 1998; Argwings-Kodhek *et al.* 1999; Mbithi 2000; Karanja 2002; Nyangito & Karugia 2002b) has been mixed. For example, milk prices have inversely increased with distance from the market (Owango *et al.,* 1998), real fertiliser and maize prices have declined and seed prices have fluctuated (Argwings-Kodhek 1996; Nyangito & Karugia 2002b). Differential access of traders and households to credit, infrastructure and market information partly explain this result.

In this thesis, we examine the role of fertiliser and seed traders in linking farm households to inputs and also the role of maize and milk traders in linking farm households to consumers. The traders serve as vehicles for conveying market price incentives to farming households. Specifically, we provide evidence on the structure, conduct and performance of maize, fertiliser, seed and milk traders. In addition, we present evidence on the role of wholesale maize traders in arbitrage by examining spatial wholesale maize integration. We

also provide evidence on aggregate supply response of maize on farm household responses. In addition, we compare household maize production and marketing patterns for 1992 and 2003. The study focuses on four commodities: fertiliser, hybrid maize seed, maize and milk because fertiliser and hybrid maize seed are important productivity-enhancing inputs in maize production, the single most important food crop in Kenya. Maize constitutes three percent of Kenya's Gross Domestic Product (GDP), 12 percent of the agricultural GDP and 21percent of the total value of primary agricultural commodities (Wangia *et al.* 2000). Although milk is not as important as maize at the national level, it is the second most important household farm enterprise in North Rift (Rees *et al.* 1998a). Like maize, milk is an important source of household food (nutrition) and significantly contributes to household income in addition to being a major employer through linkages in production and marketing.

1.2 Objectives

Not all impacts of market liberalisation are observed instantaneously. There is a time lag between implementation and impact. Since most of the studies were carried out within a decade of market liberalisation, there was need to do a study after a relatively longer period after market liberalisation to allow for market adjustments. The underlying assumption of this research is that understanding market liberalisation impacts on different market participants notably farmers and input and output traders can lead to formulation of strategies that would encourage input use leading to increased productivity and eventually raise household income. The broad objective of the research is to assess the impact of market liberalisation policy measures on farmers and traders.

Specific objectives include, to:

1. analyse the integration of maize markets in Kenya
2. assess the structure, conduct and performance of maize, fertiliser, milk and seed trade in North Rift
3. analyse the response of smallholder maize farmers to price incentives
4. assess the extent to which rural households respond to changing prices and market conditions facing them with respect to crop diversification and degree of commercialisation

1.3 Research questions

In order to get more insights on market liberalisation and elaborate on the objectives of this research, we raise the following research questions.

(i) To what extent is the wholesale maize market spatially integrated?
(ii) To what extent do private traders exploit farmers?
(iii) How do small-scale maize farmers respond to price incentives in the aggregate?
(iv) To what extent has market liberalisation affected households' commercialisation, on-farm diversification and participation in maize markets?

We answer these questions by estimating several models on the basis of a number of data sets. We address the research question on spatial maize market integration using monthly maize wholesale price data for six markets covering the period January 1992 to April 2004. The prices are adjusted for inflation using the consumer price index for Nairobi lower income group (February 1986 = the base year). Cointegration analysis is applied to the data to establish the extent of market integration.

In order to answer the question of private traders' exploitation of farmers, we use traders' survey data collected in 2003. On the basis of firm size distribution, we estimate the levels of market concentration and infer the level of competition. In addition, we estimate the levels of trader margins across different trader size groups to establish the level of margins and infer possibilities of farmer exploitation.

Farmer response to price incentives is estimated using annual aggregate production data, fertiliser and maize prices obtained from the Ministry of Agriculture (Trans Nzoia District Office). Using cointegration analysis and error correction modelling techniques, farmer responses to price incentives are estimated. Both short- and long-run elasticities are estimated.

Finally, to answer the research question on household responses to commercialisation and on-farm diversification, we use two household data sets. The households that were interviewed in 1992 were retraced and interviewed in 2003. Based on the two data sets, we compare the changes that have taken place with respect to the extent of crop diversification and degree of commercialisation using the difference-in-difference approach to estimate the average impact. In addition, we estimate the factors influencing household participation as market or non-market maize participants. Farmer perceptions on impacts of market liberalisation on households in terms of access to inputs, input and output prices, complement the empirical analyses.

1.4 The study area

This section familiarises the reader with the study area with respect to its agricultural potential, production and marketing constraints, and opportunities.

1.4.1 Location, climate and demographics of study area

Kenya occupies an estimated area of 581,677 km^2 lying between 4^0 21´N and 4 ^{0} 28´S of the Equator and 34^0 E and 42 ^{0} E of Greenwich Meridian. It is divided into 8 administrative provinces, which are further divided into 70 districts. The districts are further divided into divisions, locations and finally villages, the smallest administrative units. Households form the basic agricultural decision making units within each village. The study was carried out in North Rift region of Rift Valley Province, comprising five districts: Trans Nzoia, Uasin Gishu, Nandi, Keiyo and West Pokot (Fig. 1.1). The region lies between 0^0 03' S to 2^0 49' N of the equator and 34^0 38' E to 35^0 49' E of Greenwich Meridian occupying an area of 19,217 km^2.

The region has varied topography ranging from <1,000 m above sea level to 4,313m above sea level. This type of topography partly explains the wide differences observed in rainfall amount (700 to 2000 mm per annum) and ambient temperatures (7 ^{0}C to 30 ^{0}C).

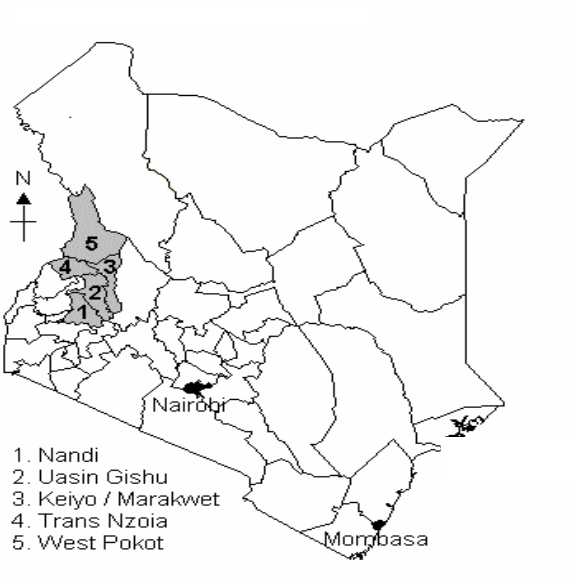


Fig. 1.1 Study Area

The region has a human population of 2.23 million of Kenya's population of 28.6 million people (1999 population census) of which 46.4% are children under the age of 15 years. The population structure shows a high dependency ratio.

Poverty incidence is high in the region. Uasin Gishu and Keiyo have higher poverty incidences than the 52 percent national average (Institute of Economic Affairs 2002b) High poverty incidences have implications on input use and extent of on-farm diversification. This is because poor farmers are unlikely to afford productivity-enhancing inputs such as fertilisers and hybrid seed. Under such circumstances, they tend to strive for food self sufficiency rather than food security and market liberalisation policies will have little influence on their farming decisions.

1.4.2 Market conditions

The extent to which households can trade for factors is central in determining their production and consumption choices (Omamo 1995). Technical choices often depend on access to markets for land, labour and inputs. These factors determine total output, factor productivity and household income (Omamo 1995).

Input markets are liberalised and market forces determine what prices farmers pay for the inputs. Land markets are thin which limit access to land for land-deficit households. Large-scale farmers with land title deeds can access credit from commercial banks. In addition, the Agricultural Finance Corporation (AFC) offers credit to farmers with a

minimum farm size of two hectares which is titled besides other forms of collateral (Nyameino *et al.* 2003b). However, farmers who grow industrial crops access credit in kind through their respective marketing agencies. In the case of tea, Kenya Tea Development Agency offers this credit. Micro-finance institutions offering small amounts of credit at high interest rates have sprung up in recent times.

Labour markets work well and are fairly competitive. The structure of the labour market is two-fold: casual market and long-term market. In the short-term market, contracts are negotiated for short periods or on a specific task basis. Common tasks include cultivation, harvesting, transportation of inputs from markets or outputs to markets and tending livestock. Employment for long-term market is mainly for herding livestock.

There is lack of insurance market in the region. Therefore, farmers in the study area have no safeguard against price or production risk. Production risk may come as a result of drought. However, it is only one in 10 years that severe drought is reported (Rees *et al.* 1998a). In addition, other biotic stress in form of pests and diseases may reduce farmer income through reduced production or death in case of cattle.

Private traders alongside state-controlled agencies sell agricultural inputs such as fertilisers to farmers and buy agricultural outputs from farmers. These traders can be found even in local market centres. However, the number and size of traders are inversely related to distance from the major urban centres.

The major source of information to farmers and traders is the government extension services and through the press, mainly the radio and local newspapers. In recent years, mobile phone technology has proven as an additional means to source market information. Both input and output traders use the mobile phones to get information about market conditions. However, it requires networking among traders and although farmers could benefit from the same technology, lack of electricity in the rural areas hampers its widespread use.

The poor network of road infrastructure increases transaction costs for all market participants (producers, consumers and traders). According to the Institute of Economic Affairs (2002a), only about four percent of length of classified roads (72,000 km) nationally is in the study area yet the area occupies about 14 percent of total high potential agricultural land in Kenya (6.8 million ha).

1.4.3 Agricultural production

Except the northern part of West Pokot District, this region has fairly fertile and well-drained soils and receives ample and well-distributed rainfall (900- 1200mm annually), making it a medium to high agricultural potential[1] area. Agricultural production is rain-fed implying that

[1] According to Jaetzold and Schimdt (1983), three categories of agricultural land are defined on the basis of rainfall amount. High potential refers to annual rainfall of 857.5mm or more; medium potential refers to annual rainfall of 735 – 857.5 mm or more and low potential refers to annual rainfall of 612.6 mm or less.
…..

yields and more importantly marketed output can vary substantially from year to year (Smith, 1992).

Mixed farming, on both large and small scale farms, for both commercial and subsistence needs is practised in the region. Farmers also practise mixed farming partly as a hedge against production and price risk arising from conditions such as drought and fluctuating output prices.

Besides maize, farmers grow a wide array of food crops such as millet, potatoes, and vegetables. They also grow cash crops such as tea, wheat, pyrethrum and coffee depending on agro-ecological conditions. The farmers also tend livestock, mainly cattle for milk, in addition to free range poultry and sheep. Generally, the region is a net producer of maize and milk.

Maize production in North Rift is characterised by a dualistic supply structure; comprising large-scale and small-scale systems as both a subsistence and cash crop. Small scale maize producers often use labour intensive production methods. They are often subsistence- oriented and commonly use family labour. Large scale producers (over 20 ha) often use capital intensive farming methods (machinery and agro-chemicals) and are commercially-oriented. They also rely on hiring-in labour from other households in the village or employ seasonal farm workers for farm operations such as land preparation, weeding and harvesting (Rees *et al.* 1998a). Hiring-in labour occurs mainly when insufficient labour is available within households. Majority of the large-scale farmers who produce over 30 percent of the total maize production in Kenya are found in Trans Nzoia and Uasin Gishu districts (Nyameino *et al.* 2003a). Unlike the large-scale farmers, the small-scale farmers rarely access credit from formal institutions but mainly use own savings and informal credit sources to finance their production and marketing activities.

Unlike the small-scale and medium-scale farmers who are engaged in other enterprises, large-scale farmers concentrate on maize farming and dedicate all their effort to this activity. Access to land for maize production is mainly through inheritance.

Maize production in North Rift relies on two important productivity enhancing inputs: fertiliser and hybrid seed maize which contribute significantly to household and national food security. Both inputs constitute about 40-50% of the maize production costs in North Rift (Mose *et al.* 2002). Fertiliser use is necessary because soil fertility in North Rift is declining partly due to continuous cropping without adequate nutrient replenishment, leaching, erosion and poor stover disposal such as burning (Rees *et al.* 1998a). Hybrid seed adoption rate is over 70% in the region (Mose *et al.* 2002). More recently developed hybrid maize seed produce two to three times the yield of local unimproved maize seed.

Tea, a cash crop, is emerging as a major competitor for household resources (mainly land and labour) in Nandi district. Wheat and dairy are major competitors for household resources in Uasin Gishu District. In other districts, maize is the dominant farm enterprise with only modest competition from dairy.

Dairy production is a major farming activity in North Rift. Dairy cattle are kept under three major grazing systems; zero, semi-zero and free range. In the zero grazing system, often

high-yielding dairy cattle are mainly stall-fed on Napier grass, crop residues and commercial dairy supplements. Under free range systems, relatively poor yielding cattle (mainly local zebu) are often grazed on communal properties such as road reserves, school compounds and areas reserved for forests whereas under semi-zero grazing systems a wide range of cross-bred cattle are kept in varying combinations of stall-feeding and free range depending mainly on the type of dairy cattle, availability of animal feeds and level of milk production. Overall, dairy cattle comprise pure breeds mainly the Friesians, Aryshires, Guernseys and the Jerseys, and varying degrees of cross-breeds of the pure breeds with the local zebus.

1.5 Outline of the thesis

The thesis is divided into six chapters (Figure 1.2).

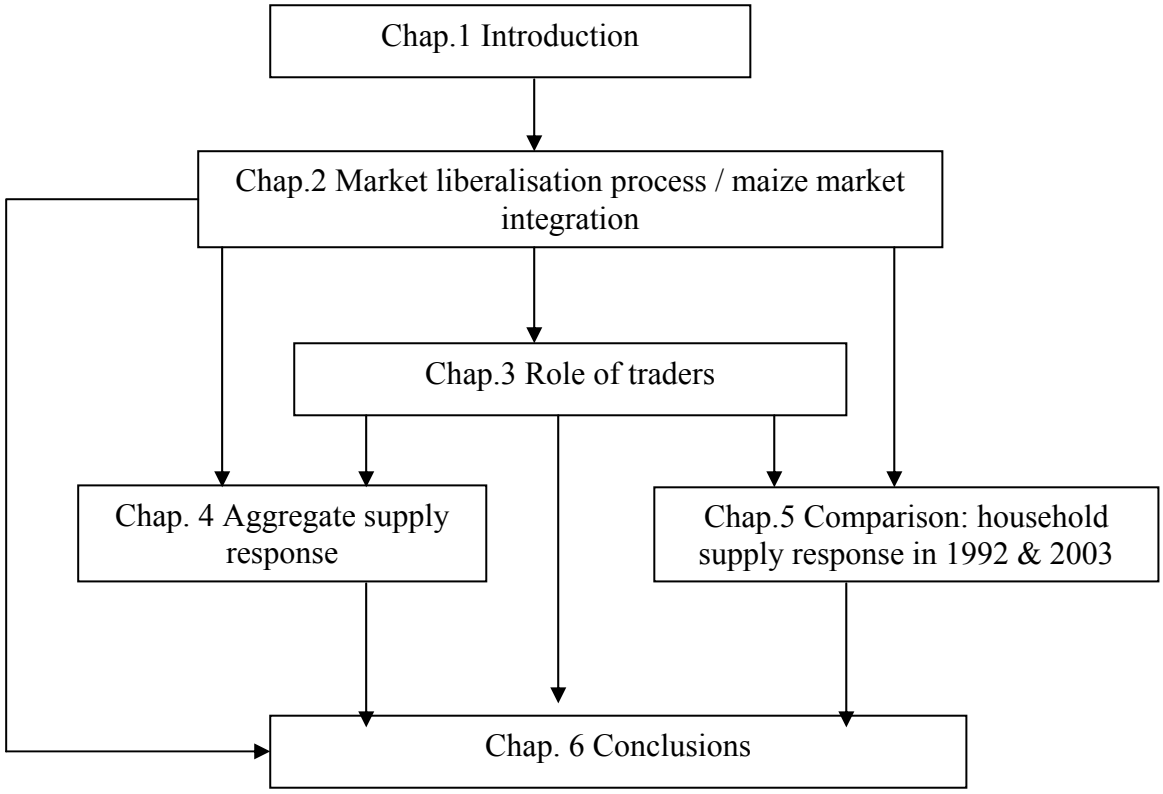


Fig. 1.2 Schematic representation of the Thesis

Chapter two provides evidence on the need for and highlights the process of market liberalisation in Kenya. It also provides an analysis of the integration of maize markets. Chapter three discusses the role of traders in fertiliser, maize, seed and milk marketing. Issues regarding the structure, conduct and performance of the four businesses are examined. Chapter four discusses the aggregate response of maize producers to market liberalisation, in particular to producer price changes. In chapter five, we compare farm households in terms of degree of commercialisation, crop diversification, and participation in maize markets for 1992 and 2003. In addition, we provide farm households' perceptions on the impacts of market liberalisation on production and marketing of maize, in particular fertiliser and seed availability, fertiliser and maize prices. Finally in chapter six, we provide major findings and implications of the study.

CHAPTER 2

MARKET LIBERALISATION PROCESS AND MAIZE MARKET INTEGRATION IN KENYA

2.1 Introduction

In the 1960s and 1970s, the state-dominated economic development approach whereby industry was viewed as the engine of growth for economic development was practised in many developing countries in line with the views of then development economists (Lewis 1954; Hirschman 1958). The approach supported the earlier arguments of Prebisch (1949) and Singer (1950) that the terms of trade of agricultural outputs declined over time. As a result, there was need to encourage discriminatory policies against agriculture in order to shift resources out of agriculture. Government intervention in agriculture was therefore justified and was often instituted through marketing boards. The intervention obtained support for economic as well as political reasons. The system proved useful for collecting taxes and providing political patronage (Bates 1981). In addition, governments considered markets too important economically and politically to be left to the private sector.

The state marketing boards controlled the marketing of both agricultural inputs and outputs. The boards regulated supply by fixing both producer and consumer prices. They also provided farmers with inputs, purchased the raw products and usually monopolised processing (Hoffler 2001). The government guaranteed farmers stable prices and an organised outlet. The pan-territorial, pan-seasonal prices and single-channelled marketing systems contributed to low farm productivity. This is because the farmers' production environment was characterised by low producer prices, implying poor incentives for surplus production.

By the 1980s, government control in agricultural marketing in developing countries (Badiane 1998a) proved inefficient resulting in suppressing producer prices and incentives. Following the strong decline in commodity prices on the world market, the boards became excessive budgetary burdens to the exchequer that could no longer be sustained and agricultural production stagnated.

The shortcomings caused concern among economists who demanded for reform arguing that there was government failure in undertaking marketing activities. This argument was based on economic theory, which states that free markets generate efficient resource allocation. Therefore, measures of market liberalisation largely followed the theoretical reflections on the functioning of markets and the assumptions of a perfectly competitive market model. Less government control and more private participation were targeted to improve efficiency of input and output markets. A key belief of the reform process was to reduce or eliminate state control over marketing to promote private sector activity. This could result in competition and eventually increase agricultural production. It was assumed that the private sector could be more efficient than the state marketing boards.

Consequently, agricultural markets world-wide entered a long process of liberalisation to reduce imposed market imperfections such as monopolistic public trade, entry barriers and subsidies (van Tilburg *et al.* 2000). Market liberalisation started dismantling state controls in favour of a more market oriented economy, resulting in entry of private traders. It was assumed that the increased private sector efficiency could be passed on to farmers in form of higher producer prices thereby acting as an incentive to produce more output. Thus, the measures of reforms concentrated on enhancing competition and creating a more conducive environment for producers (Hoffler 2001). However as Coulter and Compton (1991) argued, that success of market liberalisation was dependent on minimising impeding constraints such as inadequate transport networks, lack of availability of trade credit, lack of storage chemicals, lack of market information, unsupportive legal framework, lack of commitments by governments and inconsistent donor support.

Agricultural commodity market liberalisation in Kenya took place between late 1980s and early 1990s. The liberalisation process was commodity-based. The reforms resulted in reducing the role of marketing boards in favour of private traders. In particular, the reforms reduced government role in pricing of agricultural commodities. Little information is however available on the consequences of these reforms on marketing efficiency and in particular, distribution of marketing margins and integration of markets. This chapter contributes in filling this knowledge gap.

The remaining parts of this chapter are organised as follows: Section 2.2 presents a review of the background, causes and processes of market liberalisation in Kenya by drawing experiences from four commodities; maize, milk, fertiliser and maize seed. The review sets the stage for understanding the subsequent chapters of the book. We focus on these commodities because maize is the major staple food for the people of Kenya and together with milk are important sources of household income in North Rift. Fertiliser and seed are the most important purchasable inputs used in maize production.

In section 2.3, we provide opportunities/ challenges arising from market liberalisation for the various market participants. Thereafter in section 2.4 we focus on the consequences of market reforms by first considering the distribution of marketing margins over time, drawing experiences from fertiliser and maize marketing. It is hypothesised that the margin between import prices and retail prices for fertiliser will decrease with market liberalisation due to the anticipated efficiency in marketing arising from increased competition. It is also hypothesised that the margin between domestic and world price of maize will decrease with market liberalisation as production and marketing efficiency increases. Second, we consider the extent to which markets are integrated by drawing experiences from wholesale maize marketing. It is hypothesised that maize markets are integrated signalling increased efficiency in maize marketing after market liberalisation. Finally, in section 2.5 we provide major findings from the chapter.

The following section reviews the marketing liberalisation processes and preliminary impacts for maize, fertiliser, seed and milk marketing in Kenya.

2.2 Implementation of market liberalisation policies

A) Liberalisation of maize grain marketing: process

Maize is a major staple food for the people of Kenya, providing 45 percent of the calorie intake of the average Kenyan household (Nyameino *et al.* 2003a). Over 95 percent of the Kenyan farmers, who constitute about 80 percent of the population, grow it across all agro-ecological zones (Nyameino *et al.* 2003a). Food security in Kenya is equated to availability of adequate supplies of maize both at national and household level (Republic of Kenya 1994a). Because of its strategic nature, maize has received considerable government policy attention.

Government intervention in maize marketing dates back to the colonial days when the government created the Maize Control Board (MCB) as the sole buyer of maize and other grains at fixed prices. MCB provided a minimum guaranteed return per acre for colonial settlers who were facing competition from African producers. At independence in 1963, the government maintained the controls on maize pricing and marketing inherited from the colonial era. With reference to pricing, it set prices in a bid to encourage farmers to increase production. Before the crop was planted each year, the government announced the price at which it could be bought at harvest. Furthermore, the government set the selling price of maize at each level of the marketing chain, including the retailing of maize meal. In the early 1970s, MCB was restructured and renamed the Maize Marketing and Produce Board (MMPB) which in 1979 was restructured and merged with the Wheat Marketing Board to form the National Cereals and Produce Board (NCPB).

Why did the government engage in controlling the maize market for so long? The government intervened in the maize marketing sector to (1) protect maize producers from unacceptably low or unstable prices, and provide reliable outlets for sale (2) protect consumers from unacceptably high or unstable consumer prices and (3) promote food security through assurance of maize availability at all times within the country.

Thus, under the pre-liberalisation era, the government had strict control of maize price, movement and storage under NCPB (Wangia *et al.* 2000a). The government through NCPB controlled foreign trade in maize. Formally established in 1985, under the National Cereals and Produce Board Act (Cap 338) of the laws of Kenya, NCPB is mandated by the government to regulate and control the marketing and processing of grains in Kenya. It does this through licensing and regulating the key players in the sector, who mainly include farmers, traders and millers (Export Processing Zones Authority 2005).

Prior to full maize marketing liberalisation, NCPB offered farmers a pan-seasonal, pan-territorial price. The board was required to buy all the maize offered at the set producer price and sell it to millers or agents at the set selling price. NCPB offered a fixed official price

for maize with the aim of achieving three objectives: an increase in rural incomes, provision of cheap cereals to urban areas, and extraction of a surplus from agriculture to finance state investment in other sectors. This pricing policy had a twofold role: to ensure price stabilisation and food security in the country (Mbithi & van Huylenbroeck 2000).

Price stabilization was pursued through a strategy of restricting intra- and inter- district maize movements. The NCPB equalized maize supply and therefore stabilized maize prices in various parts of the country by moving maize produce from surplus producing regions to deficit areas. To transport maize from one district to another, a trader required to obtain a movement permit which had a time bound. To some extent, this contributed to rent seeking among officials issuing the permits and corruption by law enforcers from traders. As a result, the interregional maize movement restrictions impeded efficient food distribution and increased marketing costs (Republic of Kenya 1981).

To achieve food security, NCPB maintained the strategic maize reserve, which ensured stocks were available during periods of maize shortage (Republic of Kenya 1981). The annual national strategic maize reserve is 3 million 90-kg bags.

In addition to NCPB, there was a parallel informal maize sector. Though the sector was unregulated and unofficial, it had numerous market participants. By 1989, the sector handled 50-60 percent of all marketed maize in Kenya, despite the movement and price restrictions (Wangia *et al.* 2000).

Large-scale farmers favoured selling maize to NCPB. This is because the board in collaboration with the Agricultural Finance Corporation (AFC) and the Kenya Farmers' Association (KFA) operated an interlocked credit system. Through the credit system, when farmers delivered maize to NCPB, loans taken from AFC or inputs taken from KFA were recovered. The aim was to assist farmers to purchase inputs in a timely manner and assure timely maize production.

Under this dual maize-marketing system, the NCPB did not achieve the objective of price stabilisation as often prices in the surplus regions fell below the gazetted prices while prices rose above the gazetted prices in maize deficit regions (Schmidt 1979; Maritim 1982; Winter-Nelson 1995). Further, the restrictions of the inter-district movement of maize prevented the formal marketing system from balancing demand and supply between surplus and deficit areas. The controlled prices and illegality of trade thus failed to arbitrate sufficiently between price differentials.

This failure led to inefficiencies in the official marketing system. The seasonal and interregional fluctuations in actual market prices made the pan-seasonal, pan-territorial pricing policy prohibitive. In most years, the NCPB could not get funds to pay the official price for maize deliveries and this led to payment delays of up-to six months. The delay acted as a disincentive to producers as they neither could buy inputs in time for the next season nor meet other household financial obligations. High overhead and operational costs emanating from its expansive network of depots and buying centres added to the NCPB debt burden. By 1987, the debts exceeded five percent of GDP (O'Brien & Ryan 1999).

Given the shortcomings of the maize marketing system, the process of liberalizing the market was initiated in 1988 under the Cereals Sector Reform Programme (CSRP). The CSRP falls into three areas: rules governing maize trading and movement; NCPB cost reduction; and pricing policy (Republic of Kenya 1991). The major reforms in trading rules involved (1) increased issuance of inter-district and inter-provincial maize movement permits by NCPB (2) raising weight limits on maize which could be moved without permit and (3) raising mill input quotas allowing sifted millers to purchase a percentage of maize directly from private marketing channels. The main objective of the change in trading rules was to encourage and facilitate private sector participation in maize marketing.

NCPB internal cost-reducing measures included (1) modifications in NCPB network (primarily reduction in number of buying centres), and (2) NCPB cost reduction and efficiency measures in the areas of finance, management and planning. The main objective of this change was to make NCPB an efficient institution that could handle its major role of maintaining strategic stocks in order to provide food security in years when maize production fell short of target.

Finally, changes in official pricing policy included increasing focus of government price intervention points on the into-depot and into-mill levels, and maintenance of a fairly narrow margin (relatively high into-depot price and low into-mill price). The policy changes aimed at effecting an orderly transition to a more liberalised marketing system (Republic of Kenya 1991).

It was hypothesized that the raising of weight limits and easing of movement controls could ease trade between surplus and deficit areas. The easing of the trading restrictions could in turn increase the volume of trade between surplus and deficit areas making grain flows from surplus areas more responsive to short-term changes in market conditions in deficit areas. In addition, removal of maize movement controls could make it easier to realise arbitrage opportunities and reduce transaction costs[2]. Eventually, this could increase participation of private traders, create more market outlets and improve availability of maize in all parts of Kenya. Millers' increased intake of maize from private traders, a cheaper maize source, hitherto a monopoly of NCPB, implies that ex-mill prices could be lower than they previous were. The price decrease could benefit consumers.

Eventually, in early 1995 maize marketing was fully liberalised (Wangia *et al.* 2000). In 1996, the NCPB was exempted from the State Corporation Act and its activities were commercialised. The prevailing market trends determine NCPB pricing policy except when the board is carrying out market stabilisation function or any other social function such as food relief distribution on behalf of the government.

At present, maize prices and movement in the country depend on market forces. Nonetheless, NCPB sets the pace for maize pricing under the competitive free market situation. The government continues to regulate maize imports by invoking or revoking

[2] In the presence of trade barriers such as barriers to inter-district maize movements, those that continue to engage in trade must spend resources to evade trade barriers and this increases their transaction costs.

import tariffs. This often causes uncertainty for private traders, consumers and producers. For instance, until 1996, maize imports into Kenya attracted a variable duty of 15 percent which was increased to 25 percent. In addition, a suspension duty for imports of 50 percent can be invoked by the Minister for Agriculture when deemed necessary, a situation tantamount to banning imports (Wangia *et al.* 2000). However, once the trading rules of the East African Community (EAC), the Common Market for Eastern and Southern Africa (COMESA) and World Trade Organisation (WTO) are in operation, the Kenyan farmers will face global prices.

B) Liberalisation of milk marketing: process

With over 3 million improved dairy cattle (Bebe 2003) producing an estimated 2.65 billion litres of milk annually, dairy farming is an important part of the agricultural production systems in Kenya. The dairy sub-sector accounts for about 10 percent of national GDP or 33 percent of the agricultural GDP (Muriuki 2003b). It also creates employment to more than 450,000 small-scale farmers and their families (Export Promotion Council 2003). The small scale farmers produce 80 percent of the country's milk and derive almost half of their income from livestock (Muriuki 2003a; SDP 2004). Dairying contributes to household income through marketing of forage, milk and as a source of employment (Bebe 2003).

A key characteristic of milk production in Kenya is the existence of distinct milk surplus and deficit areas often under smallholder dairy production systems. Smallholder dairy production systems range from stall-fed, cut- and carry systems supplemented with purchased concentrate feed in high human population density areas, to free grazing on unimproved natural pasture in the more marginal areas. Upgraded dairy breeds tend to be kept in stall-feeding units; cross-bred cattle in semi-zero grazing systems; and zebu cattle in free grazing systems. The agro-climatic characteristics of the area and the prevalence of animal diseases characterise the production conditions (Bebe 2003; SDP 2004).

Established by an act of parliament in 1958, the Kenya Dairy Board (KDB) is mandated to: promote dairy marketing and exports; stabilise prices; improve milk quality; and implement processing regulations. Trading in raw milk was prohibited. From its foundation, the Kenya Cooperative Creameries[3] (KCC) dominated the KDB operations thereby restricting the activities of potential competitors (Jaffee 1995). KCC operated an expansive network of milk processing plants in all major milk production areas in the country.

Before milk market liberalisation in 1992, the government gave policy guidelines, determined players, and set prices and market rules in the industry. KCC enjoyed a protected monopoly in milk processing in addition to the distribution of processed milk and milk products in the urban areas. Like NCPB, KCC operated an interlocked credit system for farmers in collaboration with AFC and KFA. By late 1980s, private processors operating besides KCC handled between 20-1,000 litres of milk daily (Sellen *et al.* 1990). This

[3] KCC is a cooperative society, with majority Government of Kenya Shares, involved in the buying, processing and sale of milk products

accounted for about 5 percent of all reported marketed milk (Sellen *et al.* 1990; Jaffee 1995; Ngigi 1995). Legally, the private processors could not procure raw milk directly from farmers. They had to buy milk from KCC or apply through KCC for particular farmers to deliver milk to them at KCC-controlled prices.

During the pre-liberalisation period the government subsidized artificial insemination (AI) services, disease control, supported KCC and KDB. This became a financial strain to the exchequer. In line with market reform in agriculture, the government commissioned a dairy sub-sector study in 1990. The outcome, the Dairy Master Plan, written in 1991, emphasized the inefficiencies and unsuitability of the Kenya dairy system, in particular KCC. It recommended *inter alia* that the KCC be opened up for competition. The Dairy Master Plan cited three major reasons for the recommendation: (1) growing financial burden of KCC resulting from losses for the fiscal budget (2) KCC late payments to farmers and co-operatives, necessitating the producers to sell raw milk to informal traders, and (3) severe shortage of milk in February to May 1992 in most urban centres as a result of drought in major production areas, leading to a decline of up-to 35 percent in milk purchases.

Subsequently, in June 1992, milk marketing was liberalised to permit the forces of supply and demand to guide dairy production, processing, distribution and marketing. This was expected to spur the development of private dairy processing. Liberalisation would create a more competitive market that would raise producer prices, encourage productivity and eventually raise income (Omiti 2001). With liberalisation, the government partially lost her influence in the dairy sub-sector with the declining role of KCC and KDB. However, through the restructuring of KDB to operate mainly as a regulator of the industry: licensing traders; regular inspection of processing plants; and protection of the consumers, the government still has a role in the dairy industry.

Market liberalisation in 1992 led to a massive entry and increase in private traders. Informal milk sales have since grown prominently though most informal traders are not licensed. Licensing is pegged on possession of fixed trading premises, thus excluding most itinerant traders. Although this requirement is not based on the Dairy Industry Act, it is enforced by the Kenya Dairy Board (KDB) under the Public Health Act (Cap. 242). Many traders have indicated their willingness to pay cess in return for licensing and security of legal status. Omiti and Muma (2000) report that KDB has licensed about 45 milk processors although only about 20 are functionally operational.

Although Morton *et al.* (1999) distinguish three components of the dairy market liberalisation; the liberalisation of services to the dairy producers, dairy co-operatives and the milk marketing, this study focuses on the liberalisation of the milk marketing only.

C) Liberalisation of the fertiliser marketing: process

All fertiliser used in Kenya is imported. The government controlled fertiliser imports and marketing prior to fertiliser market liberalisation in 1991 by imposing import quotas, setting prices and establishing controls on both distribution and marketing. A few merchants such as

KFA imported and distributed fertiliser to appointed agents and stockists. The government determined which firms imported fertiliser through licensing requirements and allocation of often - difficult to access foreign exchange (Argwings-Kodhek 1996).

The licensing procedures provided rent-seeking opportunities for public-sector officials, the costs of which were absorbed by trading firms that operated given the pre-determined trading margins. This scenario partially contributed to late fertiliser deliveries to farmers. The treasury in collaboration with the few fertiliser importers fixed the price of fertiliser for traders. It controlled wholesale and retail margins for the distribution of fertiliser. The fertiliser traders adhered to official prices set for 54 market centres throughout the country.

The pan-territorial and pan-seasonal price removed the risk of price instability in fertiliser purchase. This pricing system discouraged participation of private traders as it did not adequately take into account transport and distributional costs. Imported fertiliser was subjected to import duty. Donor aid fertiliser accounted for over half of total imports during the late 1980s. Poor coordination between donor aid and commercial imports frequently led to over- and under-supply of fertiliser.

By the early 1990s, the total amount of fertiliser used in Kenya was static. Fertiliser use stagnated around 174,000 to 285,000 metric tonnes over the past two decades despite government efforts to encourage its use. This was well below the potential level of use estimated at 600,000 metric tonnes (Omamo & Mose 2001; Nyangito & Karugia 2002a). Although the controlled pricing structure was designed to improve farmers' access to fertiliser, it nonetheless had the opposite effect. The government increasingly recognised that the structure did not ensure adequate margins for retailers to supply the relatively distant rural areas (Ariga *et al.* 2005). In particular, farmers in the more remote areas did not easily access fertiliser. The foregoing concerns led the government to reform its fertiliser marketing system.

In 1990, the government started removing some import quota restrictions. In 1991, fertiliser prices were decontrolled, and in 1992 the government abolished licensing requirements for fertiliser imports (Ariga *et al.* 2005). The objective of the fertiliser market liberalisation was to achieve efficient and timely importation and distribution of fertiliser. Abolition of import duty accompanied fertiliser market liberalisation (Mbithi & van Huylenbroeck 2000). The abolition of import duty had three objectives, to (1) encourage firms (cooperatives, farmer companies, farmer groups) to import fertiliser for their members, (2) create an incentive for the private sector to import fertiliser, thereby increasing their availability in the country, and (3) keep fertiliser prices low. To further encourage fertiliser use, the value added tax was removed in 1994. The aim of the policy shift was to make fertiliser easily available, cheaper, and provide farmers with information on its use.

In addition to the freeing of the foreign exchange rate regime in 1992, fertiliser market liberalisation led to a significant entry of new private sector firms in importing, wholesaling, distributing, and retailing of fertiliser. By 1993, donor imports dwindled to five percent of

total consumption, and since then, small-scale farmers have relied exclusively on private distributors and cooperatives for fertiliser (Wanzala *et al.* 2001).

There has been a widespread impressive private sector response to fertiliser market reform since 1993. Allgood and Kilungo (1996) reported that there were 12 major fertiliser importers, 500 wholesalers, and about 5,000 retailers, distributing fertiliser in Kenya. IFDC (2001) estimates that there are about ten active importers accounting for 95 percent of the total fertiliser imports, 500 wholesalers and 7,000 to 8,000 stockists across the country.

Following market liberalisation, annual fertiliser demand has risen steadily from 230,000 tonnes in 1992 to 370,000 tonnes in 2003. The entry of the private sector has played a major role in fertiliser importation and distribution. However, with the declining role of government amid an increasing number of private traders in the fertiliser business, a few cases of traders selling inferior quality fertiliser to farmers have been reported (Nyoro & Ariga 2004). In addition, with farmer concerns of high fertiliser prices in the North Rift, the government has renewed interest in fertiliser marketing. As a result the government has started to revive the Kenya Farmers' Association (KFA) as a farmers' organisation to take up bulky fertiliser imports. In 2004, the government through the NCPB imported and sold 30,000 metric tons. This new government intervention in marketing is likely to discourage private sector investment in fertiliser trade (Nyoro & Ariga 2004).

D) Liberalisation of maize seed marketing: process

Maize seed policies coincide with maize research in Kenya, which dates back to 1955. In 1956, the Kenya Seed Company (KSC), a quasi-private company was started to supply pasture seed and later maize seed to the settler farmers. The KSC had a monopoly to grow, process and distribute certified maize seed[4] (Smith *et al.* 2004).

The Seeds Ordinance Act of 1957 formed the basis for the Seeds and Plant Varieties Act (Cap326) of 1969. This is the key Act for the seed industry. It regulates transactions, includes provision for testing and certification of seeds and granting of property rights to breeders. The Act also gives power to impose restrictions on introduction of new varieties, control of importation of seeds, establishment of an index of names of plant varieties, and the establishment of a tribunal to hear appeals (Oluoch-Kosura 2004).

By the early 1990s, it had become apparent that the various Acts of Parliament governing the seed sector were fragmented and their administration inefficient. Per capita food production, especially maize, was declining due to factors such as poor quality seed, pests and diseases, and use of poor-quality fertiliser. These weaknesses necessitated a policy review to consolidate regulatory Acts and strengthen enforcement mechanisms. The result was the enactment of the Seeds and Plant Varieties Act, 1991 (see Box 1).

[4] KSC was a private company from its inception in 1956 up to 1976 incorporated under the Companies Act of 1956/7. After 1976, the government through the Agricultural Development Corporation (ADC) assumed a majority 52 per cent share of the company and KSC came under the ambit of the State Corporations Act of 1976. The other shareholders were Kenya Farmers'Association (KFA), farmers and KSC staff.

Box 1 The Seeds and Plant Varieties Act (1991)

The Seeds and Plant Varieties Act (1991) has sections on making laws, registration and licensing, evaluation of varieties (national performance trials and distinctiveness, uniformity and stability, inspection and certification, plant protection services and breeders' rights. These are organized into six parts which include: preliminary; seeds; seed testing; plant breeders' rights; the seeds and plants tribunal, and; a general section on powers, institutions, penalties and supplementary regulations. The Act established the Kenya Plant Health Inspectorate Service (KEPHIS), the Seed Regulations Committee and a Seeds and Plants Tribunal to register seed companies and arbitrate over aggrieved parties respectively. These institutions are mandated to develop and recommend policy for the industry, make standards, recommend registration or de-regulation of seed merchants, licensing and undertake national performance trials. Furthermore, they undertake inspection and certification fees, offer plant protection services, and ensure breeders rights/royalties and act as a moderator in cases of appeal of aggrieved persons.

Source: Government Printer, Nairobi.

Despite the 1991 Act, KSC continued to enjoy exclusive monopoly powers in seed production, processing and marketing. They also had sole access to publicly-bred varieties until the mid 1990. The Kenya Agricultural Research Institute (KARI) provided the publicly-bred seed to KSC at no cost. No other seed companies had been registered and foreign seed companies could not trade in Kenya.

Faced with problems of declining seed quality that recurred every planting season, the government came under intense pressure from stakeholders, including the donor community, to liberalise seed marketing. Seed marketing was liberalised in 1996, though the seed pricing system (pan-seasonal, pan-territorial price system) by KSC has not changed. The seed prices are reviewed annually. The seed industry was liberalised to improve seed purity and production, and marketing efficiency. Seed market liberalisation was also expected to provide farmers with a wide choice of high quality seed at competitive prices at the right place and time (Nyangito & Karugia 2002a).

Further to seed marketing liberalisation in 1996, KEPHIS was created to regulate the seed industry. KEPHIS was to establish a breeders-rights' office; license seed companies, and de-link KSC from the public sector research and extension. Two other seed companies, Western Seed Company and Oil Crops Development (now Faida), were licensed. At least 13 other maize seed companies are now in operation (Oluoch-Kosura 2004), nine of which are local while the rest are international. Seven of the companies deal in about 50 maize varieties.

To ensure seed companies had equal access to publicly-bred KARI seed varieties, KARI abolished KSC's exclusive rights to its materials. Subsequently, it introduced a system of paying royalties towards use of its varieties. Yet, the Kenya maize seed market is characterised by oligopolistic tendencies, where KSC controlled over 86 per cent of the market share (Oluoch-Kosura 2004). This would be attributed to KSC's unequal access to KARI released varieties. For instance, KSC enjoys exclusive rights to H614 (most popular

variety among farmers) even though public resources were used in its development (Oluoch-Kosura 2004).

The seed sector is currently regulated by about 32 different legislations, although four of them, the Plant Protection Act (Cap 324), Suppression of Noxious Weeds Act (Cap 325), Agriculture Act (Cap 318) and the Seeds and Plant Varieties Act (Cap 326) have the most direct influence. Besides creating multiple institutions to regulate the sector, the laws are neither functionally integrated nor administratively well coordinated. Besides, some of the laws are outdated and out of tune with the current realities.

Therefore, although the government liberalised the seed sector in 1996, many of the laws have not been revised to reflect the changes, leading to gaps, conflicts, contradictions and overlaps in the current system. For instance, the legal framework supports government controls while the policy framework, still in draft form since 1996, supports liberalised markets leading to misinterpretation and misunderstanding among the stakeholders.

In addition, importers of seed into the country face a number of restrictions that amount to trade barriers. The seed regulations provide that only registered companies may import seed for sale in the country, that the seed must comply with minimum standards contained in the regulations, and that they must have been tested for adoptability in Kenya. The sale of any imported seed is not permitted unless its quality has been assessed, tested and post-controlled. Imports must be accompanied by a phyto-sanitary certificate, an international orange certificate, and must meet Kenyan plant quarantine requirements. Companies must also issue a notice of intention to import against which an import permit must be issued. The requirements add substantially to costs and should therefore be reviewed (Ministry of Agriculture (MOA) 2004).

Nonetheless, between 1964 and 2003, 82 maize seed varieties from both local and international companies have been officially released. About 87 percent of the varieties were released between 1994 and 2003. However, seed companies have not taken up some of the varieties for multiplication. Overall, the choice of seed varieties has increased following market liberalisation (Kenya Plant Health Inspectorate Service 2003).

2.3 Opportunities / Challenges to market participants

Following the review of the market liberalisation process, several opportunities / challenges come out. We highlight four major opportunities/challenges that are evident: interlocked transactions; market information; quality; and finally, international trade.

First, market liberalisation eliminated interlocked transactions. During the era of state controls, farmers could access agricultural inputs and machinery from KFA and agricultural credit from AFC on the recommendation that they deliver maize to NCPB or deliver milk to KCC. On delivery of maize to NCPB and milk to KCC, deductions were made on behalf of KFA. This was an institutional arrangement to assist the farmers. On liberalisation, it became difficult to keep track of where farmers sold their produce. The pre-liberalisation, mainly single-market channel for maize and milk became multi-channelled. The window of

opportunity for interlocking transactions has not been taken up by the emerging private sector because of weak institutional arrangements in enforcing contracts. However, microfinance institutions fund some of the emerging traders to facilitate mainly maize trading activities, at interest rates as high as 5-10 per cent per month. Commercial banks rarely provide credit for agricultural activities.

Second, information on markets and market prices to market participants was not a major problem during the pre-liberalisation period. During this period, commodity prices and market information were known to all participants. The government gazetted commodity prices at the beginning of each season. Market liberalisation decontrolled commodity prices, leading to an asymmetric information flow. Large traders with greater ability to invest in information have an advantage over smaller traders and most small scale farmers. To take advantage of the opportunity that arose, a private sector initiative, the Kenya Agricultural Commodity Exchange (KACE) was established in 1997 (KACE 2005) to facilitate linkage between sellers and buyers of agricultural commodities, in addition to providing information on market conditions. However, its services are demand - driven and this arrangement locks out the small traders and farmers.

Third, before market liberalisation, the various marketing agencies addressed commodity quality concerns. For instance, the Kenya Dairy Board ensured milk quality along its marketing channel. However, serious concerns of commodity quality have increased with market liberalisation. With an increased number of traders, the various quality agencies are thin on the ground and cannot effectively assure quality of the commodities sold. Existing legislation on penalties for quality adulterations are lenient. For instance, a trader found adulterating fertiliser is only fined a maximum amount of Ksh 2,000, which is equivalent to less than two 50-kg bags of fertiliser A stiffer penalty on marketers adulterating product quality is one option, while self-regulation of market participants may be another.

Fourth, competition arising from international trade is expected to increase in coming years for local farmers. Currently, the impact is seen in several supermarket chains selling milk products from international markets, notably South Africa. Kenya is a signatory to the East African Community (EAC), the Common Market for Eastern and Southern Africa (COMESA) and the World Trade Organisation (WTO). While consumers are expected to benefit from increased competition, domestic agricultural prices are likely to be depressed. This calls for increased efficiency in production of maize and milk.

2.4 Further consequences of market liberalisation

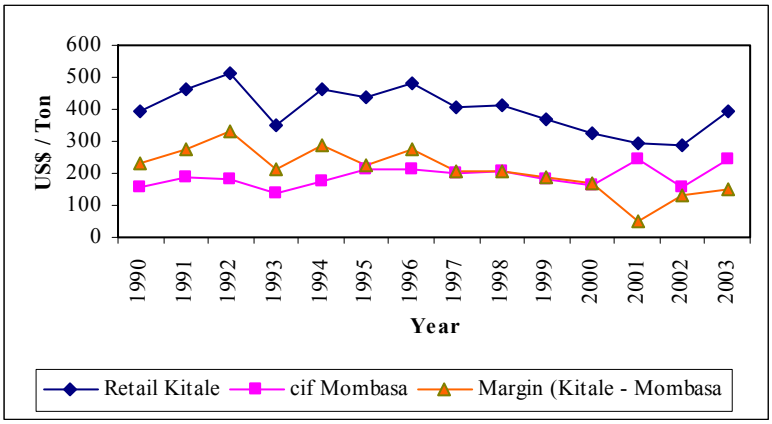
The available evidence on the consequences of marketing reforms have mainly concentrated on input availability, level of input prices at the farm gate, and producer prices at the farm-gate for the various commodities. This study moves a step further by examining the level of margins between fertiliser, in particular Di-ammonium Phosphate (DAP) retail price and world price, and also by comparing the margin between maize producer price and the world market price. The results obtained from the analyses will give insights into the performance of

the fertiliser and maize markets before and after market liberalisation. In addition, the wholesale maize market integration for major maize marketing centres is examined.

2.4.1 Distribution of marketing margins

Trends in commodity prices and domestic marketing margins are important indicators of market performance. In this section we examine the marketing margins for fertiliser and maize. First, we examine the marketing margins between the world price of DAP, (c.i.f., Mombasa) and the retail price (Kitale). Second we examine the marketing margins for maize between the producer price (Kitale) and world price (f.o.b., US Gulf). The margins reflect the transfer costs and the mark-ups for the various actors in the marketing chain. Market liberalisation was expected to result in the narrowing of marketing margins between market points, reflecting the reduced marketing costs of a more competitive and efficient distribution process.

Fig. 2.1 presents a comparison of the trends between the cif –Mombasa and the retail DAP price at Kitale with their corresponding marketing margins.



Source: author

Fig 2.1 Trends: Margin between cif Mombasa and Kitale retail price

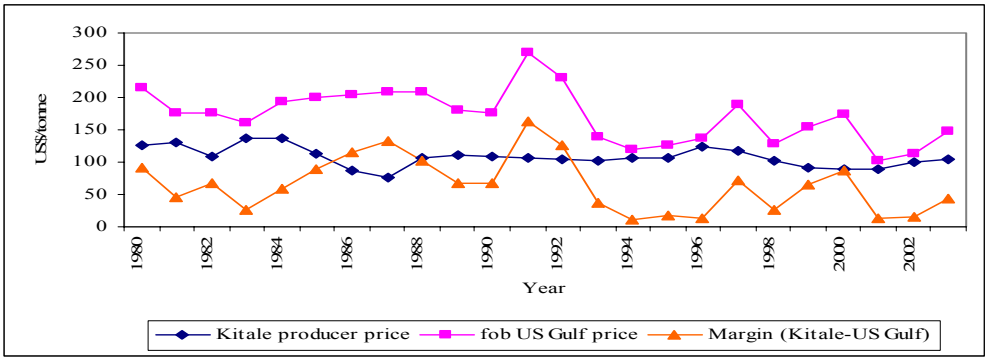
The mean (standard error) of the marketing margin between 1990 and 2004 was US$ 210 (19.2). The yearly margin between cif Mombasa and retail price Kitale ranged between 50 and 100 percent of the c.i.f. Mombasa price, reflecting high domestic costs. The increased world fertiliser prices in recent years, differences in the exchange rate, the costs of freight and insurance, and high domestic handling costs, bagging, various institutional levies, transportation costs and mark-ups for the various traders in the fertiliser marketing chain explain the apparent high nominal retail price of DAP in Kitale.

Despite the inter-year variations in marketing margins observed, there is a declining trend in DAP price margins. This perhaps reflects some measure of increased efficiency in fertiliser trading in recent years. This would probably reflect increased competition along the marketing chain and increased synchrony between fertiliser deliveries at Mombasa and its

availability in Kitale. Increased trader synchrony minimises warehousing duration and subsequent storage costs.

Similarly, we investigated the distribution of margins between world (US Gulf) maize prices and producer prices of maize at Kitale. Overall, although the fob US Gulf prices showed some variation, they oscillilated around the US $ 100 per tonne mark, whereas inter-year variations for Kitale producer prices wandered greatly, ranging from US$103-US$270 per tonne, reflecting the unstable production environment. The fluctuating weather conditions, untimely availability of inputs, fluctuating exchange rate, and in some cases, policy reversals regarding maize marketing characterise the unstable production environment.

The results (Fig 2.2) indicate that inter-year margins vary, but overall the mean (s.e) price margin for the pre-liberalisation period (1980-1994) was US$ 80 (10.7) per tonne, whereas it was US$ 39 (9.5) per tonne for the post liberalisation era (1995-2003). Overall, the price margin was US$ 65 (8.7) per tonne for the entire period. There are significant differences ($t(22) = -2.54$, $p<0.05$) between the margins during the pre-liberalisation and post-liberalisation periods. The declining trend in margins points to a possible increase in efficiency of maize marketing. This would partly be attributed to increased competition and competitive pricing unlike the administered government prices during the pre-liberalisation era.



Source: author

Fig 2.2 Trends: Margin between fob US Gulf and Kitale producers' price

2.4.2 Maize market integration

We now assess the wholesale maize market integration in Kenya. In addition to price changes, an understanding of wholesale maize market integration in Kenya requires knowledge of maize trade flows. Both external and internal maize sources influence its trade flows.

Kenya produced an annual average of 2.2 million metric tonnes of maize, between 1997 to 2002, whereas mean annual consumption was estimated at 2.6 million metric tonnes (RATES 2003). Domestically, wholesale traders obtain maize supplies from farmers in high production areas or from other wholesale markets where arbitrage allows. The major producing areas include North and South Rift, and high potential areas of Western Province. The major maize deficit areas are in Eastern Kenya. They mainly comprise Machakos, Kitui,

Mwingi, Makueni and Mombasa districts. Internally, maize moves from Western Kenya to Eastern Kenya. There are also internal maize movements within Western Kenya particularly to the maize deficit districts of Kisumu and Siaya.

Kenya has on average become a net maize importer since the early 1990s. Most of the imported maize is obtained from East Africa in addition to supplies from as far south as Malawi, Zimbabwe and South Africa. Within East Africa, seasonality plays a role in providing opportunities for trade. Figure 2.3 shows the seasonal availability of maize (shaded portion) within East Africa.

	Jan	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***
Kenya	▒	▒	▒	▒					▒	▒	▒	▒
Uganda	▒	▒	▒	▒	▒			▒	▒	▒	▒	▒
Tanzania	▒	▒					▒	▒	▒	▒	▒	▒

Source: RATES, 2003

Fig 2.3 Maize availability calendar

The maize availability calendar shows opportunities for regional trading throughout the year. It is only in June that maize is not available in East Africa. However, during this period, maize could be supplied from Malawi and Zimbabwe who are at harvest. Opportunities to trade in Kenya are high between May and August when maize supplies are low and prices tend to increase. The marketing period seems to coincide in all countries between September and February when all countries have maize to trade.

In addition to seasonality, liberalisation of the maize markets in the region implies that the private sector engages in maize trade alongside government agents (RATES 2003). However, market information, infrastructural limitations, policy and regulatory constraints impede regional trade.

The restrictive trade practices encourage informal cross-border trade with high transaction costs and therefore high prices for the importing consumers. For instance, within the East African Community (EAC), comprising Kenya, Uganda and Tanzania, maize imports attract an import tariff of three, four and five percent in Kenya, Uganda and Tanzania, respectively. In addition, Kenya and Uganda levy import declaration fees or a commission on maize imports exceeding US $5,000. Other non-tariff barriers include phyto-sanitary certificates and technical quality specifications such as maize moisture content. Maize imports into Kenya should have a maximum moisture content of 13.5 percent. In Uganda, the allowable moisture content is 13 percent whereas in Tanzania, the allowable moisture content is 14 percent. The requirements further restrict maize movements across formal border crossings.

Nonetheless, following RATES (2003), trade takes place and maize trade flows through the following major routes.

1. High quality white maize from eastern Uganda flow into Kenya through Suam and Malaba deeper into Kitale.

2. Coloured maize from central Uganda flows as far as Kisumu and Nairobi. The maize is of lower quality and high moisture content. The maize attracts lower prices than white maize dampening prices of white maize in major maize consuming areas.
3. Maize from Tanzania's Lake Victoria Basin gets into southwestern Kenya to major consuming areas as far as Kisumu. The reverse flow to the Lake Victoria Basin occasionally occurs from major producing areas of South Rift.
4. Maize from/through Kilimanjaro and Tanga areas of Tanzania flows wide and deep into southeastern Kenya, including Nairobi and Mombasa. Maize coming from as far as Southern Tanzania, Malawi and Zambia passes through this route.
5. Southern Africa imports pass through Mombasa. They are, however, expensive as they are subject to a 25 percent import tariff.

Product flows between regions can be determined by spatial equilibrium models. These models determine the equilibrium levels of production, consumption and prices in each region and the equilibrium trade flows within the regions (Takayama & Judge 1971; Martin 1981). This is beyond the scope of this study. Table 2.1 provides information on maize production in, exports from and imports into Kenya. The data indicate that both domestic supplies and external trade in maize influence market integration in Kenya.

Table 2.1 Maize production, exports and imports (metric tonnes) - Kenya

	1997	1998	1999	2000	2001	2002	2003	2004
Prod'n	2,214,000	2,464,101	2,322,140	2,160,000	2,790,000	2,408,596	2,710,848	2,138,425
Exports	2,636	9,124	30,489	1,867	421	30,059	8, 165	14, 538
Imports	1,101,105	368,721	73,520	409,416	314,381	16,348	100,132	241,757

Source: FAOStat, 2006. legend: prod'n = production

2.5 Market integration: theory, hypotheses and modelling

2.5.1 Theoretical aspects

Market integration refers to the extent to which events in one section of a market has an impact on events elsewhere in the same market. It is concerned about linkages among markets. Broadly, market integration between two or more markets is a multidimensional concept implying similarity in price variation (price integration), standardisation of measures and common trade habits (Wyeth 1992). Price integration is one of the several necessary conditions for market integration.

In a competitive market, price integration is the outcome of an arbitrage process: exchange (trade) between actors in different markets who aim to take advantage of price differences that exceed transaction costs. Market imperfections such as entry or exit barriers and insufficient market information hinder the integration of markets. Narrowly, market integration is defined as the extent to which changes in prices in one part of the market lead to

changes in prices in another part of the market (Wyeth 1992). This study has adopted this definition.

Four forms of market integration are distinguishable – integration across space, time, product forms ((Timmer *et al.* 1983; Tomek & Robinson 1990), and within the marketing chain (Wyeth 1992). Two markets in different locations are said to be spatially integrated[5] if, when there is trade between the markets, the price in the importing market equals the price in the exporting market plus transfer costs between them. In stating the 'spatial arbitrage' conditions, trade occurs if

$$p^i{}_t + z^{ij}{}_t \leq p^j{}_t \tag{2.1}$$

where $p^i{}_t$ denotes the price of a good in the exporting market in period t, $p^j{}_t$ denotes the contemporaneous price of the good in the importing market in period t, and $z^{ij}{}_t$ denotes the transfer costs in the same period. The incentive to trade will be non-existent if

$$p^i{}_t + z^{ij}{}_t > p^j{}_t \tag{2.2}$$

In such a case, markets will be segmented and price movements in one market will be irrelevant to price movements in another market. Markets for the same commodity in the same country are rarely segmented. However, rare segmentation may occur under situations of natural calamities or civil strife (Goletti & Babu 1994; Dercon 1995). Sarpong and Asante (2002) state that markets are integrated across time when the expected price difference does not exceed the physical and financial costs of storage. They also state that markets are integrated across product form when the differential price between two related commodities does not exceed processing costs. Vertical integration occurs when there is integration among producer, wholesale and retail markets for the same product in a given area (Wyeth 1992). The current study concerns spatial market integration.

The extent of market connectedness ranges between perfect market integration and complete market disconnection or segmentation. Perfect integration occurs if the price in one market is an exact translation of the price in another market. This implies that price changes are fully transmitted between the two markets. Absence of any price relationship could indicate market segmentation. Neither perfect integration nor segmentation has been observed in real markets. It is intermediate degrees of integration that occur between the two extreme cases that are found in the real world.

Market integration is influenced by a number of factors such as: the quality and quantity of transport and market infrastructure; the number of traders; the level of competition among traders; and the extent of information flow among markets. Sexton *et al.* (1991) summarise three factors that may contribute to a lack of market integration. First, markets are not linked by arbitrage i.e. they are autarkic. This may occur because transaction costs are

[5] Also referred to as horizontal or geographically integrated

prohibitive in relation to price differences or due to public market protection. Second, there may be impediments to efficient arbitrage, such as trading barriers, imperfect competition or risk aversion. Similarly, Lutz *et al.* (1995) argue that characteristics of agricultural production, marketing and consumption could impede efficient arbitrage. Lutz *et al.* (1995) specifically single out seasonality, fragmented supply and demand, inadequate infrastructure, market entry barriers, and unreliable market and price information as some of the constraints to efficient arbitrage. Third, imperfect competition would influence market integration. This would occur as a result of collusion among traders or preferential access to scarce resources such as credit and transport. This may result in higher price differences between markets than can be attributed to transaction costs. Other authors (Timmer 1974; Faminow & Benson 1990) observe that vast distances and poor infrastructure lead to high transaction costs, thereby making arbitrage unprofitable and eventually isolating markets.

There are several reasons why prices in different markets might co-move even when there is no direct causation. First, seasonality in agriculture can lead to common supply-induced price changes in markets which may be completely unconnected. Seasonality elements could be drought- related or high-rainfall related. The "integrated" aspect of market integration, however, implies that a price change in one part of the market is actually generating corresponding changes elsewhere. Second, markets could be integrated as a result of monopoly control either through the private sector or by a state marketing board. State boards often have monopolies to ensure that supplies arrive in areas that they may not otherwise reach. In these cases, although the market may be imperfect and boards inefficient, state control aims specifically to improve market integration. The third aspect may occur as a result of inflation.

Generally, market liberalisation could be expected to encourage spatial integration – the movement of products from a low-priced to a high-priced market. This in turn may reduce price gaps between some markets while raising them between other markets. Thus, market liberalisation and increased arbitrage should reduce inter-market price spreads. Goletti and Babu (1994) argue that the success of market liberalisation policy depends on the strength of transmission of price movements among the markets in various regions of the country. Integration of the markets is essential in order to transmit the intended incentives of liberalisation to the beneficiaries.

The issue of market integration in sub-Saharan Africa after market liberalisation has been a subject of a number of studies ((Alderman 1993; Dercon 1995; Alderman & Shively 1996a; Badiane & Shively 1998; Abdulai 2000; Sarpong & Asante 2002; Kuiper *et al.* 2003). With market liberalisation in place in many countries, knowledge on consequences of the policy change to economists is vital. Gains from liberalisation to farmers, especially, depend on the integration of markets.

Markets that are isolated may convey inaccurate price information that might distort producer-marketing decisions and contribute to inefficient product movements (Alderman & Shively 1991). Furthermore, given that ecological conditions often influence differences in

regional crop production patterns, governments may be interested in knowing the relationship of price movements of staple foods in different regions. In particular, knowledge on market integration can be useful to countries where famine early-warning systems are needed. It may also provide information where government effort should be concentrated (e.g. provision of infrastructure) to assure food security in a country.

Evidence from previous studies indicates that liberalisation has improved market integration in Malawi (Goletti & Babu 1994); Ethiopia (Dercon 1995); Benin (Lutz *et al.* 1995) and Ghana (Badiane & Shively 1998; Sarpong & Asante 2002). For example, Goletti and Babu (1994) attribute the increased pattern of maize market integration after market liberalisation to the capacity of the private sector to respond to the new operating environment and the improvement in the extent of price transmission across spatially separated markets. Dercon (1995) finds that liberalisation had important effects on the long-run and short-run integration of food markets in Ethiopia. The short-run test results show that liberalisation clearly improved the functioning of markets: an increasing number of markets became linked to the price movements in Addis Ababa.

Previous studies (Alderman 1993; Dercon 1995; Badiane & Shively 1998) generally assume the presence of a symmetric price response. This means that a shock of a given magnitude to the central market would elicit the same response in the local markets. This could happen regardless of whether the shock reflected a price decrease or increase. However, as documented in the literature on price relationships, certain characteristics associated with imperfect competition such as market concentration and government intervention, in addition to inventory behaviour of traders, can contribute to asymmetric price response (Scherer & Ross 1990; Roberts *et al.* 1994; Abdulai 2000). Abdulai (2000) supports the asymmetric price response hypothesis. He finds that wholesale maize price transmission from the central market (Techiman) to local markets (Accra and Bolgatanga) is asymmetric. Increases in maize wholesale prices in the central market appear to be passed on more rapidly to local markets, while price reductions take somewhat longer to get through to local markets (Abdulai 2000).

Presence of market integration implies causality. Causality occurs when lagged values of market B can be used to forecast values in market A. If this is the case, then market B prices are said to Granger cause market A prices. If market B Granger causes market A, and market A Granger causes market B, then feedback relations between the two markets occur. Only when the causation is unidirectional, can we use the past prices of one market to forecast the prices in the other market. If the analysis can identify one market that Granger causes other markets, without being Granger caused by them, that market can be interpreted as a central market. If there is only one central market, then there is a situation that is best described by a radial model (Goletti & Babu 1994).

In a radial model of price transmission, prices in each market are dependent on their own past values and on current and past values of the central market price (Ravallion 1986). In this regard, the central market must be an important supply centre or maize consumption

demand centre, so that any supply/price changes in that market will influence similar changes in other markets.

Previous empirical studies provide mixed results on the existence of central markets. Abdulai (2000) observes that wholesale maize prices from Techiman (the central market) are rapidly transmitted to the local markets. He attributes this observation to the position of Techiman as a feeder market from the maize producing regions in Brong-Ahafo. In Ethiopia, Dercon (1995) observes that maize prices in Addis Ababa (the central market) are radially transmitted to other markets. However, the Addis Ababa market is not integrated with Gojjam market despite direct road connections and proper communications. He attributes this to inadequate effective number of grain traders with adequate capital and skills.

It is clear from the foregoing discussion that many factors influence market integration. Results of previous studies on market integration after market liberalisation vary from country to country and even within a country. The results are varied due to differences in factors such as existing state of competition, extent of supply and demand, information flow and the state of infrastructure. It is difficult to generalise the results of one or several country experiences to another country.

Hypotheses

Based on the review of the theoretical and empirical work, the following hypotheses are formulated.

1. With most of the constraints to market integration removed or lessened, this study hypothesizes that the wholesale maize market is integrated.
2. Given seasonality of production which is dispersed across Kenya and varying maize imports each year, it is hypothesized that there is no central market for wholesale maize trade in the country.

2.5.2 Modelling market integration

Correlation analysis, regression analysis and cointegration analysis are the three common methods used to determine market integration. A brief description of each method follows below.

A) Correlation analysis

A correlation is a measure of linear relationships between variables. Determining the correlation coefficients among prices in spatially separated markets or among actors in the marketing chain indicates the extent of market integration. This method is commonly used to measure market integration partly because it requires less mathematical rigor (Goetz & Weber 1986; Heytens 1986). One tempting error to make when using correlation analysis is to assume that high correlation coefficients, indicating that prices co-move, imply that markets are integrated. This is not always true because parallel movements in prices can occur for

many reasons other than the integration of markets. Parallel price movements may occur because of similar seasonal influences between markets. They may also occur because of inflation or fluctuations in transport and other marketing factors that affect both markets simultaneously. Another error is to assume that low correlation coefficients imply low degree of market integration. There are cases where correlation coefficients for prices between markets are low and yet the markets are well integrated. As Blyn (1973) argues, this could characterize markets which are both important supply and consumption centres.

The biggest danger with correlation analysis is probably inferring market integration when there is none. Yet, low correlation coefficients from a correctly implemented analysis, probably imply poor integration. Conversely, if the data are good enough and if there is sufficient subjective understanding of the market to allow sensible interpretation of the results, correlation coefficients may provide an easy method of gaining a general view of the patterns of market integration.

B) Regression analysis

Regression techniques for assessing marketing integration are based on the 'Law of one price'. The law involves tests for the integration of markets. It involves the regression of the current price change in one market on the price changes in another market (Richardson 1978). If p^i_t and p^j_t denote prices of a homogenous good in the exporting and importing market in period t, the following equation is estimated

$$\Delta p^i_t = \alpha + \beta \Delta p^j_t + \varepsilon_t \qquad (2.3)$$

The null hypothesis that $\alpha = 0$ and $\beta = 1$ is then tested using a standard F-test. Rejecting the null hypothesis implies rejecting the 'Law of One Price'.

Ismet *et al.* (1998) indicate that weakness in the 'Law of One Price' approach is the implication that trade flows must occur in every period. Yet, non-random changes in transfer costs may cause the model to reject market integration when spatial arbitrage actually holds, and a choice must be made between absolute and proportional marketing margins as a maintained hypothesis. Another assumption the authors maintain is that prices in one market are exogenously determined using this approach.

Following these criticisms, Ravallion (1986) developed a regression approach which Timmer (1987) later modified. This approach assumes that prices in outlying areas of a market are dominated by prices in a single central or reference market (Wyeth 1992) mathematically expressed as:

$$P_i = f_i (R, X_i) \quad \text{for } i = 1,\ldots,N \qquad (2.4)$$

where *p* is the price in the local market, *i*, *R* is the price in the reference market and *X* is a vector for market *i* which includes other variables, such as seasonal factors. At the same time price in the reference market is a function of prices in all the local markets, as follows:

$$R = f(P_1,\ldots, P_N, X) \tag{2.5}$$

Allowing for the effects of price changes over time, a dynamic structural model is estimated as

$$P_{it} = a_i P_{it-1} + b_{iO} R_t + b_{i1} R_{t-1} + c_i X_{it} + \varepsilon_{it} \qquad \text{for } i = 1,\ldots,N \tag{2.6}$$

In order for equation (2.6) to be estimated by OLS, it is rewritten in the form of an error correction mechanism as

$$P_t - P_{t-1} = d_0 + d_1(P_{t-1} - R_{t-1}) + d_2(R_t - R_{t-1}) + d_3 R_{t-1} + d_4 X + \varepsilon_t \tag{2.7}$$

where P = price (say of 1kg of maize) in the local market in the period referred to in the subscript "t".
R = price (say of 1kg of maize) in the reference market in the period referred to in the subscript "t".
X = exogenous seasonal or other trend variables that may influence prices independently of the reference market.
d_i = the estimated coefficients of the independent variables
ε_t = random error term in period t.

The exogenous variables represented in the equation by "X" appear in the equation as dummies for trend (assumed to consist mainly of inflation) and seasonal variables.

For purposes of interpreting the regression results, Timmer (1987) constructed an Index of Market Connection (IMC), which is based on two of the coefficients of the regression equation. The IMC = $(1+d_1)/ (d_3-d_1)$ where d_1 and d_3 are the local market and the central (reference) market coefficient, respectively. The coefficient $(1+d_1)$ reflects the relative contribution of the local market price history on the formation of the current local market price level. The coefficient (d_3-d_1) reflects the relative contribution of the reference market price history to the formation of the current local market price level. The nature of the coefficients is such that it will be smaller for better integrated markets and higher for markets which are less well integrated. As a rule of thumb, Timmer (1987) suggests that markets can be considered well-integrated in the short run whenever the index is less than one and the market is less integrated in the short run if the index is greater than one. This is an arbitrary guideline that has no obvious econometric foundation. If the IMC is used, therefore, it is probably best to see how it moves over time or compares between markets, without taking too much notice of its absolute value.

The Ravallion approach has two problems. First, it assumes that a central market is exogenous to other markets. This may not always be the case. Second, it is not amenable to modeling trends which are likely to exist in time series data.

C) Cointegration analysis

Cointegration analysis allows a detailed study of price co-movements. Whereas cointegration analysis allows us to say something about causality, Goletti and Babu (1994) argue that it is not powerful enough to highlight possible uses of market integration studies for policy analysis, such as (a) strength of the relationship between two markets; (b) the period a shock takes to be transmitted from one market to another; and (c) if price transmission is symmetric or not. Nonetheless, this study uses cointegration analysis to study maize marketing integration in Kenya.

Cointegration analysis provides a way of maintaining the validity of the Ravallion equations by using cointegrated series. The cointegrated series are stationary, that is, they have no trend of any sort. The extent to which a series is integrated depends on how many times a difference has to be taken before it becomes stationary. If the series is to be differenced once before it is stationary, then the first difference is stationary i.e. $\Delta y_t \sim$ I (0), and the series is itself integrated of order one. Determination of market integration using the cointegration techniques is a sequential procedure.

First, each price series is determined for order of integration. The Augmented Dickey Fuller (ADF) test or the Phillips-Perron (PP) test is used to investigate the order of integration in each individual series. The first stage is to test whether each series is stationary i.e. I (0). If the null hypothesis of nonstationarity cannot be rejected, that is the absolute value of the ADF statistic is smaller than the critical ADF value, then the next stage is to test whether the first differences are stationary. If the null hypothesis of nonstationarity cannot be rejected, then the series is still not stationary. Therefore, continue differencing until the series becomes stationary and note the order of integration.

Second, the integrated series are tested for cointegration. If the series to be investigated are both integrated with the same order, the next stage is to investigate whether they are cointegrated with each other and this is done either through the Engle-Granger two-step procedure or the Johansen's multivariate framework. In the Engle-Granger approach a linear regression using OLS is estimated then the residuals saved. The residuals are tested for stationarity using either the ADF or PP test. If the null hypothesis of non-stationarity is rejected, then the series are stationary and hence have a long run relation. However, this approach is limited only to single equation estimation. This study uses the Johansen's multivariate approach. Following Thiele (2002), the Johansen procedure is based on the maximum likelihood estimation of the error correction model as in (2.8).

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-1} + \Pi X_{t-1} + \varepsilon_t \qquad (2.8)$$

where X denotes the vector of endogenous variables, Γ_i the matrix of short run coefficients and Π, the matrix of long-run coefficients. ε_t is the vector of independently normally distributed errors.

The matrix Π contains the cointegrating vectors and a set of loading vectors which determine the weight of the cointegrating vectors in each single equation. By means of normalization, the cointegrating vectors can be identified from the estimated Π matrix. To determine the number of cointegrating relationships *r*, the Johansen's procedure provides two likelihood ratio tests: the trace (TR) and maximum eigenvalue (MAX) test. The trace statistic tests the null hypothesis of *r* co-integrating relations against the alternative of *k* cointegrating relations, where *k* is the number of endogenous variables, for r = 0, 1,…, *k*-1.

$$\text{TR (r/k)} = \text{T} \sum_{i=r+1}^{k} \ln(1 - \lambda_i), \tag{2.9}$$

where λ_i is the i-th largest eigenvalue in the Π matrix and T is the sample size. The maximum eigenvalue statistic tests the null hypothesis of *r* cointegrating vectors against the alternative of *r* + 1 cointegrating vectors. It is computed as

$$\text{MAX (r / r + 1)} = \text{-T ln(1-}\lambda_{r+1}\text{)} \tag{2.10}$$

The third step involves determination of causality and exogeneity. If two price series are integrated and they are also *'cointegrated of order 1,1'*, then there must be some causality in one direction or the other between the two price series (Wyeth, 1992). Causality reflects the fact that price changes in the location towards which causation moves, occur both after, and in a way which is related to price changes in the location from which the causation comes.

To test for Granger causality, Eviews (EVIEWS 1994), runs bivariate regressions in the form

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + ... + \alpha_l y_{t-l} + \beta_1 x_{t-1} + ... + \beta_l x_{t-l} \tag{2.11}$$
$$x_t = \alpha_0 + \alpha_1 x_{t-1} + ... + \alpha_l x_{t-l} + \beta_1 y_{t-1} + ... + \beta_l y_{t-l} \tag{2.12}$$

for all possible pairs of (x,y) series in the group. The reported F-statistics are the Wald statistics for the joint hypothesis

$$\beta_1 = ... = \beta_l = 0 \tag{2.13}$$

for each equation. The null hypothesis is therefore that *x* does not Granger-cause *y* in the first equation and *y* does not Granger-cause *x* in the second equation. For instance, if we cannot

reject the hypothesis that *x* does not Granger cause *y*, then the F-value is insignificant (P<0.1). Conversely, if the null hypothesis is that y does not Granger-cause x, and the F-value is significant (P<0.1), then we reject the null hypothesis that *y* does not Granger-causes *x*. The two tests show that the Granger causality runs one-way, from *y* to *x* and not the other way.

2.5.3 Data and empirical model for maize market integration in Kenya

Cointegration analysis and error correction modelling were applied to monthly wholesale real price data (expressed in logarithms) for six maize markets spread all over Kenya. Kitale (Ktl), Eldoret (Eld) and Nakuru (Nkr) are located in maize surplus regions while Nairobi (Nbi), Kisumu (Ksm) and Mombasa (Msa) are located in maize deficit regions. The collected wholesale nominal prices were deflated by the Nairobi lower income- group consumer price index with February 1986 as the base year. The price series cover January 1992 to April 2004 with a total of 148 observations. We examine the results of the descriptive statistics in the next section.

2.6 Market integration results

The market integration results are presented in four parts: the descriptive analysis and the cointegration results, error correction models and causality. We first present the descriptive analysis results.

A) Descriptive analysis results

Table 2.2 provides descriptive results of wholesale real price of the six markets. In order to obtain the real wholesale monthly maize prices, the nominal wholesale maize prices are deflated with the Nairobi lower income group consumer price index (February, 1986 = the base year). The analysis is divided into three periods: pre-liberalisation (January 1992 to December 1994); post-liberalisation (January 1995 to April 2004); and for the whole sample (January 1992 to April 2004).

Table 2.2 Summary statistics of wholesale maize real prices for six markets in Kenya

Whole sample (1992_1 to 2004_4)		Nairobi	Kitale	Eldoret	Kisumu	Mombasa	Nakuru
N=148	mean	205.14	166.52	175.93	198.48	215.58	184.94
	s.e	4.45	4.63	4.93	4.57	5.58	4.41
	variance	2926.16	3168.14	3601.06	3094.04	4612.91	2882.21
	minimum	100.5	65.8	71.3	104.4	108.2	81.1
	maximum	370.4	357.1	361.7	373.6	528.8	329.6
Pre-liberalisation (1992_1-1994-12)		Nairobi	Kitale	Eldoret	Kisumu	Mombasa	Nakuru
N=36	mean	264.13	215.96	238.28	245.88	298.95	240.2
	s.e	8.32	9.15	7.92	9.01	12.16	6.58
	variance	2494.84	3013.08	2257.05	2925.43	5327.45	1560.74
	minimum	192.8	111	145.4	154.7	209.3	150.7
	maximum	370.6	357.1	361.7	373.6	528.8	329.6
Post –liberalisation (1995_1-2004_4)		Nairobi	Kitale	Eldoret	Kisumu	Mombasa	Nakuru
N=112	mean	186.18	150.63	155.89	183.25	188.79	167.18
	s.e	3.78	4.43	4.62	4.44	3.60	4.24
	variance	1597.28	2198.15	2391.61	2212.21	1450.73	2016.29
	minimum	100.5	65.8	71.3	104.4	108.2	81.1
	maximum	263.4	313.9	304.1	312.7	279.8	284.3

Source: author's computation

As expected, Table 2.2 shows that Kitale and Eldoret (located in surplus regions) have low mean prices while Mombasa and Kisumu (located in deficit regions) have high mean prices. Overall, the mean wholesale real price of maize has decreased over time. Results of the analyses of variance (ANOVA) for prices in the various markets in the different periods indicate that prices in the different markets are statistically different from one another: mean prices for the whole sample were statistically different among different markets [$F(5,882) = 15.09$; $P<0.01$]. For the pre-liberalisation sample, the ANOVA results were $F(5, 210) = 9.84$; $P< 0.01$ whereas for the post –liberalisation sample the ANOVA results were $F(5, 666) = 15.27$; $P<0.01$. Though there was a decline in wholesale prices in the markets between the pre- and post-liberalisation periods, the highest decline is observed in the markets located in surplus maize-producing regions.

The increasing number of traders following market liberalisation has resulted in increased competition and probably explains the decrease in price in the major markets. The prevailing prices reflect supply/demand conditions in the markets. Furthermore, due to inadequate farm-storage, farmers tend to sell their maize immediately after harvest (Nyameino *et al.* 2003a). This partly explains the relatively low maize prices in markets located in surplus regions.

B) Cointegration analysis results

Test of stationarity

The first step in cointegration analysis is to determine whether the price series from the various markets are stationary, and if not to investigate their order of integration. Stationarity tests were applied using the model with a constant and linear trend as provided in EVIEWS. Using both the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test, Table 2.3 shows that at the price levels, the null hypothesis of unit roots is not rejected at five percent for all markets. When the price series are differenced once, they all become integrated, and the null hypothesis of unit roots is rejected at five percent level. Therefore, the price series for the six markets under study are integrated of order one. This means that the series have a constant mean and variance which are independent of time (Harris 1995).

Table 2.3 Unit root tests for wholesale price series

	Augmented Dickey- Fuller (ADF)		Phillip-Perron (PP) test	
Series	Levels (3 lags)	Differences (3 lags)	Levels	Differences
lnrNbi	-3.322ns	-8.612***	-2.767ns	-9.685***
lnrKtl	-3.177ns	-9.506***	-2.890ns	-9.353***
lnrEld	-2.980ns	-10.630***	-2.710ns	-10.625***
lnrKsm	-2.822ns	-7.178***	-2.794ns	-9.371***
lnrMsa	-2.944ns	-7.553***	-3.131ns	-12.104***
lnrNkr	-2.820ns	-11.193***	-2.760ns	-11.174***
	1 %=-4.022; 5%=-3.441; 10%=-3.145		1%=-4.022; 5%=-3.441; 10%=-3.145	

Source: author's computation

* significant at P < 0.10 significance level; ** at P<0.05 significance level; *** at P<0.05 significance level

The next step involves checking for cointegration among the price series. Johansen's multivariate procedure was used to determine the presence or absence of cointegration among the integrated series. Using Akaike Information Criterion (AIC), a lag length of 3 was chosen and is used in the cointegration test estimated with a linear deterministic trend. The results of the cointegration tests summarised in Table 2.4 indicate that there is cointegration among the price series. This implies that even though the markets have significant short-run divergences, long-run relationship(s) among the various maize markets exist(s). Both the trace and maximum eigenvalue tests have a rank (Π) of three at the 95 percent significant level. The rank is the number of cointegrating relationships.

Table 2.4 Cointegration test results

Trace Test				
Rank	*Eigenvalue*	*Trace statistic*	*0.05 critical value*	*Prob.***
None*	0.278	156.57	117.71	0.0000
At most 1*	0.248	109.64	88.80	0.0007
At most 2*	0.205	68.50	63.88	0.0194
At most 3	0.101	35.55	42.92	0.2232
At most 4	0.083	20.15	25.87	0.2182
At most 5	0.052	7.64	12.52	0.2821
Maximum eigenvalue test				
Rank	*Eigenvalue*	*Max-Eigen statistic*	*0.05 critical value*	*Prob.***
None*	0.278	46.93	44.50	0.0266
At most 1*	0.248	41.14	38.33	0.0232
At most 2*	0.205	32.95	32.12	0.0395
At most 3	0.101	15.39	25.82	0.5990
At most 4	0.083	12.51	19.39	0.3691
At most 5	0.052	7.64	12.52	0.2821

Source: author's computation

Both the Trace test and Maximum eigenvalue tests indicate 3 cointegrating equations at the 0.05 level.

* denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-value

Testing for long-run price integration

We focus on the long run cointegration of the price series by analysing the normalised cointegrating coefficients (β). To estimate the cointegrating coefficients β, we use the Johansen's test as implemented in EVIEWS. The cointegrating coefficients β estimated above when the rank = 3 are presented in appendix 2.1. If we normalise with respect to wholesale price in Nairobi, Kitale and Eldoret, the three normalised cointegrating equations are as follows:

Table 2.5 Long-run price integration

lnrNbi =	$1.27*10^{E-04}$T +	0.094lnrksm -	0.228lnrmsa –	0.752lnrnkr
	$(3.3*10^{E-04})$	(0.108)	(0.086)**	(0.108)***
lnrKtl =	$-1.5*10^{E-03}$ T -	0.886lnrksm -	0.531lnrmsa +	0.035lnrnkr
	$(4.6*10^{E-04})$***	(0.146)***	(0.117)***	(0.146)
lnrEld =	$-2.3*10^{E-03}$ T -+	0.078lnrksm +	0.625lnrmsa -	1.666lnrnkr
	$(7.0*10^{E-04})$***	(0.223)	(0.178)***	(0.222)***

Source: author's computation

The significant coefficients in all the cointegrating equations (Table 2.5) indicate that Nairobi has a long run relationship (cointegrated) with Mombasa and Nakuru, whereas Kitale is cointegrated with Kisumu and Mombasa. Eldoret is cointegrated with Mombasa and Nakuru. The results indicate that Mombasa and Nakuru prices co-move with Nairobi prices in the long run. Similarly, Kitale prices co-move with Mombasa and Kisumu prices whereas Eldoret prices co-move with Mombasa and Nakuru prices.

C) Testing for short-run integration with a Vector Error Correction Model

When long-run integration is observed, it can be incorporated in the model by specifying a Vector Error Correction Model (VECM). This VECM can be used to estimate the dynamics in the short run. Using the same price series used to obtain the cointegrating equations, we obtain the results presented in Appendix 2.1. The results of the short run dynamics are presented in Table 2.6. The numbers presented are the coefficients of the cointegrating relations in the regression for the price changes.

Table 2. 6 Estimates of the dynamics in the short run

Error correction	D(lnrNbi)	D(lnrKtl)	D(lnrEld)	D(lnrKsm)	D(lnrMsa)	D(lnrNkr)
CointEq1	-0.699403	0.186646	0.236063	-0.275756	0.221047	-0.056871
	(0.15454)	(0.20644)	(0.21625)	(0.18729)	(0.18374)	(0.17585)
	[-4.52568]	[-0.90411]	[1.09160]	[-1.47237]	[1.20302]	[-0.32341]
CointEq2	-0.088407	-0.568600	-0.220410	0.280136	0.280136	0.012983
	(0.09945)	(0.13285)	(0.13916)	(0.11824)	(0.11824)	(0.11316)
	[-0.88896]	[-4.28002]	[-1.58382]	[-1.19104]	[2.36916]	[0.11473]
CointEq3	0.100003	-0.003959	-0.192650	0.091675	-0.136020	0.284036
	(0.07501)	(0.10021)	(0.10497)	(0.09091)	(0.08919)	(0.08535)
	[1.33315]	-0.033951]	-1.83532]	[1.00844]	[-1.52510]	[3.32771]

Source: author's computation Note: All figures in brackets (…) are standard errors and all figures in parenthesis […] are t-values

Table 2.6 shows that in the short run each market, except Kisumu and Eldoret, react to at least one of the long-run cointegrating equations. The partial short run adjustment of price changes at Nairobi, Kitale, Mombasa and Nakuru markets react significantly on the deviation from the long-run equilibrium. Nairobi is the strongest follower of cointegrating equation (1) while Kitale is the strongest follower of cointegrating equation (2), as measured by the coefficient: -0.699403 and -0.568600 for Nairobi and Kitale, respectively. In the cointegrating equation (3), Nakuru with a coefficient of 0.284036 has the strongest short-term reaction to the long-run equilibrium. However, price adjustments do not occur instantaneously and completely. This result is consistent with results of Goletti and Babu (1994) who found that maize markets in Malawi displayed a low level of integration, as measured by the co-movements of price changes across spatially separated markets. The degree of integration was not perfect. Imperfect degree of market integration would be attributed to imperfect information on market conditions by traders.

The results also reveal a number of other relationships (Appendix 2.1). In the model for Nairobi, the change in wholesale price is influenced by its own one-period lagged change in price and also one-and two-period lagged changes in price in both Kisumu and Nakuru. In the model for Kitale, only the one-period lagged change in price in Nairobi and three-period lagged change in price in Nakuru influence changes in price in Kitale. In the short run, it appears that changes in prices in major consuming markets (Nairobi and Mombasa) are

influenced by prices in many other markets. Conversely, changes in prices in major producing markets are influenced by prices in a few other markets.

D) Causality

Cointegration implies Granger causality in at least one direction. The concept of causality is here interpreted in the limited meaning of contribution to predictability (Goletti & Babu 1994). The direction of causality in maize prices was examined using the Granger causality test. Granger causality is a useful approach in determining whether price movements follow well defined paths, that is, start around demand or production centres and then spread around the country.

Table 2.7 presents results of Granger causality test. The results which are applied to a maximum of two lags show that most markets exhibit a bi-directional causality (feedback causality) and none of the markets was exogenous. A few other markets exhibited uni-directional causality e.g. Kisumu Granger causes Kitale, Mombasa, Eldoret and Nakuru, but not vice versa. Mombasa Granger causes Kitale and Nakuru but not vice versa. It is only Nakuru that Granger causes Kisumu, and Mombasa was only Granger caused by Nairobi and Kisumu. Therefore, the results indicate an absence of a central market and therefore no radial price transmission model. Bi-directional price movements signal changes in seasonality and the accompanying changes in prevailing demand / supply relations in the various markets.

Table 2.7 Pairwise Granger causality

To / From	Nairobi	Kitale	Eldoret	Kisumu	Mombasa	Nakuru
Nairobi	-	8.297	7.981	2.504ns	7.784	7.704
Kitale	6.218	-	6.030	0.970ns	0.424ns	8.767
Eldoret	4.434	3.380	-	0.971ns	0.834ns	6.625
Kisumu	11.202	25.413	15.613	-	3.724	27.024
Mombasa	3.127	4.868	3.626	2.326ns	-	5.646
Nakuru	3.607	3.412	3.607	2.960	0.783ns	-

Source: author's computation; ns refers to no significant cointegration at ≤ 5 percent level

2.7 Discussion, conclusions and implications

This chapter examines three closely related issues. First, it reviews market liberalisation policies in Kenya for four commodities; seed, fertiliser, maize and milk. Second, it highlights some of the opportunities/challenges arising from market liberalisation, and third, it examines some of the consequences of market liberalisation and in particular (1) the consequences of market liberalisation on distribution of margins between world and domestic fertiliser and maize market prices, and (2) the integration of wholesale markets by applying cointegration analysis to maize markets in Kenya.

A review of market liberalisation process shows that although the four commodity markets were liberalised in the first half of 1990s, the government still plays a role, albeit in varying degrees, in all commodity markets. Therefore, the emerging marketing scenario is

that of partial rather than complete market liberalisation. In some cases, like in the seed industry, the existing regulatory framework conflicts with the policy framework. Urgent harmonisation of the two is therefore necessary. Nonetheless, it is clear from the review that there has been a massive increase in number of fertiliser traders particularly at the retail level, number of seed companies and number of maize varieties available to the farmers after market liberalisation.

At the same time, the absence of interlocked transactions, increased asymmetric information, inadequate capacity for commodity quality control and the exposure of farmers to global prices have increasingly emerged as challenges/opportunities after market liberalisation. The increasing number of marketing outlets for maize and milk has made it difficult to interlock agricultural credit and acquisition of inputs such as fertiliser and seed for farmers. The increasing number of traders also means that government agencies charged with the task of assuring that farmers obtain good quality inputs and that consumers access good quality products are increasingly facing difficulties in achieving this objective because of inadequate resources. This scenario has for instance resulted in several cases of fertiliser and maize seed adulterations each year. Enactment of stiffer penalties for unscrupulous traders involved in adulteration of inputs should be enforced to discourage them.

Market information regarding price, demand and supply conditions prevailing in various markets eludes most traders. Current access to market information is dependent on the press, and trader investment in information and networking. This has led to an asymmetric market information pattern among traders. Initiation and expansion of rural electrification program would enhance the use of mobile phone technology, which in turn will improve market information flow.

Although there are signs of increased market efficiency as evidenced by declining fertiliser and maize margins between domestic and world prices, domestic traders not only face competition arising from market liberalisation but also international competition. Since Kenya is a signatory to several trading blocks (EAC, COMESA and WTO) and is required to open up to international trade, this poses a challenge to traders to improve marketing efficiency to compete effectively. Yet, it gives them an opportunity to expand the market for their products beyond domestic boundaries.

Evidence on market integration analysis shows that although the six maize markets examined are geographically-dispersed, and therefore potentially-segmented, they are nonetheless spatially integrated. Each maize market has a long-run price relationship with at least one other market, but price adjustments do not occur instantaneously and completely due possibly the lags in market information flow. The result of long-run price relationship is expected because the removal of maize movement restrictions led to an increased number of traders who operate where arbitrage allows. Furthermore, these major market centres are well connected by all-weather roads, have a rail network and ample grain storage facilities. The increased role of mobile phone technology has also contributed to improve information on market conditions among traders. This result of market integration corroborates a finding by

Gluschenko (2003) who showed that the Asian part of Russia excluding difficult-to-access regions is more integrated than European Russia when he analysed price dispersion between regional commodity markets. Furthermore, Gluschenko (2005) while analysing the spatial pattern of goods market integration in Russia also observed that difficult-to-access regions are not integrated to the national market and contribute to the overall disconnectedness of regional markets.

The causality analyses provide mixed results. In most cases, causality is uni-directional. Therefore, there is no evidence of the existence of a central maize market in Kenya. Central markets are common in situations where market networks are organised around regional centres partly due to infrastructural reasons which impede trade flows among regions, which is not the case for the markets studied. This study found that both demand and supply markets are important in driving maize wholesale prices. Alexander and Wyeth (1994), explain that for the case of the rice market in Indonesia, price changes mainly originate from supply centres because demand for rice remains steadier than supply in the course of the year as is the case for Eldoret and Kitale. Like the case of rice in Jarkata in Indonesia, Mombasa and Kisumu are major maize deficit regions in Kenya and while they are important sources of causality, their price changes are also significantly caused by price variations in other large markets of the country. The deficit status of Mombasa and Kisumu may explain the causality coming to them while the causality flowing from them may reflect their positions as major ports, and hence indirect suppliers of maize shipped through them to other areas of the country. The implication of the finding that maize markets are integrated suggests that the private sector is responding to price signals appropriately.

Finally, evidence of market integration in Kenya must be understood from both domestic supplies and external trade in maize. The conclusions so far made on market integration should be treated cautiously if one wants to extrapolate to other regions of the Kenya. In particular, this is true when one considers the poorly accessible areas of northern Kenya and the inadequate storage facilities available in these areas. Therefore, in order to obtain solid evidence on maize market integration in Kenya, it is recommended that a study that covers both accessible and inaccessible market centres be conducted in future. This will assist in prioritizing investments needed to avert a famine disaster similar to the 2006 one amid adequate maize supplies elsewhere in the country. However, the possibility of such a study is contingent on availability of relevant price data.

Appendix 2.1 Vector Error Correction Estimates

	D(lnrNbi)	D(lnrKtl)	D(lnrEld)	K(lnrKsm)	D(lnrMsa)	D(lnrNkr)
CointEq1	-0.699	-0.187	0.236	-0.276	0.221	-0.057
	(0.155)	(0.206)	(0.216)	(0.187)	(0.184)	(0.176)
	[-4.526]	[-0.904]	[1.092]	[-1.472]	[1.203]	[-0.323]
CointEq2	-0.088	-0.569	-0.220	-0.144	0.280	0.013
	(0.155)	(0.133)	(0.139)	(0.121)	(0.118)	(0.113)
	[-0.889]	[-4.280]	[-1.584]	[-1.191]	[2.369]	[0.115]
CointEq3	0.1000	-0.004	-0.193	0.092	-0.136	0.284
	(0.075)	(0.100)	(0.105)	(0.091)	(0.089)	(0.085)
	[1.333]	[-0.040]	[-1.835]	[1.008]	[-1.525]	[3.328]
D(lnrNRB(-1))	0.392	0.354	-0.039	0.405	0.344	0.146
	(0.138)	(0.185)	(0.193)	(0.168)	(0.164)	(0.157)
	[2.832]	[1.917]	[-0.202]	[2.418]	[2.091]	[0.926]
D(lnrNRB(-2))	0.032	0.033	-0.051	0.167	-0.045	0.054
	(0.121)	(0.162)	(0.169)	(0.147)	(0.144)	(0.138)
	[0.264]	[0.201]	[-0.302]	[1.137]	[-0.315]	[0.389]
D(lnrNRB(-3))	0.111	-0.132	-0.291	0.114	0.189	0.101
	(0.105)	(0.140)	(0.146)	(0.127)	(0.124)	(0.119)
	[1.064]	[-0.945]	[-1.986]	[0.895]	[1.518]	[0.847]
D(lnrKTL(-1))	0.175	0.046	0.282	0.064	-0.251	-0.072
	(0.094)	(0.126)	(0.132)	(0.114)	(0.112)	(0.107)
	[1.852]	[0.361]	[2.139]	[0.567]	[-2.237]	[0.670]
D(lnrKTL(-2))	0.102	-0.005	0.127	0.159	-0.180	0.080
	(0.086)	(0.115)	(0.120)	(0.104)	(0.102)	(0.098)
	[1.192]	[-0.045]	[1.057]	[1.532]	[-1.768]	[-0.815]
D(lnrKTL(-3))	-0.061	-0.150	0.162	0.069	-0.363	-0.077
	(0.077)	(0.103)	(0.108)	(0.094)	(0.092)	(0.088)
	[-0.785]	[-1.451]	[1.504]	[0.714]	[-3.959]	[-0.881]
D(lnrELD(-1))	-0.059	0.140	-0.169	-0.102	0.076	-0.164
	(0.091)	(0.121)	(0.129)	(0.110)	(0.108)	(0.103)
	[-0.649]	[1.156]	[-1.333]	[-0.926]	[0.703]	[-1.588]
D(lnrELD(-2))	0.062	0.010	-0.131	-0.005	0.157	-0.067
	(0.083)	(0.111)	(0.117)	(0.101)	(0.099)	(0.094)
	[0.746]	[0.089]	[-1.124]	[-0.047]	[1.583]	[-0.710]
D(lnrELD(-3))	0.096	-0.024	-0.175	-0.170	-0.088	-0.036
	(0.056)	(0.101)	(0.106)	(0.092)	(0.090)	(0.086)
	[1.262]	[-0.242]	[-1.652]	[-1.850]	[0.976]	[-0.413]
D(lnrKSM(-1))	0.274	0.025	0.217	0.140	0.413	0.372
	(0.115)	(0.153)	(0.160)	(0.139)	(0.136)	(0.130)
	[2.387]	[0.162]	[1.350]	[1.004]	[3.026]	[2.849]
D(lnrKSM(-2))	0.216	0.194	0.210	0.064	0.312	0.299
	(0.109)	(0.145)	(0.152)	(0.132)	(0.129)	(0.124)
	[1.989]	[1.333]	[1.382]	[0.488]	[2.410]	[2.416]
D(lnrKSM(-3))	0.087	0.088	0.278	-0.211	0.096	0.286
	(0.103)	(0.138)	(0.144)	(0.125)	(0.123)	(0.117)
	[0.848]	[0.639]	[1.922]	[-1.685]	[0.874]	[2.439]
D(lnrMSA(-1))	-0.106	-0.081	-0.012	-0.240	-0.011	-0.086
	(0.097)	(0.129)	(0.135)	(0.117)	(0.115)	(0.110)
	[-1.100)	[-0.630]	[0.090]	[-2.048]	[-0.097]	[-0.784]
D(lnrMSA(-2))	-0.084	-0.107	0.070	0.065	0.043	-0.102
	(0.092)	(0.123)	(0.129)	(0.112)	(0.110)	(0.105)
	[-0.906]	[-0.866]	[0.542]	[-0.576]	[0.388]	[-0.970]
D(lnrMSA(-3))	-0.021	0.089	-0.029	-0.006	-0.016	-0.195
	(0.081)	(0.108)	(0.113)	(0.098)	(0.096)	(0.092)
	[-0.256]	[-0.832]	[-0.261]	[0.063]	[-0.162]	[-2.131]
D(lnrNKR(-1))	-0.286	-0.062	-0.083	-0.049	-0.178	0.058
	(0.106)	(0.142)	(0.148)	(0.128)	(0.126)	(0.121)
	[-2.702]	[-0.436]	[-0.562]	[-0.381]	[-1.410]	[0.478]
D(lnrNKR(-2))	-0.403	-0.010	-0.071	-0.233	-0.142	0.006
	(0.091)	(0.121)	(0.127)	(0.110)	(0.108)	(0.103)
	[-4.450]	[-0.079]	[-0.556]	[-2.116]	[-1.320]	[0.057]

D(lnrNKR(-3))	-0.081	0.211	0.214	0.034	0.080	0.093
	(0.084)	(0.113)	(0.118)	(0.102)	(0.100)	(0.096)
	[-0.966]	[1.874]	[1.814]	[0.330]	[0.083]	[0.968]
constant	-0.003	-0.001	-0.0003	-0.003	-0.003	-0.001
	(0.006)	(0.008)	(0.009)	(0.007)	(0.007)	(0.007)
	[-0.560]	[-0.168]	[-0.031]	[-0352]	[-0.344]	[-0.141]
R-squared	0.458	0.506	0.390	0.254	0.349	0.467
Adj. R-squared	0.364	0.420	0.284	0.126	0.237	0.375
Sum sq. resids	0.655	1.169	1.284	0.962	0.926	0.848
S.E. equation	0.073	0.098	0.103	0.089	0.087	0.083
F-statistic	4.902	5.941	3.707	1.978	3.117	5.085
Log likelihood	183.971	142.273	135.587	156.296	159.046	165.372
Akaike AIC	-2.250	-1.670	-1.578	-1.865	-1.903	-1.991
Schwarz SC	-1.796	-1.217	-1.124	-1.411	-1.450	-1.538
Mean dependent	-0.002	-0.001	-0.0005	-0.001	-0.003	-0.0009
S.D. dependent	0.092	0.129	0.121	0.095	0.100	0.105

Determinant resid covariance (dof adj.)	4.40E-14
Determinant resid covariance	1.63E-14
Log likelihood	1059.976
Akaike information criterion	-12.597
Schwarz criterion	-9.441

Note: Included observations = 145 after adjustments; standard errors in brackets (…) and t-values in parenthesis […]

CHAPTER 3

THE ROLE OF TRADERS IN FERTILISER, SEED, MAIZE AND MILK MARKETING

3.1 Introduction

The major role of traders is to link consumers to producers. To achieve this role, the policy, legal, physical, political and socio-economic environment in which traders operate are important. For instance, the policy environment determines the type of market structures the traders operate in, with the legal framework influencing the institutions at play. The physical environment such as transportation and communication infrastructure influences the performance of the traders. The socio-economic environment affects farmer demand for inputs and their supply of farm outputs.

On the supply side, input traders provide farmers with farm productivity-enhancing inputs such as inorganic fertiliser, certified seed and pesticides. Besides the transfer of inputs to farmers, local retail traders disseminate information on agricultural technologies (Mwaura & Woomer 1999). In a few cases, traders extend interest-free short-term credit to a few farmers on the basis of trust (Mwaura & Woomer 1999). To enhance availability of the inputs and their access to farmers, an efficient marketing system is necessary. The economic cost associated with poorly performing domestic markets was an important reason for liberalising input markets under structural adjustment and stabilization programs (Freeman & Kaguongo 2003). On the demand side, traders provide an outlet for farm produce to consumers. As a result, traders provide producers with income. The income provided is in turn used to meet the farmers' day to day financial obligations and the purchase of farm productivity-enhancing inputs. In addition, traders are involved in the spatial and temporal allocation of farm produce in the domestic market (Dembele 1999).

Market liberalisation ushered in a change in market actors; from a dominantly state-controlled marketing system in the pre-liberalisation era to a dominantly private traders-controlled marketing system in the post-liberalisation era. In the pre-liberalisation era, the government controlled most of the trading activities, thereby forming a major link between input suppliers and farmers on the one hand and between producers and consumers on the other hand. Through the state marketing boards, the government undertook the functions of input supply, provided farmers with credit and marketed their outputs. Private traders only played a peripheral role relative to the state marketing boards. In the post-liberalisation era, private traders, and to a lesser extent public traders, play these roles in markets characterised by poor institutions, high search costs and imperfect or asymmetric information (Fafchamps & Minten 1999).

A major consequence of market liberalisation is increased entry of private traders in both input and food markets in the reforming countries. Several studies provide evidence of private trader entry into the liberalised input markets in Africa (Beynon *et al.* 1992;

Argwings-Kodhek 1996; Badiane & Shively 1998; Badiane 1998a; Kherallah *et al.* 2000; Kherallah 2000; Omamo & Mose 2001). In spite of the rapid entry, only a few traders have invested in productive assets and distribution facilities such as storage, transport and advisory services, limiting their expansion (Beynon *et al.* 1992; Badiane 1998b; Kherallah *et al.* 2000). Consequently, inadequate and often poor infrastructure coupled with inadequate investment in storage and worsened by limited access to credit has constrained private traders to market opportunities (Staatz 1990). Furthermore, low availability of market information constrains private trader activities (Coulter & Golob 1992). These factors lead to high transaction costs, which reduce efficient private trader activities.

Although it is generally accepted that private traders have entered the market rapidly, limited knowledge exists on their pattern of distribution, i.e. their structure, conduct and performance. In this chapter we (1) assess the extent to which private traders have responded to maize grain (henceforth referred to as maize), maize seed (henceforth referred to as seed), fertiliser and milk marketing liberalisation, (2) analyse the structure, conduct and performance (SCP) of the maize, seed, fertiliser and milk traders, and (3) assess the trader perceptions of the impact of market liberalisation. Overall, the set objectives will answer the main research question of the study "To what extent do traders exploit farmers?" This chapter contributes to the literature by providing information on the functioning of traders in imperfect markets following market liberalisation. In particular, it will give insights into factors constraining trader competitiveness and efficiency.

It is hypothesized that (1) firm size varies with location of firms, (2) firm size varies with year of entry, (3) unit of measurement for purchase or sale of commodities varies with stage in channel, (4) the marketing margins across different firm size groups will be the same, and (5) vertically integrated firms incur less per unit costs than non-vertically integrated firms.

This chapter examines the role played by four types of traders: fertiliser, seed, maize and milk in linking producers with consumers after market liberalisation. In section 3.2, theoretical considerations on types of markets and the conceptual framework of the structure, conduct and performance of a market are given. Section 3.3 presents the data sources, types of data and collection procedures. Section 3.4 provides the empirical estimation results. In particular, the response of traders to the liberalised market is provided from the entry perspective, that is, the pace in private trader participation following market liberalisation. In addition, trader investments in the various businesses are highlighted. This is followed by the SCP analyses for the four commodities, trader constraints to effective business operations and trader perceptions on market liberalisation. Finally, conclusions on the key findings are provided in section 3.5.

3.2 Theoretical considerations

3.2.1 Market types

Bressler and King (1970) define a market as an area or setting within which producers and consumers are in communication with one another, where supply and demand conditions operate and the title to goods is transferred. Tomek and Robinson (1981) define a market as a set of buyers and sellers whose activities affect the price at which a particular commodity is sold. Central to both definitions is the price and existence of a commodity.

Economic theory postulates the existence of a continuum of several market structures. Economists distinguish among the different markets according to (1) number of firms, (2) whether the products in the different markets are identical or differentiated, and (3) ease of trader entry into or exit from the market (Baumol 1985). On one extreme is a perfect competition market structure whereas on the other extreme is a monopoly market structure with oligopoly and monopolistic competition existing between the two extreme market structures.

Following Pindyck and Rubinfeld (1989), Varian (1996), and Henderson and Quandt (1980), perfect competition is characterised by (1) numerous participants with each seller and buyer constituting a small portion of the market. The decisions of the participants have no effect on the price. This requirement rules out trade associations or other collusive arrangements strong enough to affect price. This implies that there is no market power (ability to decide on the price) as all market participants are price takers; (2) the product offered by one seller is identical (homogenous) to that supplied by other sellers. Consumers do not care from which firm to buy because the product is homogenous; (3) there are no barriers to entry or exit; and (4*)* each firm and each customer is well informed about the available products and their prices.

The type of market structure has an influence on the level of client exploitation via a deviation from a competitive equilibrium price. Competition influences economic performance by affecting the actors' incentive structure, encouraging their innovative activities, and selecting more efficient ones from less efficient ones in the long run (Sanghoon 2002; Arn 2003). The next three sections highlight variants of client exploitation based on different market structures.

A) Case of no exploitation: perfect competition market structure

A firm in a competitive market structure faces a perfectly elastic demand curve (Fig.3.1). This is equal to the price of the good in question. The demand curve for a firm is a horizontal line given by

P = constant; where p = price

The firm's total revenue (R) is given as R= pq; where p = price and q = quantity of sales. Marginal revenue is the rate at which total revenue increases as a result of a small increase in sales. Mathematically, $\partial R/\partial q = p$, since p is a constant, the marginal revenue curve faced by

an individual is identical with its demand curve and ∂R/ ∂q is the first derivative of revenue (or the marginal revenue).

The short run supply function of a perfectly competitive firm states that " the quantity a firm produces is a function of market price which can be derived from the first-order condition for profit maximization" (Henderson & Quandt 1980). The firm's short run supply curve is identical with that portion of its short run marginal cost (MC) curve, which lies above its average variable cost (AVC) curve. However, the market demand curve is downward sloping.

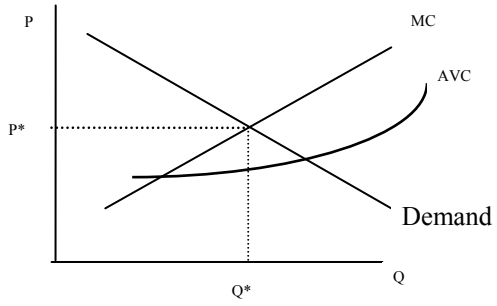


Fig. 3.1 Equilibrium conditions: perfectly competition market model

Equating supply (marginal cost curve) to demand achieves the equilibrium price and quantity where there is no buyer exploitation. This is because each firm is a price taker and all participants have perfect information about market conditions.

B) Case of mild form of exploitation: monopolistic competition

Monopolistic competition is probably the most prevalent form of industry structure. Following Burkett (2005), monopolistic competition is a market structure defined by two characteristics: the existence of numerous firms each producing a product that is a close, but imperfect substitute for the product of other firms, and free entry and exit of firms. Though it is not a defining characteristic of monopolistic competition, imperfect information is also found in monopolistic competition. Each firm faces a downward sloping demand curve and assumes that its own price and quantity have no effect on the behavior of other firms in the industry. Each firm takes as given the price and quantities offered by its rivals.

Following Petsas (2003), a firm in a monopolistically competitive industry is expected to sell (1) more with higher total demand for its industry's product and higher prices charged by its rivals and (2) less with higher competition and lower prices from its rivals. An equation for the demand facing a firm that has these properties is:

$$Q = S * [1/n - b * (p - \bar{p})] \qquad (3.1)$$

where : Q is the firm's sales, S is the total sales of the industry, n is the number of firms in the industry, b is a constant term representing the responsiveness of a firm's sales to its own price, p is the price charged by the firm itself and $\bar{p}$ is the average price charged by its customers.

In the short run (SR), a monopolistically competitive firm may earn positive or negative economic profits. In the long run (LR), positive economic profits stimulate entry into the industry while losses force firms to exit from the industry. Entry (exit) shifts the demand curve of the existing firms to the left (right). Entry and exit continue until economic rents are driven to zero. This zero profit condition is realized when the demand curve is tangent to the average cost (AC) curve: $\Pi = (P\text{-}AC)\ Q = 0$, where P equals price and Q equals quantity produced. When the demand curve reaches this position, the best a firm can do is to break even. If it produces more or less than the profit maximizing output Q*, it suffers a loss. Because Q* is the profit maximizing level of output, MC=MR at Q*.

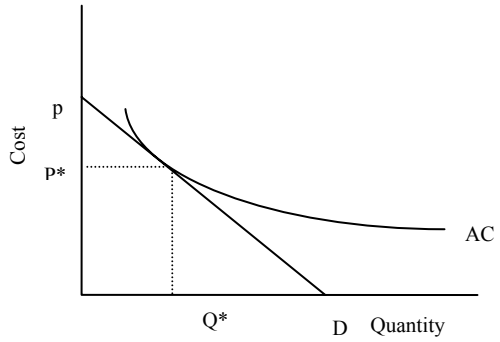


Fig. 3.2 Equilibrium price and the average cost: monopolistic competition market model

As shown in Fig 3.2, in a monopolistic competitive industry, the equilibrium price (p*) exceeds minimum average cost. Thus, sales (q*) are smaller than they could be if price equaled minimum average cost, as under perfect competition. Therefore, this is a form of exploitation through restricted output and higher price.

C) Case of serious form of exploitation: monopoly

A monopoly market structure represents a case of a serious form of buyer exploitation. A monopolistic market structure is characterized by one seller, implying that the firm's demand curve is also the market demand curve. It is also characterized by sale of a homogenous product (no product differentiation). A monopolist has market power since he faces a negatively sloped demand curve.

A monopolist's objective is to maximize profits. Economic theory states that profits are maximized when marginal revenue (MR) is equated to marginal costs (MC). Following Pindyck and Rubinfeld (1989) and Henderson and Quandt (1980), a monopolist's marginal

revenue is not equal to price (MR ≠ p) as in a perfectly competitive market structure. Total revenue of a monopolist is obtained by multiplying quantity (q) sold to price (p).

$$R = pq \tag{3.2}$$

$$\text{But MR} = \frac{\Delta R}{\Delta Q} = \frac{\Delta(PQ)}{\Delta Q}, \tag{3.3}$$

However, the extra revenue from an incremental unit of quantity $\frac{\Delta(PQ)}{\Delta Q}$ has two components. Producing one extra unit and selling it at a price p brings in revenue p. But the firm faces a downward sloping demand curve, so producing and selling this extra unit results in a small drop in price $\frac{\Delta p}{\Delta Q}$ which reduces the revenue from all units sold, resulting in a small change in revenue, $Q(\frac{\Delta p}{\Delta Q})$.

$$\text{Thus, MR} = P + Q(\frac{\Delta p}{\Delta Q}), \tag{3.4}$$

This alternatively is obtained by differentiating equation (3.2) with respect to output, thus

$$\text{MR} = \partial R/\partial q = p + q\,(\partial p/\partial q), \tag{3.5}$$

Therefore, marginal revenue is not equal to price (MR ≠ p) under a monopolistic situation. Like in the competitive market structure, a monopolist supply curve is equal to her marginal cost curve. Diagrammatically (fig. 3.3), it can be shown that a firm under a monopolistic situation can exploit farmers by limiting supply, thus charging a high price (P_m) instead of the competitive price (P_c).

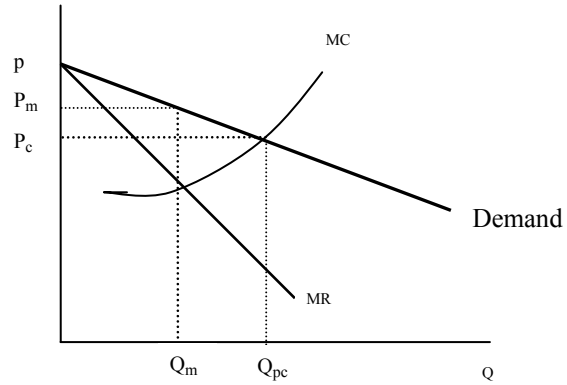


Fig. 3.3 Price charged by a monopolist

Less quantity (Q_m) is also offered to the market instead of the competitive quantity (Q_{pc}). There is also a deadweight loss to society (efficiency loss), represented by area B+C (Fig.

3.4). Area A + B is lost consumer surplus because of rise in price, while producers gain A-C, as shown in figure 3.4.

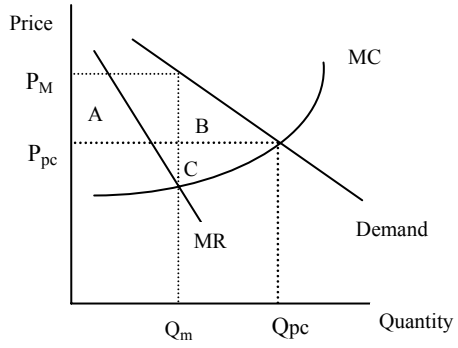


Fig. 3.4 Efficiency loss resulting from monopoly situation

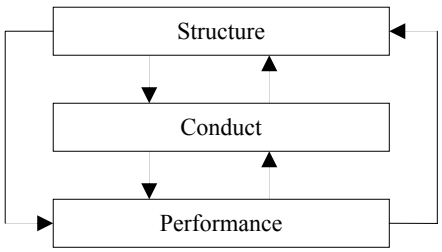
Economic theory suggests that firms in a concentrated market, if protected from competition through some form of entry barriers, are expected to make supra-normal profits. A firm with market power in the sales' market is able to sell at a higher price than a corresponding firm in a competitive market because its buyers will not so easily substitute for lower price sellers. Similarly, a firm with buyer power will be able to buy less for some of its inputs than a comparable firm that needs to compete for its suppliers.

Having set the theory of the possible market structures that influence performance, we next examine the theory of the structure, conduct and performance model.

3.2.2 The structure-conduct–performance model

Bain (1951), Clodius and Mueller (1961) and Slater (1968) developed the structure-conduct-performance (SCP) analysis model. It originates from the theory of industrial organisation, which posits that the structure of a market influences the conduct of firms within a market, which in turn influences the market performance (Marion & Mueller 1983; Scherer 1980). Collectively, market structure and trader conduct determine market performance. In turn, market performance determines market structure and traders' conduct in the long run (Dijkstra 1997).

Summing this up, Scarborough and Kydd (1992) and Scott (1995) pose that relationships exist between structural characteristics of a market and the competitive behaviour of market participants, and that their behaviour in turn influences the performance of the market. Schematically, the SCP model is conceptualised as in Fig. 3.5.



Source: (Lutz 1994)

Fig. 3.5 Structure, Conduct and Performance framework

The SCP approach tries to capture how closely actual marketing systems approximate an efficient marketing channel. In neoclassical economics, an efficient market channel is characterised by numerous traders operating at different levels of the market system and where market participants easily access information (Ellis 1992). The SCP method emphasizes two economic goals, efficient resource allocation and equitable income distribution (Bateman 1976), but being a mono-disciplinary approach it does not explain the contribution of agricultural markets to economic development. Jansen and van Tilburg (1997), offer three arguments for this inability: SCP (1) does not usually examine the costs and benefits of successful intervention, (2) analysis normally does not include the process of change and instability through which most developing economies are passing, and (3) criteria may be useful to review the existing agricultural marketing systems, but are poor indicators of their potential for effecting change.

A) Structure

Market structure refers to the organizational characteristics of the market. These characteristics comprise buyer and seller concentration (number and size distribution), conditions of entry, power distribution, diversity of participants at different levels, degree of product differentiation, and availability of market information (Tomek & Robinson 1981; Dijkstra 1997). The structure of a market provides insights into the level of competition in that market. Three of the market structure components: trader concentration, firm size distribution and market integration are further highlighted.

Trader concentration

Trader concentration signals the level of competition among traders. The level of competition is measured by either the concentration ratios (CR) or by the Hirschman-Herfindahl (HH) index.

A market concentration ratio is a measure of the percentage share of the market controlled by a specified percentage of firms ranked in order of market share from the largest to smallest (Karugia 1990). High concentration and inequality indicate oligopolistic

tendencies while low concentration suggests tendencies towards competition. This assertion is only true when there are no serious barriers to entry into the market and none of the traders occupies a monopolistic position in the market sufficient to influence market activities of other traders (1951; Bain 1968). The CR is zero in a perfectly competitive market and one when a trader is either a monopsonist or monopolist. Computationally, the CR is given as:

$$CR_m^n = \sum s_i \qquad (3.6)$$

where n = the number of firms; s_i = the market share of the i^{th} firm (i =1, …, n) as a percentage; m = the number of the largest firms.

The Hirschman-Herfindahl (HH) index is a measure of industrial organization. To obtain the index, the individual market share of each firm in fractional terms is squared. The HH index is given by the sum of these squared terms, thus

$$HH= \Sigma S_i^2 \qquad (3.7)$$

where S_i is the market share of the i^{th} firm. The HH index takes into account both the number of firms in an industry and their size differences. The value of the HH index equals one when there is only a single firm in the industry and tends towards one when there are a few firms and / or greater degree of inequality in market shares. As the HH index tends to zero, it signifies increased competition, indicating increasing difficulty for a firm to exercise market power.

The Lorenz curve is a graphical device used to illustrate the inequality of the distribution of some variable such as income, wealth, or size distribution of firms. In the case of firm size distribution, the Lorenz curve graphs a fraction of the value of output of the top k ranking firms in the population of N firms as k/N. This depicts the percentage of total industry sales accounted for by the top k firms operating within the industry, ranked in descending order of firm size within the industry.

$$C_k = k/N \qquad (3.8)$$

where C_k is the k-firm output concentration ratio.

The concentration ratios for the 4, 8 and 20 largest firms in an industry are commonly used in the literature as measures of competition. As a "rule of thumb", Kohls and Uhl (1985) state that if the four-firm concentration ratio (CR4) is less than or equal to 33 percent, it indicates a competitive market structure, while a concentration ratio of 33 percent to 50 percent or more indicate weak and strong oligopolistic market structures.

For this study both the HH index and the concentration ratios are used to assess firm structure and its influence on competition.

Firm size distribution

During entry and exit from industry, different firm sizes emerge depending on the number of opportunities in the market each firm takes (Walsh & Whelen 2002). At any period, both entry and exit could occur. Efficient firms remain while inefficient ones exit. Average firm

size can increase or decrease depending on the behaviour of prices. Hopenhayn (1992) observes that as demand shrinks and price declines, the least efficient producers exit first. As long as firm size and efficiency are positively correlated, firm size distribution then stochastically increases as smaller firms exit.

Dinlersoz and MacDonald (2005) observe that the ideal theoretical measure of firm size is output rather than employment or physical sales. While both employment and sales have traditionally been used as measures of firm size, relatively little is known about the relationship among different measures of firm size. If firm productivity increases along the life-cycle, and especially if the increase is non-uniform across firms of different sizes, firm employment may not be the best measure of firm size heterogeneity. Sales, on the other hand, suffer from the effects of price changes over time. Therefore, the authors advocate for the use of firm output (sales * unit price) to measure firm size.

Following Dinlersoz and MacDonald (2005), analysis of firm size distribution can be achieved by looking at the moments of firm size. Skewness captures whether the firm size distribution is symmetric around its mean. Positive values of skewness indicate a pile-up of scores on the left of the distribution. That is, it assigns more of the probability to the left of the mean, toward smaller firms. Negative values of skewness indicate a pile-up on the right, assigning more of the probability toward larger firms.

In a normal distribution, the value of skewness should be zero. The farther the point is from zero, the more it is that the data are not normally distributed (Field 2004). The Kolmogorov-Smirnov test is used to test for normality of the distribution. The test compares the set of scores in the sample to a normally distributed set of scores with the same mean and standard deviation. If the Kolmogorov-Smirnov test shows $p>0.05$, then it indicates that firm sizes are normally distributed.

Firm size distribution is therefore important because it is tied to the distribution of productivity, the heterogeneity of production technology, and the degree and type of competition among firms (Dinlersoz & MacDonald. 2005). In this study the Kolmogorov-Smirnov test for normality and skewness are used to assess firm size distribution. They give a general picture of the distribution of the firms in each market.

Market integration

Economic theory states that as firms enlarge production, they sell more output thereby decreasing average fixed costs - taking advantage of economies of scale. Firms increase in size either through horizontal or vertical integration. Horizontal integration refers to a situation where a firm takes control of similar firms handling the same or similar activities where they could be having a competitive advantage (Lafferty & van Fossen 2001).

Vertical integration occurs when successive stages of marketing are linked together. This could be through direct ownership or by contract (Tomek & Robinson 1981). It implies that one firm acts on different production stages and integrates various production activities such as purchasing raw product, processing and retailing it.

There are several arguments for vertical integration. Smith (2005) argues that inputs and outputs may serve farmers best when there is a high degree of vertical coordination among input distribution, output marketing and credit functions. This arrangement lowers costs and improves loan repayment rates. In addition, there are transaction cost economies and risk-bearing advantages associated with vertical integration. Dries and Swinnen (2004) argue that when firms are faced with small buyers, unable to make basic investments and restricted in their access to basic inputs (such as working capital), vertical integration will be justified. In this case, firms will need to supply farmers with inputs who in turn will have to sell outputs to these firms. Enforcement of payments is done by effectively interlinking output and input markets. However, an effective legal framework that respects property rights will be required.

In addition to the economies of scale, mitigation against double marginalization is another argument for vertical integration. Vertical integration can enable firms to gain a competitive advantage over equally efficient rivals, generating barriers to entry and greater certainty of contracts (Lafferty & van Fossen 2001). Therefore, vertical integration can overcome deficiencies in pricing or information systems, and increase the likelihood that supply is more consistent with demand.

According to neo-classical economics, both horizontal and vertical integration should produce greater economies of scale and lower unit costs. Yet, these processes may reduce competition, with the effect of increasing prices (Lafferty & van Fossen 2001). Decreasing costs and increasing prices raise profits, therefore increasing incentives both for horizontal and vertical integration. However, Jara-Diaz *et al.* (2004) argue that increased competition among an increasing number of firms with market liberalisation would permit cost and price deductions, and therefore, efficiency gains that can compensate for the cost increases due to the loss of economies of vertical integration.

In principle, vertical integration can reduce marketing costs, while in practice there is no assurance that these cost savings will be passed on to consumers as lower retail prices or to producers as higher farm prices. The degree of vertical integration is measured by the percentage share of volume traded by integrated firms relative to the volume traded in the entire market (Hastings & Gilbert 2005).

B) Conduct

Market conduct refers to the set of competitive practices and tactics that traders use such as promotion, information and provision of non-core trading functions to influence market behaviour. Specifically, market conduct consists of a firm's policies towards its product market and towards the moves made by its rivals in that market (Caves 1982). It includes the methods employed by a trader(s) in determining prices and output; their attitudes towards grading, sorting, quality control, customer relations and adoption of innovations. Conduct may also require understanding of the means by which price and product policies of competing traders are coordinated and adapted to each other, and the extent to which

predatory and exclusionary tactics are directed against established rivals or potential entrants. It may take the form of informal cooperation or collusion.

The primary objective of the conduct of firms is to increase or maintain their market share and profit. Thus, pricing mechanisms and sales promotion policies are the main aspects of market conduct (Kimenye 1998).

C) Performance

Market performance refers to the economic result of market structure and conduct. The indicators of market performance include (1) product suitability in relation to product quality, (2) rates of profit in relation to the margins at the different trading levels, (3) level of output in relation to any deliberate restrictions to influence prices, and (4) price integration between markets and the degree of unpredictable variation of prices in markets including accuracy and adequacy of information flows throughout the marketing system (Dijkstra 1997). However, according to Hoffler (2001), market efficiency is the most common criterion for market performance. Different dimensions of performance can be assessed quantitatively and qualitatively.

Dessalegn *et al.* (1998) state that a typical SCP analysis tends to assess market performance largely in terms of (1) whether marketing margins charged by various actors in the marketing system are consistent with costs, and (2) whether the degree of market concentration is low enough to ensure competition[6], which in turn is assumed to drive down costs.

The SCP approach postulates that as market structure deviates from the paradigm of perfect competition, the extent of competitiveness of the market will decrease, leading to a decline in marketing efficiency (Scarborough & Kydd 1992). Nonetheless, Dessalegn *et al.* (1998), argue that there are several shortcomings with these criteria for assessing market performance. First, the criterion that observed marketing margins should be consistent with costs does not indicate that the marketing system is performing adequately. Marketing margins may approximate costs, but these costs may be too high and unstable to encourage rapid investment in the marketing system to promote on-farm productivity growth.

The second criterion, establishing competition through the number of firms in the market, is also problematic in the presence of scale economies. For instance, Dessalegn *et al.* (1998), argue that in the Ethiopian grain markets scale economies may arise both from technology and existence of isolated thin markets. The high costs of transportation between a production region and a major regional market may result in low producer prices in the remote production region. Low prices in turn depress the marketable grain surplus available for purchase. The existence of small surpluses in turn limits the number of grain traders that can profitably operate in an area, particularly in the presence of scale economies in marketing activities (for example, transportation). Therefore, the existence of a few traders (high market

[6] Competition is assumed to take place in a perfectly competitive market situation. For details see section 3.2.1.

concentration among grain buyers) would not necessarily point to lack of competition or artificial barriers to entry, nor would a large number of traders each handling very small volumes indicate that per unit marketing costs are being minimised.

Thirdly, the ability to capture the gains from specialization and commercialisation is limited to the size of the market. The size of the market is in turn influenced by transaction costs. The costs include the *ex-ante* costs of collecting the information necessary to decide whether to engage in exchange, negotiating the deal, the *ex-post* cost of contract monitoring and enforcement. Where these expected costs exceed the expected gains from exchange, no transaction takes place. Therefore, high transaction costs prevent what would otherwise be beneficial trade and depress the dynamic development of exchange-based economic systems required for structural transformation. Therefore, market performance should also be assessed on the range of activities that do not exist in addition to assessing the efficiency of existing exchange arrangements.

In this study, levels of marketing margins and marketing costs across different firm size groups are used to assess market performance. The next section presents data and data sources used to apply the SCP model to the fertiliser, seed, maize and milk in Kenya after market liberalisation.

3.3 Data and data sources

The data used in this chapter originate from trader surveys conducted between December 2003 and June 2004. The survey covered 169 maize, 122 fertiliser, 119 seed traders and 115 milk traders, randomly-selected across 59 dispersed market centres in six districts of North Rift, Kenya. Using structured questionnaires, enumerators supervised by the researcher collected the data.

The major data collected include type and location of the traders, volumes traded in, prices of purchase and sale, transaction costs incurred, and trading practices. Other data and information collected include constraints faced and trader perceptions on market liberalisation. In the next section we present the results of trader entry into four commodity markets studied: fertiliser, seed, maize and milk, and investments made by traders.

3.4 Empirical estimation results for fertiliser, seed, maize and milk

3.4.1 Response of traders to liberalised market

The response of traders to liberalisation is assessed from two perspectives: trader entry and trader investment.

A) Trader entry

Proponents of market liberalisation policies hypothesised an increase in private traders' entry into the liberalised market leading to increased competition, and ultimately to lower input prices and higher output prices.

In North Rift, rapid entry of private traders in the four commodities after market liberalisation has been witnessed. Ninety seven percent of all sampled dairy traders emerged after market liberalisation. This compares with 83 percent for fertiliser traders, 79 percent for maize grain and 65 percent seed traders. The increasing trend of new entrants into the commodity trade is a response to business opportunities made possible through the easing of the prohibitive pre-liberalisation regulatory framework including removal of import quotas, licensing and commodity movement restrictions.

The increased trader entry is expected to be more favourable for farmers in areas where infrastructure is better. These are the places where private sector response is expected to be high (Jayne *et al.* 2004). The response of the private sector in remote areas has been more controversial (Chilowa 1998; Chisvo 2000; Omamo & Mose 2001; Smith 2005). In these areas, it has been difficult to disentangle whether the evidence points to inherent problems with private sector investment in such areas, or whether lack of response is partially related to unresolved policy barriers, the continuation of state activities that undercut commercial trading incentives, and the possibility that inputs such as fertiliser are unprofitable in some areas given existing production and marketing cost structures.

B) Types and value of investments made

According to Dembele and Staatz (1999), the basic hypothesis underlying reforms is that by opening up markets to private competition, traders will invest in business and compete for supplies. In the case of inputs, this would create incentives for farmers in form of increased input availability and competitive prices. Ultimately, enhanced farmer incentives are likely to increase production.

Traders offer form, place and time utilities to their clients. Consequently, a few private traders invested in transport in order to offer place, storage in order to offer time and packaging facilities in order to offer form utilities. Table 3.1 shows that the most important investment activities across the four commodity markets were in form of storage and transport facilities. However, the level of investment was variable and reflects the heterogeneity of the traders in terms of resource endowments and ability to mobilise external resources.

Table 3.1 Type and level of investments made by different trader categories

	Level of Investment by percent traders and value (Ksh.)							
	Fertiliser (n=96)		Seed (n=94)		Maize (n=156)		Milk (n=112)	
Investment type	% traders	Mean (′ 000 Ksh)	% traders	Mean (′ 000 Ksh)	% traders	Mean (′ 000 Ksh)	% traders	Mean (′ 000 Ksh)
Storage facility	24.0	130 (53)	21.3	150 (87)	14.7	450 (270)	14.3	8.5 (3.7)
Own transport	13.5	1400 (650)	19.1	590 (160)	18.6	590 (130)	24.1	110 (83)
Office equipment	9.4	6.9 (3.1)	20.2	40 (16)	-	-	< 1	0.28 (.)
Personnel training	6..3	400 (18)	8.5	6.0 (3.8)	1.9	17 (8.5)	<1	10 (.)
Packaging material	1.0	2.4 (.)	1.1	0.8 (.)	-	-	< 1	15 (.)
Other assets	13.5	140 (7.8)	-	-	-	-	-	-

Source: Traders' survey, 2003-04. Figures in brackets are standard errors of the mean

Storage racks were the main storage investments made by maize, fertiliser and milk traders. Storage was not a major investment activity for milk traders because raw milk is a highly perishable commodity and should rapidly reach its final consumers. Depending on scale of operation, traders invested in bicycles, pickups and lorries / trucks for transport. Human resource development (in terms of business skills), packaging materials and office equipment such as calculators and computers were other investments traders made.

A close observation of the data reveals that the investments made by traders varied with the location of trader (remote vs. accessible), size of business (large versus small) and experience in trade (old or pre-liberalisation versus new or post-liberalisation entrants). Unintended response to private trader participation, especially for maize trading, is the emergence of seasonal businesses in the services sector at focal points of maize sales, particularly around maize milling stores, or stores into which maize is delivered. The businesses mainly include food kiosks, transport services with vehicles for hire, and increased supply of vehicle maintenance services.

As in most of Africa ((Wanzala *et al.* 2001), private traders cited fear of policy reversals as a major impediment to private sector investment after market liberalisation. It was a major investment consideration especially for the asset-specificity type of investments such as storage racks.

We now present the structure-conduct-performance (SCP) analyses for the four commodities. The analyses provide insights into the extent of trader competition and possibilities for farmer exploitation.

3.4.2 Structure-conduct-performance of fertiliser marketing

Fertiliser is a bulky commodity transported over long distances before it reaches the farmers. Fertiliser accounts for about 30 percent of the maize production costs in North Rift. Being a

major production cost item, there is need for farmers to obtain cheap fertiliser to encourage its use. Results from the 2003-04 survey indicate that, on average, fertiliser trading takes place for 6.1 months per year with only about 15 percent of the traders selling fertiliser all year round. Being a seasonal activity, the traders diversify into other trading activities such as keeping a general merchandise shop (49.6 percent), agro-veterinary products (32.3 percent), and hardware (9.1 percent) as an efficient way of resource use. Only about six percent of all the traders specialise in fertiliser business. Trade in fertiliser involves a wide array of participants ranging from stockists who sell directly to the farmers, to importers who may distribute, wholesale and even retail (Appendix 3.2).

A) Structure

Four features are considered in determining the structure of fertiliser marketing in North Rift. The features are trader concentration, product differentiation and barriers to entry and exit.

Trader concentration

The degree of concentration among the fertiliser traders is measured by using the concentration ratios (CR) and the Hirschman-Herfindahl (HH) index. The HH index for fertiliser stockists is calculated based on volume of fertiliser sales. The results indicate that the fertiliser stockists in North Rift have a HH index of 0.06, signifying that the industry is competitive. Within the largest firms, four control 41 percent, eight control 57 percent and 20 control 81 percent of the total fertiliser shares. Sixty six percent of the sampled traders handle only 10 percent of the fertiliser sales. The results indicate that, although there are many fertiliser traders operating, many of them sell small quantities of fertiliser.

Firm size distribution

The logarithm of fertiliser output (value of sales) is used to establish the fertiliser firm size distribution in North Rift. Results show that the fertiliser firms are positively skewed around the mean implying a tendency of more, smaller firms than are larger ones. The Kolmogorov-Smirnov test ($p>0.05$) indicates that the firm sizes are log-normally distributed. Partly because of ease of entry into the fertiliser business, a large number of firms selling fertiliser have proliferated in both remote and accessible areas (Table 3.2), selling varying amounts of fertiliser. Traders in remote places are considered as those located in areas far removed from major trading centres and / or located off the all-weather road networks. Conversely, traders in accessible places are those located in major trading centres or along all weather road networks.

The smallest traders are concentrated mainly in remote areas although some are also found in accessible areas. The largest traders are mainly located in accessible areas.

Table 3.2 Sale of fertiliser by location

Location	Trader type	N	50-kg bags sold		
			Mean ± s.e.	minimum	maximum
Remote	Stockist	41	553 (118)	18	3,050
	Wholesaler	2	7,248 (7,152)	96	14,400
Accessible	Stockist	47	3,511 (813)	16	26,685
	Wholesaler	19	45,571 (15,375)	400	240,000
Total	Stockist	88	2,133 (463)	16	26,685
	Wholesaler	21	41,922 (14,108)	96	240,000
	Total	109	9,799 (3,086)	16	240,000

Source: Traders' survey, 2003-04

Further analysis (Table 3.3) shows that traders who entered the market after liberalisation handle small amounts of fertiliser. The results also indicate that even those who entered the market immediately after market liberalisation have not expanded, pointing to possible constraints in firm expansion. Such constraints could include inadequate working capital and entrepreneurial skills, and reputation. Pre-liberalisation entrants, often located in more accessible areas, handle large amounts of fertiliser. Further, the results also show that about two-thirds of the traders have been in business for less than 10 years, of which a few are large firms.

Table 3.3 Fertiliser sales by entry of traders

Year of entry	Trader type	N	50-kg bags sold		
			Mean ± s.e.	minimum	maximum
Before 1992	Stockist	9	5,399 (2,347)	410	19,040
	Wholesaler	10	68,625 (24,579)	450	240,000
1992-1995	Stockist	9	1,204 (449)	210	4,512
	Wholesaler	5	7,590 (3,256)	2,800	20,200
1996-1999	Stockist	24	3,484 (1,273)	27	26,685
	Wholesaler	4	35,338 (33,328)	96	135,290
2000-2003	Stockist	46	971 (248)	16	6,940
	Wholesaler	2	7,400 (7,000)	400	14,400
Total	Stockist	88	2,133 (463)	16	26,685
	Wholesaler	21	41,922 (14,108)	96	240,000
	Total	109	9,799 (3,086)	16	240,000

Source: Traders' survey, 2003-04; 1 US Dollar is equivalent to Ksh. 75.00.

Integration

In the fertiliser industry, a few firms are vertically integrated. Six of the firms interviewed were vertically integrated and imported and distributed fertiliser. In addition, they were

involved in wholesaling and retailing fertiliser in North Rift. In effect, they compete with firms that buy from other wholesalers.

Survey data show that the degree of vertical integration among fertiliser traders is 30.6 percent. In terms of sales volume, vertically integrated firms are about seven times larger than the non-vertically integrated firms and had been in business before market liberalisation (> 15 years). Unlike the more experienced vertically integrated firms, more than 70 percent of the non-vertically integrated firms emerged after market liberalisation.

Table 3.4 provides results of the gross margins of integrated and non-integrated firms. The gross margin is calculated as the difference between marketing margins and marketing costs per bag. Results indicate that both categories of traders obtain low margins, signaling competition among the traders. The results are consistent with others (Wanzala *et al.* 2001) who attribute the high fertiliser prices in Western Kenya to internal marketing costs rather than trader exploitation of farmers. The internal costs include transportation and handling, storage and interest charges for financing the fertiliser purchases, and charges for transit losses and bagging, most of which are beyond the control of traders.

Table 3.4 Gross margins for vertically- and non-vertically integrated fertiliser firms

Integration	Mean sales volume (50kg bags)	Selling price (Ksh/bag)	Buying price (Ksh/bag)	Margin (Ksh/bag)	Marketing Cost (Ksh/bag)	Gross Margin (Ksh/bag)	% mark-up margin
Vertical	54,560	1,118.00	1,021.00	97.00	55.60	41.40	4.1
Non-Vertical	6,440	1,206.00	1,129.00	77.00	52.50	24.60	2.2

Source: author; Prices, costs and margins are in Kenya Shillings (Ksh). US Dollar is equivalent to Ksh. 75.00.

However, the vertically integrated firms have a higher gross margin per bag of fertiliser sold than the non-vertically integrated firms (Table 3.4). The result points to the advantages inherent with vertical integration especially in information. They buy more cheaply than the non-vertically integrated firms.

Product Differentiation

Product differentiation is one strategy in market segmentation[7] (McCarthy & Shapiro. 1983). The basic idea underlying market segmentation is that any market is likely to consist of sub-markets – which need separate marketing mixes such as product differentiation, a strategy used to out-compete rivals in business.

To out-compete rivals in the business, survey results indicate that fertiliser traders differentiate their products in a variety of ways by using (1) brand names such as *MEA, Chemagro, Norsk Hydro* and *Devji Meghi*, (2) names of fertiliser source such as Ex-Romania, US Gulf, Ex-Saudi Arabia and Ex-Norway, (3) fertiliser colour such as black or grey, (4)

[7] Market segmentation is the process of identifying more homogenous sub-markets or segments within a market – in order to select target markets and develop suitable marketing mixes. The aim is usually to increase sales.

fertiliser grain size; small or course, (5) package[8] size such as 5kg, 20kg, 25 kg and 50kg, and (6) differential pricing. Fertiliser brand loyalty is therefore a major item in fertiliser product differentiation as it is also associated with customer - perceived product quality and price. It influences the farmer on where to buy fertiliser.

Barriers to entry and exit

Economic theory states that so long as firms enjoy "abnormal" profits, there will be entry into the business until the profits are wiped out. However, other factors may deter prospective traders into entering the fertiliser business. A barrier to entry provides incumbent firms in the industry with an advantage over potential entrants.

Table 3.5 shows that inadequate initial capital is a major deterrent to entry into fertiliser business. Other notable barriers to entry include inadequate storage and transport facilities, and competition. The mean (s.e.) initial investment capital for stockists is Ksh. 216,200 (114,300) while for wholesalers it is Ksh.1.5 million (1.2 million) for fertiliser, an amount beyond the reach of many traders. Initial investment ranges from a minimum of Ksh. 1,000 to a maximum of Ksh. 10 million for stockists, while it ranged from a minimum of Ksh. 15,000 to a maximum of Ksh. 20 million for wholesalers. Initial capital is needed to purchase fertiliser, obtain trade licences, labour and for transportation and storage. However, out of the 122 sampled fertiliser traders, only 11.7 percent obtain credit as a source of initial capital with minority, 6.3 percent, sourcing initial capital from informal sources (friends and relatives) and 82 percent from owners' equity. Seventy five percent of initial investments from own savings is less than Ksh.100, 000.

Barriers to entry closely related initial capital include inadequate storage and transport facilities. Storage ensures that fertiliser is always available when demanded. Fear of competition, inadequate storage and transport problems were more pronounced among wholesale than stockists (Table 3.5).

Table 3.5 Barriers to entry into fertiliser trade

Type of entry barrier	Stockist	Wholesaler
	Traders (%) with barrier to entry (n=96)	Traders (%) with barrier to entry (n=22)
Inadequate initial capital	95.8	90.9
Inadequate storage facilities	58.3	90.9
Inadequate transport facilities	41.7	72.7
No credit services	29.2	31.8
Competition	22.9	54.5
Inadequate business talent	27.1	27.3
Not creditworthy	18.8	13.6
Difficult to exit once started	5.2	18.2

Source: Traders' survey, 2003-04

[8] Packaging also serves other purposes: facilitates the sale of the commodity in small quantities, minimises deterioration of the product by preventing contact with the environment, facilitates storage, transportation, handling and identification of the commodity, serves as a means of promotion and as a unit of measure.

Theoretically, when firms continuously experience business losses, they may exit trading. However as shown in Table 3.6**,** certain factors may in the short run prevent such firms from exiting business. In the fertiliser trade, high initial capital investment often in business-specific-type assets is cited as a major exit barrier. Other equally important deterrents to exit are stocks in store and high profits realised. Fertiliser trade synergises sales of other businesses and is cited as a major deterrent to exit. Of the sampled fertiliser traders, 94 percent are engaged in other business activities besides fertiliser. In such a case, the main objective of the trader is to enhance whole business sales output and not output from fertiliser trade *per se.*

Table 3.6 Barriers to exit from fertiliser trade

Type of exit barrier	Stockist	Wholesaler
	Percent of trader with barrier to exit (n=96)	Percent of trader with barrier to exit (n=22)
High initial capital investment	28.1	45.5
High profits realized	33.3	22.7
Stocks in store	22.9	45.5
Customer loyalty	21.9	27.3
Inadequate alternative business opportunities	12.5	13.6
Enhances sale of other shop merchandise	9.4	22.7
Legally bound	3.1	40.9

Source: Traders' survey, 2003-04

B) Conduct

In a bid to increase volume of sales and market share, some fertiliser traders provide non-price incentives in form of additional services to their clients. The services they offer depend on the level of competition, location of the traders and volume of fertiliser involved. The services include: (1) providing information on fertiliser use (62.3 percent), (2) re-packaging fertiliser into small packs in line with demand (42.6 percent), (3) offering subsidized transportation services or delivery of fertiliser depending on volume and distance (37.7 percent), (4) selling to a limited number of trusted retail traders and farmers on short-term interest-free credit (37.7 percent), (5) selling by sample i.e. by displaying the contents of a sample of fertiliser next to the actual fertiliser. This is often done to influence illiterate farmers who buy fertiliser on the basis of colour and grain size, and (6) providing limited technical services such as subsidized soil sampling. In addition, they may offer price incentives such as sales discount depending on volume and reputation. Depending on the firm's market share and location in the market, some firms may sell both at a lower or higher price relative to the prevailing market price.

C) Performance

The performance of fertiliser marketing in North Rift is assessed by examining the marketing margins and marketing costs of the various firms. Marketing margins are defined as the difference between the selling and buying price per unit quantity of fertiliser (in this case 50-

kg bag). Market margins reflect the underlying market structure. Generally, high market margins depict situations where oligopolistic or monopolistic conditions prevail whereas low marketing margins are a pointer to a more competitive market situation.

The nature and structure of marketing costs is provided in appendix 3.1. The fertiliser marketing margin analysis seeks to determine (1) the average fertiliser marketing cost by firm size, (2) if there are differences in marketing costs incurred by different firm-size groups, and (3) if there are differences in the level of margins realized by different fertiliser firm-size groups. It is hypothesized that smaller firms incur higher per unit fertiliser marketing costs than larger firms due to diseconomies of scale.

Marketing costs for each firm are determined by summing up direct labour costs for loading and off-loading fertiliser, direct transport costs using hired vehicles, cost of own transport for fertiliser business, rent/storage costs, repackaging, license fee and value of fertiliser losses incurred for each period each firm carried the fertiliser trade. Finally, the marketing cost for a 50-kg bag is computed for each firm. Firms are arranged in ascending order of volume of sales. Four groups (quartiles) are formed on the basis of firm size, that is, firms in quartile 1 formed group 1, firms in quartile 2 formed group 2, and so on until the four groups are constituted. Quartile 1 forms the smallest firm size category whereas Quartile 4 is the largest. For each firm-size group, an average composite 50-kg bag buying and selling prices are determined from the several fertiliser types and package sizes.

To determine differences in buying price, selling price and marketing costs, 3 analyses of variance (ANOVA) estimates are done. For significant ANOVA, orthogonal contrasts were made to detect for statistical differences in prices, margins and costs among the groups. For each variable – buying price, selling price and marketing cost – three contrasts were performed.

Marketing margins and costs

The mean (s.e.) fertiliser sales for the four firm groups in ascending order are 77.4 (11.4), 438.8 (33.8), 1,992.7 (180.8), and 38,381.0 (11,374.6) 50-kg bags, respectively.

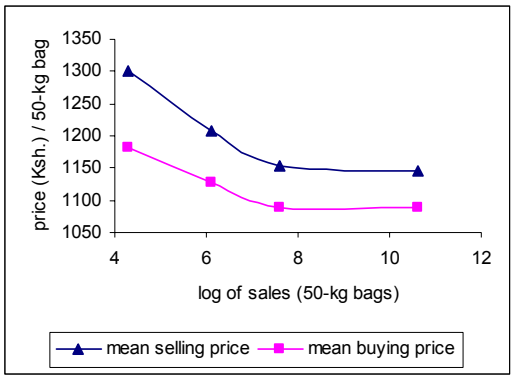


Fig.3.6a. Buying & selling prices by firm size

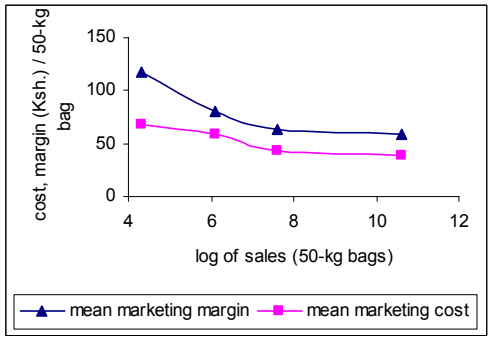


Fig. 3.6b Marketing margins & costs by firm size

The results indicate that marketing margin as a percent of fertiliser buying price decreased with increased firm size. The smallest firms have the largest percentage margin (9.9 percent), whereas the largest firms have the smallest (5.3 percent). Large firms buy and sell at lower prices than smaller firms (Fig 3.6a). However, there is an overlap between the buying price of smaller firms and selling prices of larger firms indicating that some of the small firms buy from large firms. This probably suggests that larger firms experience lower marketing costs and therefore sell at lower prices. As a result, they do not seem to exploit smaller traders or farmers. Both marketing margins and marketing costs decrease with increasing firm size (Fig. 3.6b).

The smallest firms sell fertiliser at an average price of Ksh1,300.00 per 50-kg bag compared to the price of Ksh.1,150.00 for the largest firms. The package size explains the high selling price by small firms. Small firms often sell small package size fertiliser which is more expensive on per kilogram basis. They often open the 50kg fertiliser bags and sell it in smaller quantities as demanded by farmers. This is consistent with results obtained by Mose (1998), where 68 percent of the 59 fertiliser stockists interviewed opened 50kg bags and resold them in smaller packs to increase sales turnover and profits. Conversely, the largest firms purchase fertiliser at relatively lower prices, a mean of Ksh.1,090.00 per 50-kg bag compared with the smallest firms who paid on average Ksh. 90-100.00 more for the same quantity. This can be partly explained by the fact that large firms often buy on discounts and some of them are vertically integrated, whereas small firms often buy from wholesalers who are also partly involved in retailing.

The ANOVA results for marketing margins indicate that there are differences ($F(3,105) = 3.05$, $p<0.05$) among quartile groups. The smallest traders (Quartile 1) obtain higher marketing margins ($t(105) = -2.82$, $p<0.01$) than medium and large traders (Quartiles 2, 3 and 4). However, there are no significantly different marketing margins ($t(105) = -1.1$, $p>0.05$) between the small to medium traders (quartile 2) and the medium and large traders (Quartiles 3 and 4) nor between the medium to large traders (quartile 3) and large traders ($t(105) = -0.16$, $p>0.05$).

The ANOVA results also indicate that there is a significantly different effect of volume of sale (firm size) on marketing costs ($F(3,105) = 9.98$, $p< 0.01$). The very small traders (Quartile 1) incur higher marketing costs ($t(105) = -4.36$, $p<0.01$) than medium and large traders (Quartiles 2, 3 and 4). Mean marketing costs decrease with firm size, indicating that larger firms enjoy economies of scale, probably in transportation and information. Small traders handle small quantities leading to diseconomies in transportation and information. Marketing margins for fertiliser traders are similar except for the very small scale firms who obtain slightly higher margins. This indicates that larger firms tend to maximize on sales volume rather than per unit margins. This is a pointer to greater competition even with increased firm size.

Fertiliser hedonic prices

The hedonic pricing technique is used to explain the spatial price differences observed in the commonly used fertiliser types in maize production: Di-ammonium Phosphate (DAP) and Calcium Ammonium Nitrate (CAN). The technique uses regression to estimate the prices of the attribute of a good. In the case of fertiliser, such attributes may include: service at delivery (transport, credit and information on use), package size, and location of the market.

In this respect, the price of fertiliser is shown as endogenous and the value determining attributes as exogenous. While the attributes are not sold separately, the resulting regression coefficients yield the marginal contribution of each attribute to the sales price for the good (Maurer *et al.* 2002). In general, the regression model takes the form:

$$p = f(x, \beta) + \varepsilon$$

where, p = vector of observed price of a good; x = matrix of characteristics or attributes; β = vector of coefficients; and ε = error term

The regression parameters β_i reflect the price of the attribute x_i, and are thus called hedonic prices. Apart from the specification of the value-influencing attributes, it is necessary to determine which function-type best explains the connection between price and the attributes of a good. Often linear, semi-logarithmic or log-linear models are chosen. The models are particularly easy to interpret and the estimated parameters possess a direct economic meaning. With the linear model, the parameters give absolute prices for the unit of the attributes, and with semi-logarithmic models, the coefficients of a variable are equal to the percentage effect of that variable being explained[9]. The price elasticities of the goods in the log-linear functions are displayed in terms of the relative change in the respective characteristics[10].

In this context, it is hypothesized that the observed spatial fertiliser prices are influenced by specific characteristics farmers look for. In this regard, the distance to the fertiliser market, type of trader-package size interactions and the purchase price of fertiliser per kg were considered. The logarithm of the price of fertiliser sold is used as the dependent variable. This model is estimated for each of the two fertiliser types, thus;

p_{DAP} = f (trader-package size dummies, distance to fertiliser market, transport cost, buying price)

p_{CAN} = f (trader-package size dummies, distance to fertiliser market, transport cost, buying price)

where, p_{DAP} is the logarithm of the selling price of one kg of DAP and p_{CAN} is the logarithm of the selling price of one kg of CAN; stockist or wholesaler-50kg dummy is a dummy specified as: 1= 50 kg; 0 = otherwise; stockist or wholesaler – 10kg dummy is a dummy

[9]This interpretation holds only for continuous variables; for dummy variables, see Halvorsen and Pollakowski, 1980.

[10] Whereby only the metric variables can be subjected to a logarithm, as dummy variables can approach the value zero and the logarithm of zero is not defined. Hence, parameters of the dummy variables are not elasticities but rather semi-elasticities.

specified as: 1= 50 kg; 0 = otherwise. To avoid the dummy variable trap, the 50kg stockist dummy was excluded from the estimation equation.

For both fertiliser types, the selling price of fertiliser decreases with increasing pack size (Table 3.7). Source of fertiliser as manifested in purchase price positively influenced fertiliser price. The farther the distance from the major fertiliser distribution centres, the higher the selling price of fertiliser. Transport costs per kilogram of fertiliser positively and significantly influenced the selling price of fertiliser. This implies that traders sourcing fertiliser from distant distribution centres sold it more expensively.

Table 3.7 Factors influencing selling price of DAP and CAN

	DAP		CAN	
Variable	β	***t***	β	***t***
Distance to supplier (km)	0.01	1.7*	0.01	1.4
Stockist - 10kg dummy	3.6	13.6***	3.6	8.2***
Stockist - 25kg dummy	1.3	5.8***	1.8	4.0***
Wholesaler - 10kg dummy	2.6	5.7***	3.5	3.2***
Wholesaler - 25kg dummy	0.7	1.9*	-0.5	-0.7
Wholesaler - 50kg dummy	-0.003	-0.01	-0.4	-1.1
Transport cost /kg fertiliser bought	0.8	3.3***	0.6	1.9*
Purchase price / kg	0.6	13.1***	0.7	13.5***
Constant	10.2	9.6***	6.1	5.4***
R^2	0.83		0.87	
Adjusted R^2	0.82		0.86	
N	221		107	
F	F(8,213) = 128.8***		F(8,99) = 81.1***	

Dependent variable is price per kg of DAP and price per kg of CAN, respectively. t- statistics: H_o: $\beta i=0$, H_1: $\beta i \neq 0$, *** =p<0.01, ** =p<0.05 and * = p<0.1

Source: authors' computations

To find out what the results mean to the farmers, we investigated the factors influencing the hedonic cost of DAP and CAN at the farm-gate. The cost of fertiliser at the farm gate is a function of the actual purchase price of fertiliser per unit, say 50kg, and transport costs from trader to farm. Therefore, hedonic cost of each fertiliser type is a function of transport costs per kilogram of fertiliser bought, distance to the fertiliser market, size of pack in which fertiliser is bought (represented as dummies) and total amount of fertiliser purchased by each farmer.

As expected, size of fertiliser pack significantly influences hedonic cost of fertiliser at the farm-gate (Table 3.8). The smaller the pack, the more expensive the per-unit cost of fertiliser. Distance to the fertiliser source provides mixed results. The negative sign for the coefficient for distance is unexpected. However, it reflects the mode of fixing transport costs which is pegged more on pack size for a wide range of distances than the actual distance itself.

Table 3.8 Factors influencing hedonic cost of basal and top-dress fertiliser at farm level

	Basal		Top-dress	
Variable	*β*	*t*	*β*	*t*
Distance to market (km)	-0.02	-2.0**	-0.01	-0.4
10kg dummy	4.5	4.6***	2.5	0.9
25kg dummy	3.0	3.4***	2.5	0.9
1 kg dummy	5.0	4.1***	8.6	3.0***
2.5kg dummy	-	-	10.1	7.2***
Transport cost per kg of fertiliser	0.5	2.4**	0.7	1.2
Total kg of fertiliser purchased	-0.002	-1.4	0.003	1.2
Constant	27.4	79.3***	21.5	30.3***
R^2	0.36		0.45	
Adjusted R^2	0.33		0.40	
N	147		82	
F	F(6,141) = 13.2***		8.9***	

Dependent variable is price per kg of basal fertiliser and price per kg of top-dress fertiliser, respectively. [1] *T statistics,* H_o: $\beta i=0$, H_1: $\beta i \neq 0$, **** indicates 1percent significance, ** indicates 5percent significance and * indicates 10percent significance*

Source: author's computations

Overall, the results show that farmers who demand small pack-size fertiliser incur higher per unit cost of fertilisers than those who demand large pack-sizes.

3.4.3 Structure-conduct-performance of maize seed marketing

Hybrid seed maize is the most adopted technological component of the maize production package in North Rift, with adoption rates ranging between 60-95 percent. It accounts for about 10 percent of the maize production costs. Heavy production losses up-to 30 percent may occur due to non-use of hybrid seed exacerbating the low yields farmers get. It is estimated that farmers in North Rift only realise about 40 percent of the research potential yield of 8-10 tonnes per hectare (Rees *et al.* 1998a).

Reliable information on the marketing of seed is therefore pertinent given the prominence of maize in household food security and as a major source of household income. Seed trading is a seasonal activity and on average takes place for 4.3 months per year with only about one percent of the traders selling seed all year round. Being a seasonal activity, the traders diversify into other trading activities such as keeping a general merchandise shop (50.4 percent), agro-veterinary products (32.7 percent), and hardware (8.4 percent). Only about six percent of all traders specialise in seed trade.

A) Structure

In determining the structure of the seed market in North Rift, four aspects of structure are considered: trader concentration, firm size distribution, product differentiation, and barriers to entry and exit.

Trader concentration

The degree of concentration among the maize seed stockists is measured by using the CR and HH index. Both the CR and the HH index for seed trading firms are calculated based on volume of maize seed purchases. The results indicate that the maize seed industry in North Rift has a HH index of 0.04, signifying that the industry is competitive. Within the largest firms, four control 31.8 percent, eight control 48.3 percent and 20 control 71.5 percent of the firms' total maize seed shares. About 53 percent of the traders control 10 percent of the seed purchases, signifying a high concentration of small scale traders in maize seed business. Participants in seed trading involve seed companies, agents, stockists and the farmers (Appendix 3.3).

Firm size distribution

The logarithm of kilograms of maize seed purchases is used to establish the seed firm size distribution in North Rift. Results suggest that the maize seed firms are positively skewed around the mean. The results imply that there is a tendency of more smaller firms than are larger ones. However, the Kolmogorov-Smirnov test ($p>0.05$) indicates that the firm sizes are log-normally distributed.

Tables 3.9 and 3.10 show that there is a great variation in the amount of seed sold across traders in different locations and by year of entry into the seed business. Table 3.9 shows that small traders are mainly concentrated in remote areas whereas in more accessible areas, both small and large traders abound.

Table 3.9 Sale of seed by location

			Kg of seed sold		
Location	Type of trader	No. of traders	Mean ± s.e.	minimum	maximum
Remote	stockist	37	5,201 (935)	206	24,110
	wholesaler	1	47,760 (.)	47,760	47,760
Accessible	stockist	50	15,983 (3,391)	144	136,304
	wholesaler	18	72,356 (17,274)	2,000	270,800
Total	stockist	87	11,398 (2, 062)	144	136,304
	wholesaler	19	71,061 (16,390)	2,000	270,800
	All	106	22,092 (4,012)	144	270,800

Source: Traders' survey, 2003-04

Table 3.10 shows that the average pre-liberalisation traders are about four times as large as the earlier post liberalisation (1997-2000) traders and eight times as large as the latter post-liberalisation (2001-2003) traders. However, there is a wide variation in size within each group. Many factors such as location of the business, demand for hybrid seed in the area, access of the traders to business resources such as working capital, transport, storage facilities and market information explain this observation.

Table 3.10 Sale of seed by year of entry of traders

Year of entry	Type of trader	No. of traders	Kg of seed sold		
			Mean ± s.e.	minimum	maximum
Before 1997	stockist	21	24,471 (7,128)	880	136,304
	wholesaler	13	91,107 (21,010)	3,200	270,800
1997-2000	stockist	28	8, 130 (1,472)	206	26,772
	wholesaler	4	40,086 (19,592)	8,762	90,910
2001 -2003	stockist	38	6,580 (1,700)	144	53,970
	wholesaler	2	2,711 (711)	2,000	3,422
Total	stockist	87	11,398 (2,062)	144	136,304
	wholesaler	19	71,061 (16,390.3)	2,000	270,800
	All	106	22,092 (4,013)	144	270,800

Source: Traders' survey, 2003-04

Among the seed traders, only the four seed companies (Kenya Seed Co., Western Seed, Pioneer and Pannar) are vertically integrated. The companies produce, process and also sell seed. They often sell seeds to agents who in turn sell to stockists. This group of traders did not fall in the sample that was interviewed and hence we did not analyse their gross margins.

Product differentiation

Product differentiation in the seed market is achieved through a variety of ways: type of packaging material, source of seed, size of seed, and price of seed. The two major types of packaging material used are the transparent polyethylene bags and the opaque manilla-type bags. Generally, transparent bags are used for smaller size packs (1 kg, 2kg and 5kg). Farmers prefer the bags because of the ease to identify broken or rotten seed. Seeds packed in these bags are not easily adulterated like those packed in the opaque-type bags generally used for larger size packs (10kg and 25kg).

Perceived seed quality based on the reputation of the seed company is another way of differentiating maize seed. Farmers prefer certain seed varieties from a particular seed company, even when the same seed is offered by another seed company. This is based on their perceived risk of obtaining adulterated or lower quality seed in response to several cases of seed quality adulterations following seed market liberalisation. Seed companies also differentiate seeds offered to the market by grain size (large flats, medium flats and hand planting). This is often done to cater for both machine planting (large and medium flats) and for hand planting. However, with continuous sub-division of land, this form of product differentiation is waning. Differential seed pricing by companies is also another strategy.

Barriers to entry and exit

In a liberalised marketing system, continuous entry and exit of firms into a market is expected until equilibrium is reached. However, barriers to entry and exit from the market may limit this occurrence. Table 3.11 shows that licensing is a serious barrier to entry in seed trade. All

prospective stockists must get a letter recommending them to the seed companies from the local District Agricultural Office to trade in seed. This requirement intends to safeguard farmers from unscrupulous traders who may sell commercial maize as seed. The prospective traders pay a token fee for the paperwork. The procedure may be lengthy, especially for new entrants. The licences are renewed annually.

Lack of initial capital and lack of adequate storage facilities are also key barriers to entry into the seed market. Of the 119 traders interviewed, 66 percent used own savings, and only 9.2 percent got credit from formal institutions. A minimum initial start-up capital of Ksh 10,000.00 was reported for traders using own savings and those who borrowed from family and friends. A minimum of Ksh. 50,000.00 was borrowed from commercial banks. The mean initial investment capital for stockists was Ksh. 152,000 while for wholesalers it was Ksh.1.5 million for seed, an amount beyond the reach of many traders. Initial investment ranged from a minimum of Ksh. 1,000 to a maximum of Ksh. 2 million for stockists, while it ranged from a minimum of Ksh. 50,000 to a maximum of Ksh. 10 million for wholesalers. This initial start-up capital limits prospective entrants. It is more pronounced among stockists than wholesalers (Table 3.11).

Table 3.11 Barriers to entry into the trade

	Stockist	Wholesaler
Type of entry barrier	Percent of trader with barrier to entry (n=96)	Percent of trader with barrier to entry (n=22)
License for operation	100.0	100
Lack of initial capital	88.3	59.1
Lack of storage facilities	47.9	72.9
Inadequate business talent	38.3	27.3
No credit services	33.0	13.6
Lack of transport facilities	29.8	22.7
Fear of competition	20.2	9.1
Difficult to exit once started	8.5	9.1

Source: Traders' survey, 2003-2004

Start up capital is needed to purchase seed, labour and a trading license. As the business grows, additional requirements such as pallets, personnel, office equipment and even pesticides are needed. Table 3.11 shows that inadequate business talent, lack of credit and fear of competition also impedes trader entry.

Despite the problems faced by those already in seed business, they do not readily quit due to barriers to exit emanating from asset specificity in form of heavy initial investments, high profits and customer loyalty (Table 3.12).

Table 3.12 Barriers to exit from maize trade

	Stockist	Wholesaler
Type of exit barrier	Percent of trader with barrier to exit (n=96)	Percent of trader with barrier to exit (n=22)
High initial capital investment	29.8	36.4
High profits realized	30.9	27.3
Inadequate alternative business opportunities	24.5	18.2
Customer loyalty	18.1	13.6
Legally bound	7.4	9.1

Source: Traders' survey, 2003-2004

B) Conduct

Pricing is used as a strategy among competing seed companies. Individual seed companies determine the price of seed at all levels in the marketing chain, which is usually pan-territorial and pan-seasonal. However, there are variations in seed prices among seed companies. For example, WSC prices her seeds slightly lower than KSC, while other seed companies offer slightly higher prices for seed of similar productivity and volume. KSC which controls about 90-95 percent of the domestic seed sales in North Rift offers pan-seasonal, pan-territorial prices for all her varieties. Other seed companies such as Pannar and WSC offer pan-territorial but differentiated prices on the basis of perceived seed productivities and cost of production.

Seed companies promote seed sales through field demonstrations to influence client behaviour. Field demonstrations show the performance of particular seed varieties given particular environmental conditions and management. Additionally, seed traders offer other services (Table 3.13) to influence customers. In particular, traders who buy more than five tonnes of seed from seed agents as a rule get free transport to their shops. All these services are a strategy to counter competition and increase sales.

Table 3.13 Non-trading core functions seed traders perform

Type of non-trading core function	Percent of traders performing function (n=119)
Provision of information on use	51.3
Provision of credit	27.7
Provision of transport	21.0
Re-bagging or re-packaging	0.8
Pricing	0.8

Source: Traders' survey, 2003-2004

C) Performance

Performance of the seed traders is assessed by comparing the marketing margins and costs across seed-firm size groups. The mean (± s.e.) seed purchases for the four firm groups in ascending order are 981(±113), 3,891 (±279), 11,039 (±638), and 73,487 (±11,503) kg. Seed purchase prices range from Ksh. 125.80 to Ksh.128.10 per kg whereas selling prices range from 131.60 to 132.80 per kg (Fig 3.7a).

A one-way ANOVA results indicate that mean selling prices are similar ($p<0.1$) across all firm size groups, but the purchase prices are dissimilar ($p>0.1$). This could be due to the fact that large firms who buy as wholesalers obtain seed more cheaply than smaller firms.

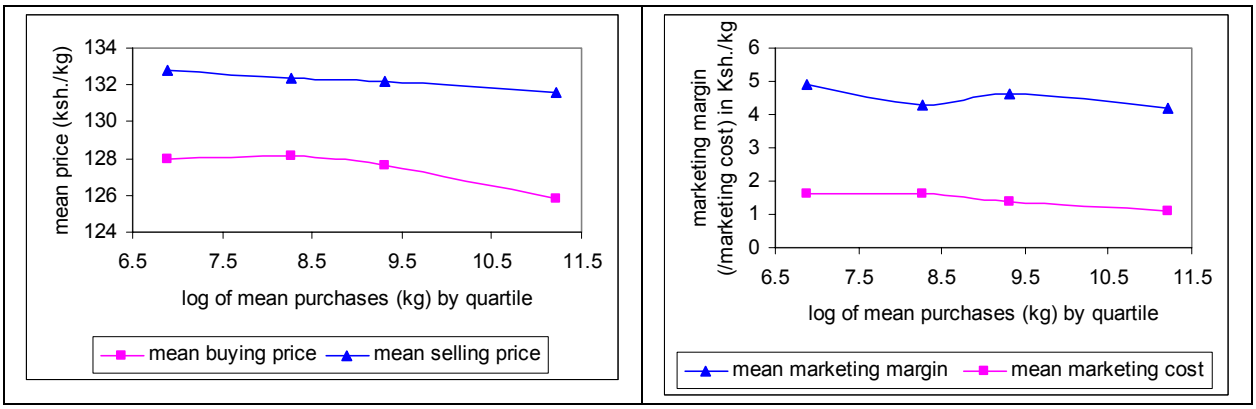


Fig 3.7a Seed buying & selling prices by firm size

Fig. 3.7b Seed marketing margins & costs by firm size

The results also show that both marketing margins and marketing costs (Fig 3.7b) are similar across firm size ($p<0.1$), although they tend to decrease with increasing firm size probably due to economies of scale, especially in transportation. The major marketing costs considered are labour for loading and off-loading seed during transportation and storage, transport, licensing, rent, storage and seed losses.

3.4.4 Structure-conduct-performance of maize grain marketing

Maize production in Kenya is dominated by small-scale farmers who produce over 75 percent of the produce (Pearson *et al.* 1995). It is the most important agricultural enterprise for most of the rural households in North Rift accounting for most of their food requirements and income. North Rift accounts for over 50 percent of the national traded maize volume. Jointly with other surplus districts like Kericho and Nakuru, they account for about 95 percent of the total marketed maize in Kenya (Wangia *et al.* 2000b). Therefore, understanding maize marketing is important to researchers and policy makers.

Maize marketing is multi-channelled (Appendix 3.3). Over 50 percent of the maize traders are farmers. In most cases, these are small-scale traders who take advantage of high profits realised during the peak season. They often use the income from sale of their own maize crop as initial start-up capital for the seasonal business. Only 13 percent of the traders sell maize all year round. Mainly as retailers operating in periodic markets they sell to the final consumers. On average, maize trading occurs for 6 months within any given year.

The majority of the traders have invested in a combination of the following: bicycles, weighing scale, several empty volume measures such 2-kg tins, gunny bags and a simple store. The smallest traders are assemblers who are the first commercial buyers of maize in the maize marketing chain (Appendix 3.4). The assembly of raw commodities is associated with

place utility since commodities are found in widely scattered geographic areas remote from consumption areas (Branson & Norvell 1983). Assemblers perform the physical function of transporting the products from the farm-gate to the next hierarchy in the marketing chain thus providing place utility. They usually buy small quantities directly from the farmers. They may also buy sizeable amounts depending on available supply, their level of working capital, accessibility to transport and also distance to the nearest sale destination. The large quantities are often sold to the National Cereals and Produce Board (NCPB) or maize millers.

The traders sort, dry and grade or standardise the maize. When maize is assembled, it is separated into classes most suitable for particular end users or next level of buyers. Grading is associated with form utility. For instance, depending on their sale destination (NCPB or large scale millers), if assemblers buy maize of higher than minimum required moisture content, they further dry the maize at the sellers' cost. Often the sellers provide an extra 3kg free for every 90kg bag sold as compensation for the high moisture content. Alternatively, the buyers reduce the price per bag for maize bought from the farmers. Sorting the maize ensures that the maize meets the minimum required RDD (Rotten, Discoloured and Diseased) specifications. Finally, they also bag the maize to the standard 90-kg bags, a common unit of sale. In so doing they facilitate maize trading at the next hierarchy of the marketing chain. The assemblers then sell the maize to millers or NCPB or traders with vehicles who may also operate stores (Appendix 3.4).

A) Structure

The structure of the maize market is assessed by considering the following: trader concentration, firm size distribution, product differentiation, integration and barriers to entry and exit.

Trader concentration

The HH index for small maize traders (stockists) was calculated based on volume of maize purchases. The HH index of maize stockists is 0.03, signifying that the industry is fairly competitive. Within the largest firms, four control 22.8 percent, eight control 37.3 percent and 20 firms control 62.7 percent of the firms' total maize purchased. About 63 percent of traders control only 10 percent of maize trade, signifying ease of entry of small traders into the seasonal, supplementary income-type business.

Firm size distribution

Using the logarithm of maize purchases to determine the distribution of maize traders, the results show that maize traders are positively skewed around the mean, implying a tendency of larger firms than smaller ones. The Kolmogorov-Smirnov test ($p>0.05$) indicates that the distribution of trader sizes is log-normal. Ease of entry in maize trading partly explains the many small traders who sell maize. However, there are differences observed in the pattern of distribution of these firms across location and time of entry into maize trade.

Maize production as well as maize traders is dispersed over a large geographical area (Table 3.14). However, traders located in the remote areas are often small in size and constitute mainly the assemblers. Those in accessible areas are mixed in size. They include both small and large traders (Table 3.14) constituting mainly traders with stores and millers.

Table 3.14 Sale of maize by location

			90-kg bags sold		
Location	Type of trader	No. of traders	Mean ± s.e.	minimum	maximum
Remote	Smaller traders	52	865 (184)	10	8,000
	NCPB and millers	1	160	160	160
Accessible	Smaller traders	100	2,227 (365)	5	20,000
	NCPB and millers	12	95,340 (38,084)	15	300,000
Total	Smaller traders	152	1,761 (253)	5	20,000
	NCPB and millers	13	88,019 (35,789)	15	300,000
	All	165	8,557 (3,276)	5	300,000

Source: Traders' survey, 2003-04

Post-liberalisation entrants are small compared to pre-liberalisation entrants (Table 3.15). There are also variations within each group, partly due to differences in resource endowments, accessibility to credit and location of the business among traders.

Table 3.15 Maize purchases by age of traders

			90-kg bags sold		
Year of entry	Type of trader	No. of traders	Mean	minimum	maximum
Before 1995	Smaller traders	34	2,185 (610)	6	14,000
	NCPB and millers	7	119,899 (51,150)	15	300,000
1995-1997	Smaller traders	25	1,318 (396)	10	7,000
	NCPB and millers	1	3,000	3,000	3,000
1998-2000	Smaller traders	55	2,354 (516)	10	20,000
	NCPB and millers	3	100.068 (99,966)	45	300,000
2001-2003	Smaller traders	38	816 (271)	8	8,000
	NCPB and millers	2	875 (825)	50	1,700
Total	Smaller traders	152	1,761 (253)	5	20,000
	NCPB and millers	13	88,019 (35,789)	15	300,000
	All	165	8,557 (3,276)	5	300,000

Source: Traders' survey, 2003-04

Product differentiation

Maize grain is fairly homogenous. Nonetheless, quality differences arising from biotic (pests and diseases) and abiotic (weather and mode of handling) factors do occur. As a result, traders often differentiate maize based on quality. Maize quality is based on NCPB specifications which comprise of: the standard moisture content for dry maize of 13.5 percent; an allowance

for broken grain of one percent, one percent for foreign matter and two percent for Rotten, Discoloured and Diseased (RDD) grain. Variants of these standard specifications attract different prices.

There is little evidence of traders colluding to set maize prices. NCPB is the price setter and all traders adjust their prices relative to the NCPB price. Depending on supply conditions, private traders offer higher or lower prices relative to NCPB price. When supply is low (high), the private traders often offer slightly higher (lower) prices than NCPB.

Integration

Survey data show that the degree of vertical integration among maize traders is 77.1 percent. Presently, the millers directly buy maize from farmers, unlike in the past when they could only buy from NCPB. The millers process the grain into various products such as flour, livestock feeds and edible oils.

Barriers to entry and exit

Despite the rapid entry into the maize trade, several barriers hinder prospective traders. Lack of initial working capital is cited as a serious entry barrier. The mean initial investment capital for small traders is Ksh. 67,500 while for large traders it is Ksh.168,000 for maize, an amount beyond the reach of many traders. Initial investment ranged from a minimum of Ksh. 250 to a maximum of Ksh. 2 million for small traders while it ranges from a minimum of Ksh. 2,100.00 to a maximum of Ksh. 1 million for wholesalers Among those who invest in maize trade, 87 percent of the initial capital is sourced from own savings and about 15 percent from friends and relatives, with only less than 5 percent from banks and cooperatives. Other entry barriers include lack of storage and transport facilities, inadequate business talents and fear of competition (Table 3.16).

Table 3.16 Barriers to entry into maize trade

	Small traders	Large traders
Type of entry barrier	Percent of trader with barrier to entry (n=156)	Percent of trader with barrier to entry (n=13)
Lack of initial capital	91.7	92.3
Lack of storage facilities	72.4	76.9
Fear of competition	48.7	84.6
Lack of transport facilities	49.4	61.5
Inadequate business talent	42.9	23.1
No credit services	39.7	30.8
Difficult to exit once started	14.7	7.7

Source: Traders' survey, 2003-04

Profitability of the business, high initial capital specific investments such as pallets and lack of better business alternatives are the major barriers limiting easy exit of maize traders from the business in the short run. Firms like NCPB are legally bound to sell maize

and hence cannot quit without an act of parliament and this constitutes an exit barrier (Table 3.17).

Table 3.17 Barriers to exit from maize trade

	Stockist	*Wholesaler*
Type of exit barrier	*Percent of trader with barrier to exit (n=156)*	*Percent of trader with barrier to exit (n=13)*
High initial capital investment	37.8	100
High profits realized	57.7	61.5
Inadequate alternative business opportunities	46.2	46.2
Legally bound	4.5	23.1

Source: Traders' survey, 2003-04

B) Conduct

Maize trade is multi-channelled and at every level of the marketing chain, competition is fairly stiff. In order to capture as much market share as possible, most traders have adopted a combination of the following strategies to counter the existing competition: (1) relaxation of quality standards taking into consideration supply of and demand for maize. When supply is high, the moisture content requirement of 13.5 percent is lowered and the minimum accepted standard level of RDD is raised. When supply is low, the standards are adhered to stringently , (2) differential pricing of maize, (3) subsidised transport services for onto-depot grain, (4) subsidised chequeing system - For some traders, the buyer meets the costs of processing a cheque and for others it is the sellers who meet this cost, (5) mode of payment: cash as opposed to cheque payment, (6) flexibility in payment period i.e. daily as opposed to periodic (weekly or monthly) payments, and (7) unit of measurement - weight (kg) as opposed to volume (gorogoro[11]).

In addition to these strategies, maize traders offer other services such as improving the quality of maize by further drying and sorting. Traders with hammer mills also change the maize form through processing grain into flour (Table 3.18).

Table 3.18 Non-trading core functions maize traders perform

Type of non-trading core function	Percent of traders performing function (n=169)
Re-bagging or re-packaging	82.9
Drying	78.2
Accumulation	71.2
Sorting	64.7
Pricing	52.9
Provision of transport	41.2
Provision of information on use	38.8
Grading	21.2
Provision of credit	13.5
Milling	10.6

Source: Traders' survey, 2003-04

[11] One "gorogoro" is equivalent to 2.25 kg of maize

C) Performance

The performance of the maize trading firms is assessed by considering the levels of marketing margins across various firm size groups. Prior to market liberalisation maize prices were pan-territorial, pan-seasonal, a strategy that impeded efficient maize distribution by private traders and increased market costs (Kenya 1981). This pricing system was a disincentive to the private sector because it did not cover the storage and transportation costs of the traders. However, with market liberalisation, prices are largely dictated by supply and demand conditions.

Prices offered are a function of marketing channel, volume traded, time between purchase and sale, and type of unit of measure for both purchase and sale. The volume of maize purchased is used to assess the performance of the maize traders. The volume of maize purchased by each trader is arranged in ascending order. Four groups (quartiles) are formed based on volume of maize purchased. The mean (± s.e.) purchases for each group in ascending order are 48 (±5); 302 (±23); 1,124 (±80) and 32,206 (±12,260) 90-kg bags. On average, the buying and selling price (Fig. 3.8a) decrease with firm size, but the trading margins (Fig. 3.8b) are quite similar implying that the selling and buying price are correlated positively.

The ANOVA results indicate that marketing margins are statistically similar across all firm groups, although the smallest firm group got Ksh. 290.00 compared to Ksh, 246.00 per bag for the largest firm group. This result indicates that marketing margins decrease with increasing firm size.

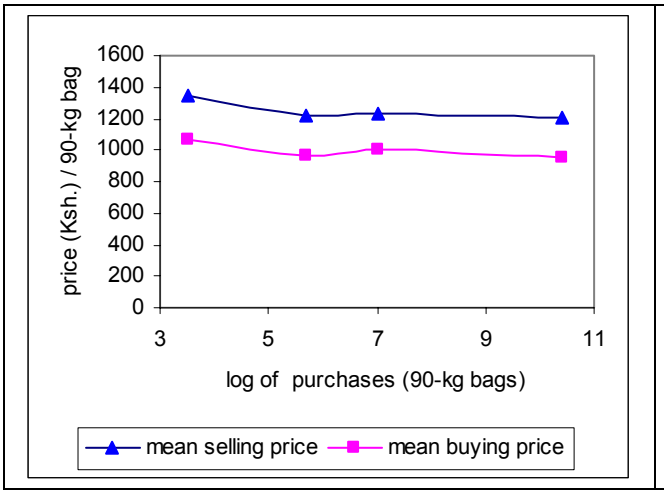


Fig 3.8a Buying & selling price of maize by firm size

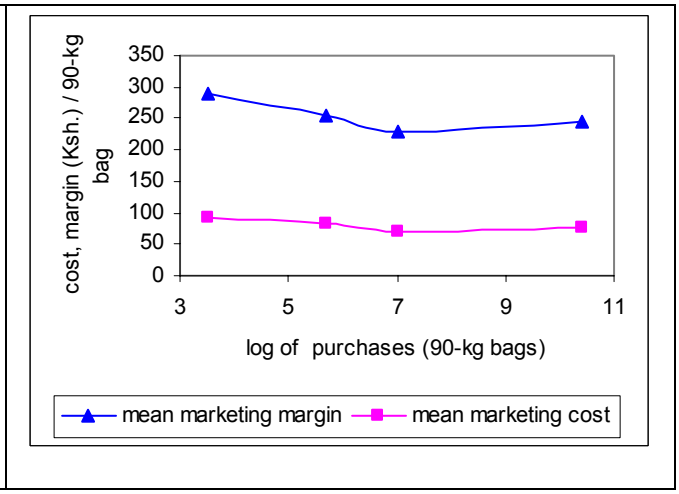


Fig 3.8b maize marketing margin & cost by firm size

Nature and structure of costs and prices

In addition to the cost of buying maize, traders incur other marketing costs such as cost of storage, transport, packaging materials, labour, rent, marketing fees and losses. Bribery is another cost usually incurred but rarely recorded. Reduction of each of the marketing costs represents an opportunity for increasing marketing efficiency. The total marketing costs are a

function of the length of the marketing chain, mode of transport, availability of labour, period of storage and the distance to the market.

Several modes of transport are available to traders. The modes range from use of bicycles to motorized transport such tractors, lorries and pick-ups. In remote areas, animal-drawn modes of transport are common. Storage period is a function of available storage facilities, available working capital and risk. Risk may result from quality deterioration, fluctuating price, and uncertainty regarding government policy. Due to these limiting factors, traders maintain a rapid turnover, storing maize between a few days to a few months. Labour is needed for loading and off-loading maize during transport and storage. Most of the traders employ casual workers to complete a particular task at hand at an area-specific wage rate. The other costs include gunny bags, at a cost of Ksh. 20-30 each and license fee, which depends on the scale of operation.

Fig 3.8b shows that marketing margin and marketing cost decrease with increasing firm size although not proportionately. Nevertheless, the first quartile traders receive the highest margin but also incur the highest cost, while the third quartile has both the lowest cost and margin. First quartile traders often retail at higher prices. By buying in small quantities, they incur higher per unit costs (diseconomies of scale).

Overall, analysis of variance (ANOVA) results for the four firm size groups indicate that there is a significantly different effect of volume of maize purchases on marketing costs ($F(3,161) = 3.3$, $p< 0.05$). Further analysis shows that very small traders (Quartile 1) incur higher marketing costs ($t(161) = -2.6$, $p<0.05$) than all other traders (Quartiles 2, 3 and 4), but there are no significant differences in the marketing costs among quartiles 2, 3 and 4.

3.4.5 Structure-conduct-performance of milk marketing

In Kenya, milk is demanded mainly for "whitening" tea and it is also consumed as *mala* (fermented milk). "Whitening" tea is considered as an indicator of well being. It is only the extremely poor households who take black tea or coffee. Some of the milk is consumed in its various processed forms as yoghurt and cheese. Being an important source of household income and food security, information on milk marketing is pertinent.

Over 50 percent of the milk traders are farmers. The majority of them are small-scale traders who buy and sell milk as a supplemental source of income. Over 64 percent of the traders sell milk all year round. Those with stalls also diversify into other business activities such as general shop-keeping. As shown in Appendix 3.5, there are several market participants in milk trade.

A) Structure

The structure of milk marketing firms is assessed by considering the extent of trader concentration, firm size distribution, market integration, product differentiation, and barriers to entry and exit.

Trader concentration

The HH index for milk firms is calculated based on volume of milk purchases. The results indicate that the milk industry in North Rift has a HH index of 0.07, signifying that the industry is competitive. Among the largest firms, four control 40.4 percent, eight control 52.4 percent and 20 control 69.4 percent of the total milk purchased output. Fifty three percent of the total firms control only 10 percent of the volume of milk purchased, signifying the presence of many small firms trading in milk. Ease of entry and exit partly explains why the milk market is competitive. It is also a business that occurs all year round signifying a stable source of income for traders.

Firm size distribution

Though heterogeneous in size, the milk trading firms are positively skewed around the mean, implying a tendency of more small firms than large firms. However, the Kolmogorov-Smirnov test ($p>0.05$) indicates that the firm sizes are log-normally distributed. The heterogeneity in size is better exemplified by location of trader and the time the trader entered the milk market relative to market liberalisation.

Many traders (93 percent) started their business after milk market liberalisation. Comparatively, post-liberalisation entrants handle smaller amounts of milk than pre-liberalisation entrants (Table 3.19).

Table 3.19 Sale of milk by year of entry of traders

		Litres of milk sold		
Year of entry	No. of traders	Mean ± s.e.	minimum	maximum
Before 1993	3	198,000 (171,079)	18,000	540,000
1993-1998	34	27,146 (6,783)	912	183,600
1999 -2004	78	10,395 (1,509)	900	93,600
Total	115	20,241 (5,129)	900	540,000

Source: Traders' survey, 2003-04

Similarly, traders located in remote areas handle a larger volume of milk than traders located in more accessible areas (Table 3.20). They buy milk from farmers and then transport it to urban consumers. They face less competition than traders close to urban centres.

Table 3.20 Sale of milk by location of traders

		Litres of milk sold		
Location	No. of traders	Mean ± s.e.	minimum	maximum
Remote	37	33,709 (15,153)	900	540,000
Accessible	78	13,853 (2,203)	912	108,000
Total	115	20,241 (5,129)	900	540,000

Source: Traders' survey, 2003-04

Product differentiation

Product differentiation is common in milk marketing especially at the processing level where milk is differentiated by: name of processor (such as Nyota, Brookside or New KCC); level of

butterfat content (whole or skimmed milk); packaging type (such as tetrapak or polythene bag); state of milk (fresh or fermented) and differential pricing. There is little product differentiation for raw milk. The demand for raw or processed milk is mainly a function of household income. Rich households prefer processed skimmed milk, which they perceive to be of higher hygienic standards. Relatively poor households prefer raw milk, which has higher butterfat content. The high butterfat milk is fermented into various products or is used to whiten tea so long as it is physically pure (not adulterated with other foreign matter such as additional water and physical impurities).

Integration

After the near collapse of KCC in the mid 1990s, there is little evidence of horizontal integration in milk marketing in Kenya at the milk purchasing and collection stage (Hoffler 2001). However, in localized situations, processors tend toward horizontal integration. Survey data show that the degree of vertical integration among milk traders is 5.5 percent. Vertical integration is evident among processors. They buy raw milk, process into several products and sell it to consuming institutions through many outlets such as supermarkets.

Barriers to entry and exit

Despite the continuous entry of milk traders, there are several barriers to new entrants.

Initial capital is a major impediment to entry into the milk marketing. Initial capital is necessary for the purchase of the basic tools for the trade; a weighing scale, milk delivery cans and transport mainly in the form of a bicycle. The mean initial investment capital for small traders was Ksh. 3,500 while for large traders it is Ksh.177,500 for milk, an amount beyond the reach of many traders. Initial investment ranges from a minimum of Ksh. 50 to a maximum of Ksh. 150,000 for small traders, while it ranges from a minimum of Ksh. 500.00 to a maximum of Ksh. 522,000 for large traders. About 83 percent of the initial capital is from own savings and the remainder from friends and relatives. None of the milk traders receive external credit from banks or cooperatives. Lack of transport facilities and fear of competition are other major impediments to trade (Table 3.21).

Table 3.21 Barriers to entry milk trade

	Small	Large
Type of entry barrier	Percent of trader with barrier to entry (n=110)	Percent of trader with barrier to entry (n=5)
Lack of initial capital	94.5	100
Lack of transport facilities	75.5	100
Fear of competition	62.7	40
Lack of storage facilities	51.8	80
Inadequate business talent	39.1	80
No credit services	27.3	40
Legally not allowed	11.8	40

Source: Traders' survey, 2003-04

Milk trade is a lucrative business. Therefore, fear of losing profits earned in an environment with few business alternatives is a major deterrent to exiting milk trade (Table 3.22). In addition, high capital investments already made hinder prospective traders from quitting.

Table 3.22 Barriers to exit from milk trade

	Small	Large
Type of exit barrier	Percent of trader with barrier to exit (n=110)	Percent of trader with barrier to exit (n=5)
High profits realized	70.9	40
Inadequate alternative business opportunities	46.4	40
High initial capital investment	44.5	60
Legally bound	15.5	20

Source: Traders' survey, 2003-04

B) Conduct

Milk trade is multi-channelled and at every level of the marketing chain, competition is fairly stiff. In order to capture as much market share as possible, most traders have adopted one or a combination of the following strategies to counter existing competition: differential pricing of the product on the basis of unit of measure used and type of customer, flexibility of unit of measure for purchase or sale and flexible mode of payment. Traders use the cup (350ml), bottle (700ml) or litre to buy and sell milk depending on the prevailing situation. The daily or periodical (week, bi-month, or month) payment for milk purchases and sales is in cash or on credit. The three different strategies aim at capturing as many consumers as possible. As an incentive strategy, the milk processors buy milk on the basis of butterfat content, with higher quality milk attracting better prices. In addition, during the dry season, the processors offer a premium price for milk as a way of encouraging farmers to deliver to them. The premium price is also meant to compensate farmers for the increased cost of milk production during the dry season.

The study shows that, on average, 21.2 percent use the cup, 21.8 percent use the bottle and 57 percent of the traders use the litre-can to sell milk. Flexibility on use of volume measures for sale ensures that almost all the prospective consumers can access milk, implying more milk is sold. In the former KCC system, milk was only purchased in kilograms as a unit of measure. This arrangement did not allow those who needed less than one kilogram of milk. Therefore, consumers have benefited in terms of increased availability of milk with market liberalisation. However, standardising to a per litre basis, consumers who purchase milk using a cup measure pay Ksh. 2.00 – Ksh. 8.70 more per litre compared to those who use the bottle or litre, who pay Ksh. 21.00 – Ksh. 25.00 per litre depending on location. This implies that the poorest consumers of milk pay more per litre of milk consumed than the rich. However, comparing the more affluent who consume processed milk and the poor who consume raw milk, the more affluent pay more per unit of milk consumed, due to costs of processing.

Flexibility in the mode of payment, which occurs as payment in cash or credit on a daily or periodic basis partly explains why the hawkers and to lesser extent other dairy processors have taken up a larger share of KCC market. The flexibility allows milk producers to meet their household financial obligations when due. Furthermore, as shown in Table 3.23, the milk traders deliver milk to consumers at household-gates. In some cases, the traders offer milk on credit while in other cases, they assemble or bulk-build for processors.

Table 3.23 Non-trading core functions milk traders perform

Type of non-trading core function	Percent of traders performing function (n=115)
Provision of transport	63.5
Accumulation	63.5
Pricing	57.4
Provision of information on use	31.3
Provision of credit	23.5

Source: Traders' survey, 2003-04

C) Performance

There are statistically significant (p>0) differences in the mean amount of milk sold among quartile groups. The mean (± s.e.) milk sales for the four quartile groups in ascending order are 2,117 (±118), 5,293(±248), 13,051 (±691) and 66,896 (±20,365) litres.

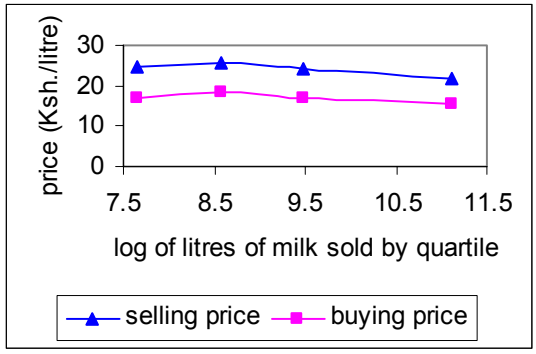


Fig 3.9a milk marketing margins by firm size

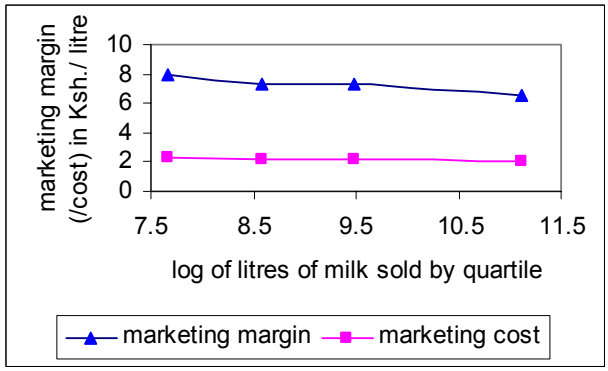


Fig 3.9b milk marketing margins and costs by firm size

The raw milk market is fairly competitive as the mean purchase and selling prices across the four quartile groups are quite similar (Fig. 3.9a). However, both the purchase and selling prices decrease in quartiles 3 and 4 after peaking in quartile 2. The difference in prices results mainly from two factors; the volume sold and the unit of measure used. The traders in quartiles 1 and 2 mainly use the "cups" and "bottles" as units of measure, while the larger traders tend mainly to use the "litre" as the main unit measure of sale. Proportionately, price per litre terms, is higher when using a "cup or bottle" than when directly using the "litre" as a unit of measure. The larger traders mainly sell to milk processors or larger consuming institutions unlike the smaller traders who mainly sell to direct consumers.

Milk hawkers who dominate the first and second quartiles are numerous and face stiffer competition for purchases. Due to stiffer competition, they often buy at higher prices than larger traders. Nonetheless, they also sell at higher prices because they are versatile and penetrate remote areas where large traders do not reach. Although hawkers rarely pay taxes and mainly use bicycles and public transport, they often incur losses resulting from milk spoilage. In contrast, large traders mainly buy from large producers at slightly lower prices. They are often licensed and incur transport, labour and storage costs, which reduce their margins.

There are no significant differences among various milk traders regarding marketing costs. The costs per litre of milk sold are similar (Fig. 9b). While the large traders benefit from economies of transportation, small traders incur little transport costs as most use bicycles.

3.4.6 Traders' constraints to effective business operations

Constraints hinder the effectiveness and efficiency of any business operation resulting in reduced performance. Constraints may be influenced by the type of business, volume of the business and the immediate business environment; policy, competitors, legal and physical. Therefore, business constraints may be many and varied.

In the fertiliser trade, strong competition (49 percent) is cited as the most limiting constraint. This compares with unavailability of transport (71 percent) for maize seed and lack of working capital / credit (59 percent) for milk and (72 percent) for maize. High transport costs and lack of reliable market information also cut across all the four commodities as serious constraints to trade.

High transport costs mean that traders neither deliver inputs to farmers nor farm outputs to consumers efficiently. The net effect is that consumers buy maize or milk at higher than efficient prices. Similarly, farmers buy fertiliser and maize seed at higher than efficient prices. Market information is asymmetric in favour of large traders who have the means to collect information through trading networks. This means that effective competition among traders is reduced. Other important constraints to trade include high interest rates on borrowed funds, lack or inadequate storage and unavailability of transport.

In addition, as (Karugia *et al.* 2005) noted, traders do not have the financial and managerial capability to store maize so as to exploit seasonal price changes. With a similar observation, Badiane and Shively (1998) suggest improvements in local storage to reduce food price variability. As a result, 64 percent of the seed traders and five percent of fertiliser traders report reduced demand because farmers complain of high input prices. Consequently, some of the farmers use substitute inputs such as recycled hybrid seed (retained farmer seed) and organic manures.

3.4.7 Trader perceptions on market liberalisation

Perceptions were sought on quantity traded, quality, and price of each commodity traded with respect to market liberalisation. Though subjective, perceptions provide indicative feedback to researchers.

A) Quantity of commodities traded

Across the four commodities, between 54 and 64 percent of traders said that the quantities of the commodities they bought and sold had increased with market liberalisation. This probably hints at the easing of conditions for trade with market liberalisation. The conditions include removal of movement restrictions for maize, allowing milk hawking, and easing licensing procedures for fertiliser and maize seed. This is in contrast with 10-32 percent of the traders who indicated that the volume traded had decreased, citing competition as the major reason. The latter response was mainly from the traders established before market liberalisation. The rest indicated that quantity traded fluctuated due to supply and demand conditions while still others indicated no change in quantities traded.

B) Quality of commodities

Perceptions on quality of commodities traded are mixed. Except for maize grain (28 percent), perceptions on the other commodities indicate that only less than 15 percent of the traders reported an increase in quality of goods traded. One of every three maize seed and maize grain traders indicated a decrease in quality of the products traded. This compares with one of every four traders in case of milk and one of every five in the case of fertiliser.

C) Price of commodities

Price is used effectively as a policy instrument to offer incentives to farmers to encourage them to produce more commodities. With market liberalisation, it was anticipated that input prices could drop as competition increases while output prices increase as monopsony conditions are eroded. However, 62 percent of the traders perceive that input prices have increased and none perceives that the input prices have decreased. This is in contrast with only three percent who have not seen any change and a further 35 percent who have seen prices fluctuate year after year.

3.5 Discussion, conclusions and implications

This chapter provides information on traders in North Rift who link farming households with consumers and input suppliers. Information obtained in this chapter is used to partly explain results that are obtained in chapter four with respect to maize supply response and in chapter five with respect to the extent to which households commercialise their maize production activities. In order to understand how well the traders perform their roles, this chapter endeavours to understand the traders from several perspectives: the extent of the trader entry in terms of year of entry, type and level of investments made. Using the structure-conduct-

performance framework, the chapter provides empirical evidence on the current structure in each market, trader behaviour and ultimately their performance, given their heterogeneity in resource endowment and location. In addition, trader perceptions on market liberalisation are provided. Next, we discuss, conclude and provide implications of the main findings.

Over 70 percent of the traders sampled emerged after market liberalisation. This shows rapid trader entry unlike in Zambia where though private trade in fertiliser is legalized, the co-existence of government programs distributing fertiliser at subsidized prices and with high loan default rates clearly impedes incentives for private investment making traders to complain that uncertainty over the timing, location, and volume of fertiliser distributed under the government programs adds risks and costs to their operations, and reduces their participation in the market (Jayne *et al.* 2003) while in Ethiopia, government policy in recent years appears to have been designed to suppress competition and maintain control over the fertiliser sub-sector (Dessalegn *et al.* 1998).

Though heterogeneous in size, the traders across the four commodity markets are log-normally distributed, and have a tendency to smaller rather than larger firms. In all the markets, the new traders are small relative to their pre-liberalisation entrants. The traders who emerged immediately after market liberalisation are often small and have not expanded to the extent of the large, well-established pre-liberalisation entrants. In addition, most of the new traders are located in remote areas, where they handle negligible volumes of commodities, in particular fertiliser. The observation underscores the difficulties inherent in firm entry and subsequent expansion which include inadequate working capital, inadequate storage and transport facilities, customer loyalty, inadequate entrepreneurial skills, and licensing (mainly in the case of seed). Furthermore, market information is not universal across all traders. Most of the traders across the commodities finance their activities from owners' equity with little external finance. This scenario partly limits the opportunities for firm expansion in terms of area covered and quantities traded, in effect dampening possible competition. These findings support similar results among Ethiopian grain traders whom shortage of financial credit limits their operations and business expansion while lack of access to working capital and facilities at convenient locations in the market place seem to be the most important barriers to entry (Dessalegn *et al.* 1998).

In order to wade off competition and increase market share, some traders have invested in bicycles and vehicles for transport, and in storage facilities. Investment in storage facilities is common mainly with fertiliser and seed traders but less so with maize traders. The result echoes the findings of Alderman and Shively (1996b) who argue that African traders have little incentives to tie up capital in speculative storage since the opportunity cost for traders of storing is high. Furthermore, the authors argue that the relative unpredictability of food imports can increase the traders' risk associated with holding commercial stocks. Moreover, Poulton *et al.* (2006) observes that due to the seasonality of most African rain-fed agriculture, many input stockists do no keep large quantities of inputs for fear of being left

with excess inventory, which often cannot be disposed of for another one year and which may deteriorate in storage.

Evidence adduced from trader conduct shows no collusion among traders in either pricing or limiting the volume traded in order to exploit farmers. This is in stark contrast with the findings of Badiane (2000) who finds that trading in certain food markets in Africa is monopolised or restricted through local trader associations. However, we observe that across the commodities, traders differentiate their products to increase their market shares. They employ several methods of product differentiation such as differential pricing which cuts across all commodities and commodity-specific measures such as using different measures to transact trade at different levels of the marketing chain in case of milk and maize.

Though there are variations in trader concentration ratios across all markets, the concentration ratios are generally low. Similar low concentration levels have been observed in the Ethiopian grain market (Dessalegn *et al.* 1998). Low concentration levels indicate a tendency towards a competitive market situation which is further supported by low marketing margins the various traders receive. Traders who buy high also sell high and vice versa, signifying that those who buy low do not sell high to exploit the consumers. The marketing costs for small traders are high though they tend to decrease with increasing firm size signifying economies of scale especially in transportation. Furthermore, vertically integrated firms have lower marketing costs than non-vertically integrated firms. Distance is a major factor influencing fertiliser prices at the stockist level and farm-gate levels. Thus, one way to reduce the retail or farm-gate price of fertiliser is to reduce transport cost, in particular by exploiting economies of scale in transportation. The increased number of traders in each market offers farmers a choice of where to buy from (in case of seed and fertiliser) and where to sell (in case of maize and milk), further suggesting that traders do not exploit farmers as generally assumed.

In order to triangulate the results of the trader surveys, we sought traders' perceptions on the impacts of market liberalisation on several variables. Results of this analysis shows that traders perceive that with the advent of market liberalisation, the volume of all commodities they handle has increased. They also unanimously indicate that the nominal prices of all the commodities had increased. The trader perceptions on quality of the commodities traded are mixed. They attribute the occasional occurrence of poor quality seed and fertiliser to inadequate quality inspection services.

Based on our findings we conclude that traders still require institutional support to increase their market participation as evidence shows that, in particular, trader activity in remote but mainly surplus-producing areas is "thin" (with small volumes traded, although in some cases e.g. for maize, large numbers of people are involved). In particular, input traders are likely to increase if there is increased demand for the inputs they sell. Improving farmer profitability through use of improved technology, increased input use and access to information on prices and markets may increase trader entry. Also, institutional support in the form of providing credit and market information to traders, in addition to improvement of

road infrastructure, are likely to improve trader performance and hence encourage more participation. This implies that both the state and the private sector have a role to play in improving input and output market development.

Appendices

Appendix 3.1 Nature and structure of the fertiliser marketing costs

Marketing costs for fertiliser traders take many forms. They include variable, quasi-fixed and fixed costs. The most important variable costs are casual labour, repackaging materials, fertiliser losses on transit and hired transport. The quasi-fixed costs include own transport, regular labour, rent, license fee and storage charges. Fixed costs include interest on use of capital and utilities like water, electricity and telephone. None of the fixed costs mentioned was collected and therefore are excluded from the analysis that follows.

Packaging of fertiliser is necessary as it serves many functions. It facilitates the sale of fertiliser in small quantities, minimises deterioration by preventing contact with the environment, facilitates storage, transportation and handling, facilitates identification, serves as a means of promotion and serves as a unit of application. A few traders repackage fertiliser and this could be a potential source of fertiliser adulteration. Generally, fertiliser offered for sale for the most commonly used fertiliser types such as Di-ammonium Phosphate (DAP) and Calcium Ammonium Nitrate (CAN) is often already packed in different sizes (5kg, 10kg, 25kg, and 50kg). For the less commonly used fertiliser types like Mono-Ammonium Phosphate (MAP) and Ammonium Sulphate Nitrate (ASN), only the 50kg package is available. Yet in certain instances and in particular for the extremely cash constrained households with limited land parcels, only small amounts of fertiliser may be demanded. In such cases, fertiliser stockists repack fertiliser into smaller quantities to meet the specific demands.

Transport costs are a major cost component for the traders. Several factors such as the distance, mode of transport used, state of the road network and volume transported influence the cost of transport. It is cheaper to transport fertiliser on roads that are paved than on non-paved seasonal roads. Consequently, stockists located in urban centres along major roads incur less transport costs than those located in remote distant areas often through seasonal roads. Most wholesalers in the three major fertiliser distribution centres in North Rift: Eldoret, Kitale and Kapsabet, mainly source their fertiliser from Nairobi, over 200 km away mainly by road. Rail transport from Nairobi to Kitale and Eldoret is equally expensive and because of delays caused by inadequate wagons, most traders prefer using road transport. Subsequently, fertiliser is transported to local market centres by hired transport, own transport or public transport. Generally, the very small traders use public transport and the very large stockists either use hired or own transport.

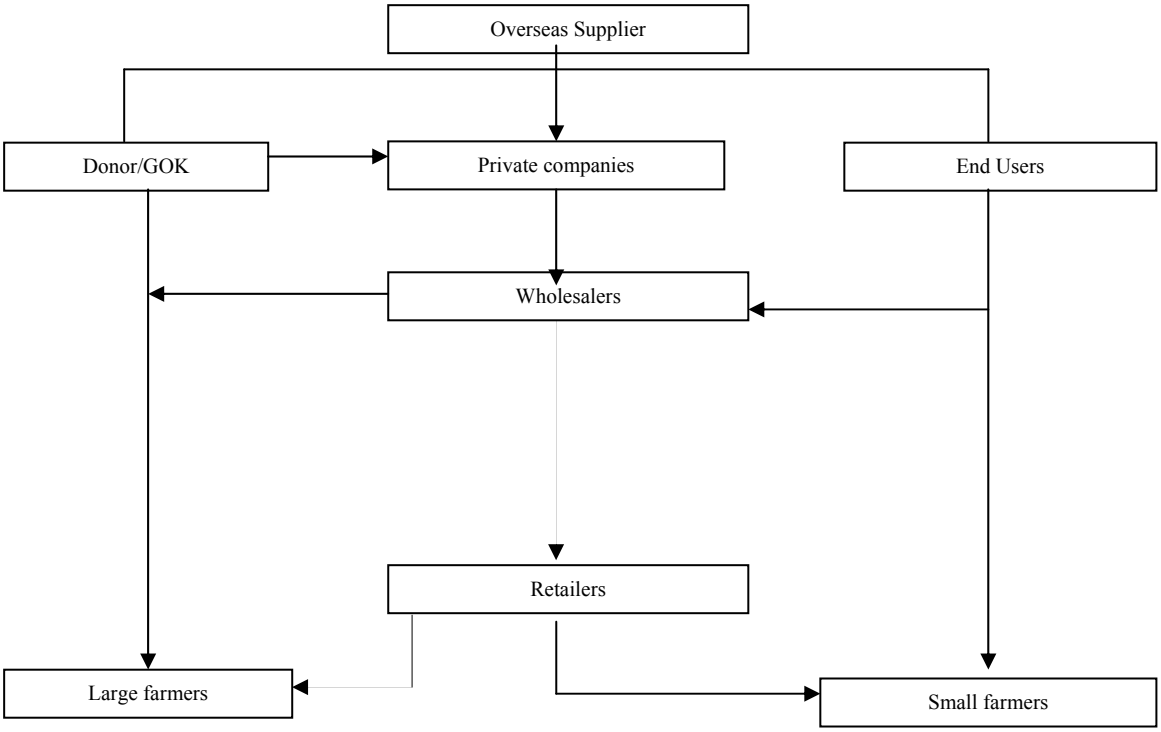
Labour for loading and off-loading fertiliser is hired on a casual basis and often paid per number of bags loaded/off-loaded or by lorry-load. The cost differs by location but it is generally high for major urban centres because of the alternative opportunities available for labour. In certain cases, large stockists hire regular labour whereas the very small stockists use family labour.

Depending on amount handled, some stockists/wholesalers store fertiliser in go-downs and only release small amounts to their shops for sale depending on available shop space. They incur both storage costs and rent for the shops. This is common with medium to large-scale traders located in the major urban centres. In certain cases, all fertiliser is kept in the shop from where it is sold and in this case only rent is incurred. This is common with small to medium scale traders mainly located in rural areas. Thus rent and storage costs largely depend on the location of the trader (rural or urban), and for those in the urban centres, the specific location in town (backstreet or central business district) is important.

Fertiliser losses also constitute a cost to some traders. Losses may arise from fertiliser theft on transit. Normally, small consignments of fertiliser are not insured against risks. Other losses may occur during storage arising from pest attack (rodents) leading to pilferage and caking due to high humidity in case of leaking roofs.

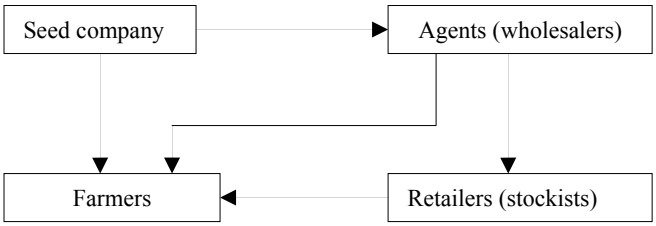
As part of revenues that accrue to local authorities (county, town, urban or municipal councils), all traders within their jurisdiction pay some license fee, usually once per year. The amount paid depends on the size of the business and the authority under which the trader operates. The fee is usually highest for large traders operating within the municipal councils and lowest for small traders within county councils. However, due to poor enforcement of this requirement, some traders, particularly the small ones do not incur the cost.

Appendix 3.2 Fertiliser Marketing Channels



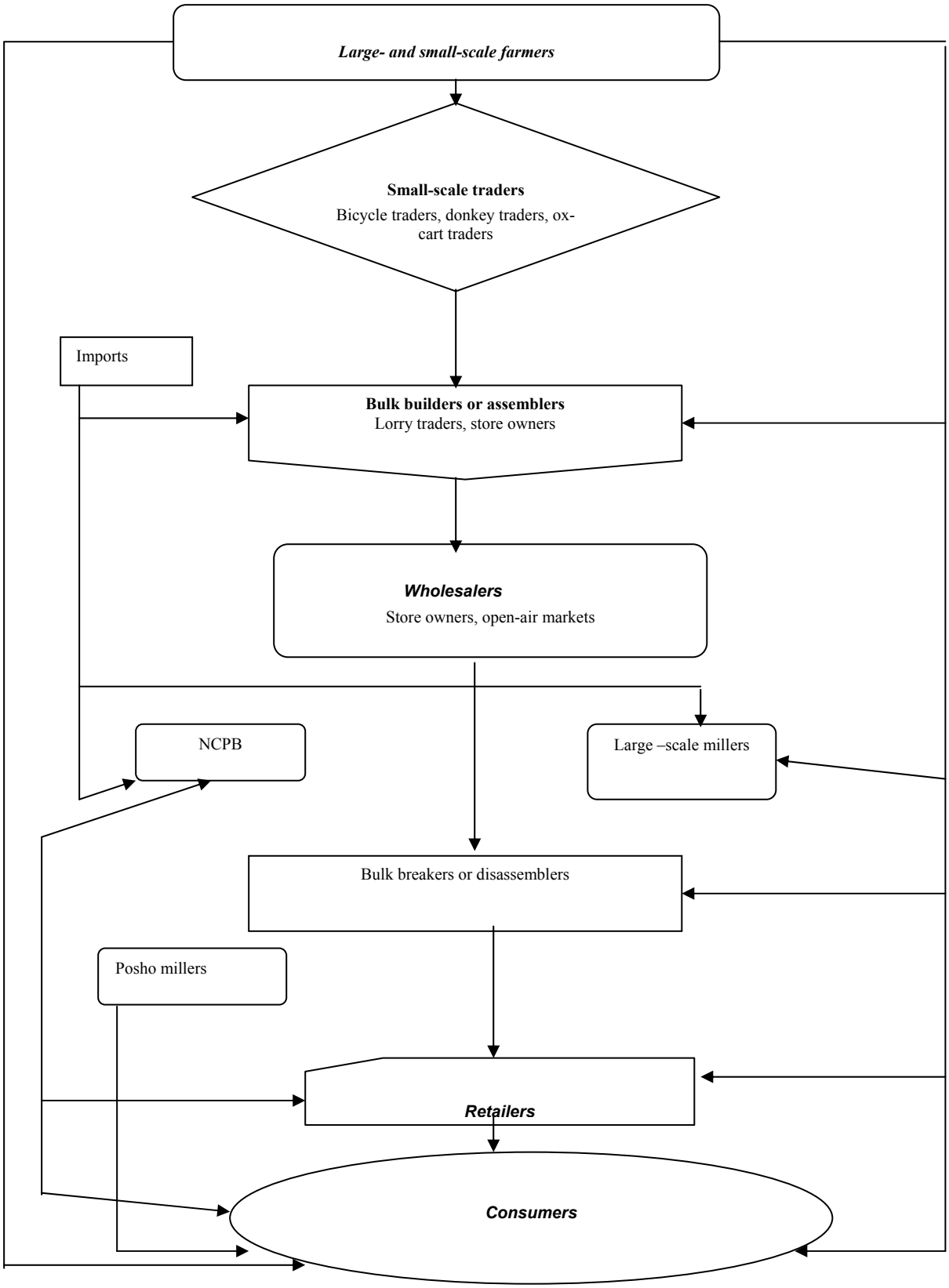
Source: Kimenye, 1997

Appendix 3.3 Seed marketing channels



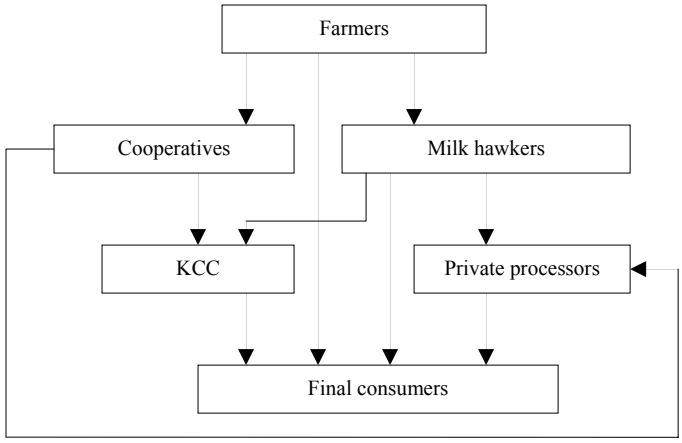
Source: author, 2004

Appendix 3.4 Maize marketing channels



Source: Karugia et al. 2004

Appendix 3.5 Milk marketing channels



Source: SDP, 2004

CHAPTER 4

AGGREGATE SUPPLY RESPONSE TO THE CHANGING MARKET ENVIRONMENT

4.1 Introduction

The seminal work of Nerlove (1956) set the pace for studies on agricultural supply response to price incentives. Since then, a number of studies on agricultural supply response to price incentives have been undertaken across many regions, on individual commodities and at aggregate level (Krishna 1963; Askari & Cummings 1977; Lamb 2000; Gafar 1997). A significant number of these studies focus on price elasticity. These studies are important to agricultural response analysis because prices are the channel through which market reform policies affect agricultural variables (output, supply, exports and income). Supply response results enhance an understanding of the impacts that alternative policy packages may have on households and other market participants.

Supply response studies conducted before market liberalisation in developing countries maintain that pricing policies were biased against agriculture. Therefore, they advocate setting of the "right" price as an effective mechanism to increase supply response and subsequently expand agricultural growth (Schultz 1964; Lipton 1977; Krueger 1992; Bautista & Valdes 1993). Whereas the studies argue that the "right" price would offer incentives for adoption of agricultural technologies that enhance production, others (Dantwala 1967; Streeten 1987; Chhiber 1989; de Janvry 1986; Mellor 1988) argue that non-price factors (mainly technology, infrastructure, research and extension) are more important mechanisms in increasing supply response and sustaining agricultural growth. In practice, a mix of the two mechanisms to supply response is often considered appropriate.

Overall, it has been found that elasticities of supply response vary with commodity, region and method of estimation, given the prevailing price and non-price factors. Chhiber (1989), demonstrates that the aggregate supply elasticity with respect to prices in many sub-Saharan African countries lies in the range of 0.3 to 0.9, partly due to inadequate supportive infrastructure, imperfect markets and lack of capital. Rudaheranwa *et al.* (2003), argue that supply response in these countries may be minimal because: (1) the subsistence sector is assumed to be risk averse and to value leisure and other activities highly, and (2) farmers are assumed to have income targets such that if the producer price increased, the production of smaller amounts of a commodity would provide the necessary income.

Kenya is among the developing countries that have liberalised their agricultural markets in the past two decades. A key expected consequence of market liberalisation was that farmers could respond positively to the expected price incentives by increasing supply. This is in line with the assertion of Bautista and Valdes (1993) who hypothesize that reforms that offer price incentives and promote efficient marketing encourage producers to respond by increasing supply. This chapter assesses this claim by examining the farmers' maize supply

response in Trans Nzoia District, Kenya. The district was chosen because it is considered to be the granary of Kenya, a major producer of maize. It is a net exporter of maize to other parts of the country. Besides, it is the district in which there were consistent district-level time series data that were used to estimate supply response other than the national aggregate data often available.

In this chapter cointegration and error correction modelling approaches with data covering the period 1980 to 2003 is used to assess the extent of the farmer responses to the expected price incentives.

The rest of this chapter is organised as follows. Section 4.2 gives a brief overview of the expected maize supply response to market liberalisation. Section 4.3 provides the theoretical framework of supply response in agriculture. Section 4.4 offers examples of common modelling approaches to supply response and their theoretical procedures while in section 4.5 an application of cointegration and error correction models (ECM) to maize supply response in Trans Nzoia District is provided. Specifically, it presents the data sources and the empirical estimation model of the maize supply response for Trans Nzoia. This section also provides the estimating model specifications. In section 4.6 the empirical estimation results are provided and finally in section 4.7, we discuss the main findings, draw conclusions and implications.

4.2 Expected maize supply response to market liberalisation

One of Kenya's food policy objectives is to attain self-sufficiency in maize production through production intensification and marketing (Republic of Kenya 1994a). Until 1994, the producer price of maize was regulated and applied on a pan-territorial and pan-seasonal basis. Official prices for the different stages in the channel from the National Cereals and Produce Board (NCPB) to consumers were being gazetted over the course of the cropping calendar. Before 1981, the producer price was based on the cost of production and a mark-up in relation to local production. In 1981, the maize pricing policy changed to that based on world market parity prices (RATES 2003). This pricing policy prevailed until 1994 when the maize market was liberalised. Although the government was the main actor in maize marketing, there was a parallel informal market. Price fluctuations were minimal as prices were guaranteed at the onset of planting season, when production decisions were being made. This price certainty influences farmers' production decisions. However, in spite of the price certainty, delays in payments for maize deliveries to NCPB were common such that farmers could not always get money to purchase necessary inputs for the subsequent season in time. During this period, production steadily increased partly due to increasing area under maize production.

Thus, the liberalisation of the maize market was expected to increase the participation of the private sector in maize marketing and change the role of NCPB from a monopoly buyer and seller of maize to a commercial trader and maintaining the strategic national food reserves (Nyoro & Nguyo 1999). Furthermore, this policy change was expected to foster efficiency in

maize marketing with increased competition among traders that could eventually benefit farmers.

However, available evidence shows that the reform process has been marked by a series of policy advances and reversals regarding the amount of freedom accorded to the private sector (Nyoro & Nguyo 1999; Wangia *et al.* 2000a). For example, in 1994, the government introduced a variable import duty following substantial imports by private firms that had been blamed for a slump in the price of domestically produced maize. Duty has since been applied on and off in an *ad hoc* manner, rather than as a consistent policy intervention. In addition, during the reform period, the real maize producer prices have significantly declined while at same time, volatility of maize prices increased. The uncertain policy environment and frequent government interventions have negatively affected the extent of maize market reforms and the participation of the private traders as intended (Karanja *et al.* 2003).

Although the policy reforms were aimed at boosting self-sufficiency in maize production, on the contrary, maize production has over the years fallen short of the consumption targets (RATES 2003). As a consequence, the country has become a net importer. For instance, between 1997 and 2001, the maize deficit was bridged through unrecorded cross border trade (RATES 2003). In addition to the unrecorded trade, the deficit was met through official cross border and offshore imports of about 2.2 million tonnes. The implications of inconsistent government policy on maize trade are that farmers face price uncertainties that make planning of how much to produce difficult. Furthermore, the problem of price uncertainty deepens when it coincides with situations when there is high domestic production. The excess production coupled with inadequate on-farm storage facilities, compels farmers to sell their maize soon after harvest to wade-off post-harvest losses due to pest attack (RATES 2003).

In view of the present scenario, it is not clear how farmers respond to these price uncertainties. But understanding farmer responses to such changes requires a better understanding of the changing role of the actors in the maize production and marketing. Specifically, this chapter focuses on the role of farmers in maize production.

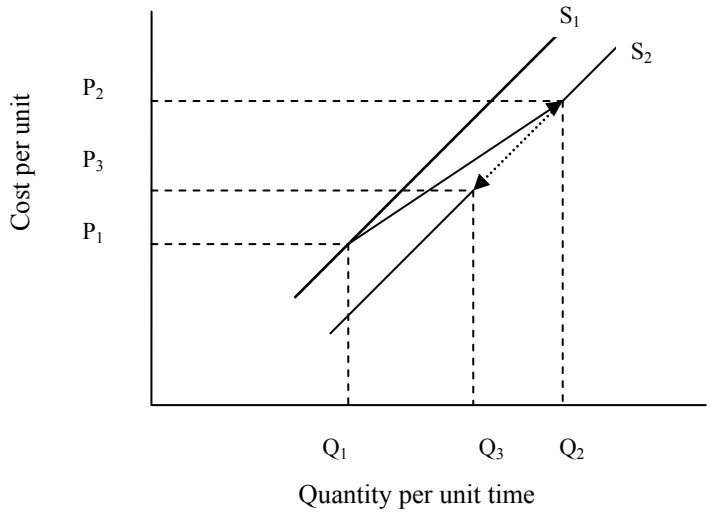
4.3 Supply response: Theoretical considerations

Supply response specifies the output response to a price change not holding other factors[12] constant. Thus, the response may involve both movements along a supply curve and shifts in supply. Under these circumstances, a change in price can be expected to have two effects (1) it may cause producers to change output along the static supply and (2) it may lead them to shift to a new supply curve. Unlike the supply curve, the supply relation is not a reversible function (Tomek & Robinson 1981). The supply response elasticity is likely to be different

[12] Access to land and tenure systems, infrastructure, technological advancements, human capital, natural factors and risk are examples of other factors not held constant. They are often referred to as non-price factors or supply shifters in the supply response literature (Tomek and Robinson, 1981).

for an increase in price than for a subsequent reduction in price. Various statistical models have been developed in an attempt to test whether or not the response of output to an increase in price differs from the response to a decrease in price. The evidence suggests that differences exist; the percentage response to a given price increase generally exceeds the response to a corresponding decrease in price (Tomek & Robinson 1981). Empirical results from the application of alternative asymmetric supply functions are reported by Traill (1978). The traditional supply curve specifies that if price increases and then decreases, the quantity supplied will return to its original level and thus is reversible.

Figure 4.1 shows a hypothetical supply response. The response concept is based on the hypothesis that when price changes, there is likely to be correlated changes in supply shifters.



Source: (Tomek & Robinson 1981)

Fig.4.1 Hypothetical supply response paths

The concept presupposes a backlog of new technologies, which may be adopted by the producer. Under conditions of rising prices, firms may be induced to adopt new techniques at a somewhat faster rate than with constant or declining prices. Under these circumstances, an increase in price can be expected to have two effects. First, it may cause farmers to increase output along the static supply curve; and second, it may lead to a new supply curve. The resulting increase in supply will thus be greater than one might have anticipated if the forecast were based on the static concept of supply. Once adopted, improved production practices usually are retained even though the price of the product subsequently declines. Farmers are

not likely to discard new technologies and thereby shift the supply function to the left once it has moved to the right. Hence, the supply response to a subsequent decline in price is likely to be less than it was for the previous increase in price. Under these circumstances, the response elasticity is higher for a price increase than for a price decline.

For instance, at price P_1, producers offer an output, Q_1, but as the price increases to P_2, output expands along the diagonal between S_1 and S_2 ultimately reaching Q_2. If the price thereafter declines to P_3, output declines along the new supply curve, S_2, resulting in the production of Q_3.

Supply relationships for individual farm commodities are often complex partly due unpredictable elements that determine yield (Tomek & Robinson 1981) and other influencing factors. Next we highlight some of these factors:

Biological characteristics of commodities. The biological nature of agricultural production means that supply cannot respond immediately to a change in price thereby creating time lags in supply response. Tomek and Robinson (1981) estimate a time lag of up to eight years or more for tree crops for a complete quantity adjustment to a change in expected prices. Supplies of livestock products are limited to the availability of breeding stock and the time required to produce a new stock.

Natural factors. Natural factors (climate and soils) determine the levels of response while pests and diseases may reduce potential yield levels. For rain-fed agriculture, ample rainfall implies high supply and dry weather implies low supply.

Access to land and land tenure systems may influence supply response. If a household has limited land and cannot access extra land through existing land tenure systems, it may not respond to price incentives.

Technology. Supply response presupposes availability of technological advancements. If a household has no access to technological advancements likely to shift the supply curve to the right, it may not respond to price incentives as presumed. The technologies often require use of productivity-increasing inputs, which a household has to access in order to respond to price incentives.

Infrastructure facilitates input flow into the farms and output flows to the consumers. They promote efficiency of farm production and marketing thereby increasing returns to the household.

Human capital may influence supply response. Human capital is a source of labour and through education; skills acquired could increase household chances of accessing market information which in turn enhances adoption of technologies.

Farmer perceptions of policy. Farmers' perceptions on policy change as permanent or temporary may influence supply response. For instance, if farmers perceive policy changes as temporary as in the case of numerous policy reversals, they are unlikely to respond to the price incentives offered. Under such circumstances enterprise substitution from activities involving high sunk costs (asset fixity) may not take place.

In attempting to predict changes in domestic production, it is important to distinguish between factors of production that can be altered within a short period of time and those that cannot. With increasing specialisation in both equipment and skills, many farmers find it difficult to change the production plans significantly in a short period of time (problem of asset specificity). Aggregate response of agriculture to changes in price is likely to be low since the major inputs to agricultural production (land, labour and capital) are essentially fixed in the short run (Lamb 2000).

Changes in relative prices may alter the pattern of farm production and therefore supply response of a particular crop. Changes that adjust the relative prices between crops are likely to shift resources into production of the crop whose relative price rises. Assuming, farmers are profit maximisers, they carry out enterprise substitution in response to changes in relative prices to maximize farm profit. For example, increased off-farm employment opportunities may lead to a reduction in on-farm agricultural production.

In the literature, we find three variants of agricultural supply (Sadoulet & de Janvry 1995) . First, production or output is used to estimate supply response (Adelaja 1991; Hansen 1991; Kenyanito 1991; Ngugi 1991; Mairura 2003). Second, other researchers have used area under a crop as a proxy for supply response (Morzurch *et al.* 1980; Omezzine & Al-Jabri 1998; Nyangweso 1999) while others have used yield as a dependent variable in supply response (Chavas *et al.* 1983; Shideed & White 1989). There are many arguments for and against the use of each of the three variants of supply response. For instance, use of output as a dependent variable is justified in cases where there is unreliable data on area (Malima 1971) or where area is constant over time (Maitha 1974). Conversely, Nerlove (1956) advocates the area under crop as the dependent variable on the premise that it is the only factor under the control of the farmer. However, there may be no perfect correlation between planted area and output. Area is therefore a surrogate for planned output because annual variations in yield are largely due to uncontrollable factors, making area to be the main decision variable under the farmer's control (Kwon & Uhm 1980). The final choice of which variant of agricultural supply response to use, depends on the available data, the research question of interest and subjective judgement of the researcher.

4.4 Modelling supply response

In this section, we discuss two supply response estimation approaches: the Nerlovian approach[13] and the cointegration and error correction model approach.

[13] Details of the approach are given in Sadoulet and de Janvry (1995)

4.4.1 Nerlovian approach

The Nerlovian approach to estimation of supply response is popular among researchers. The model uses multivariate regression techniques to estimate supply response elasticities. In the estimation of these models, it is assumed that current supply of a commodity is influenced by the previous supply, its unit price, price of competing enterprise and other supply shifters. The other variables are commonly represented by a trend variable, which includes factors such as technological change, improvement of transport network and better information, all of which are difficult to quantify directly.

The two variants of the Nerlovian model are the adaptive expectations model and the partial adjustment model. The adaptive expectations model emphasises price uncertainty as the determinant of farmer lags while partial adjustment model stresses technological uncertainty as the determinant of the lags. There are conceivable circumstances when both forms of uncertainty are present (Johnston 1984). Under these circumstances a "mixed model" is used but this presents estimation problems. Thus, for empirical work, a choice between the two is made. Griliches (1967) states that "in situations of price uncertainty the adaptive expectations model is applicable whereas in situations where price uncertainty is removed by government guaranteeing of producer prices, the partial adjustment model is applicable".

A major drawback of Nerlovian models are the theoretical assumptions used in the partial adjustment models. They are often considered inadequate as modelling the dynamics of supply comes down to an *ad hoc* assumption that in each period a fraction of the difference between the current position X_t and the long-run X_t*, is eliminated.

4.4.2 Cointegration and error correction approach

The Nerlove approach has been criticized on empirical grounds (Wyeth 1992). The approach uses ordinary least squares (OLS) to estimate a dynamic specification of its supply response. This means that the estimates of agricultural supply response are based on the assumption that the underlying data processes are stationary. However, most economic variables, including agricultural time-series are non-stationary**,** that is, their first two moments, the mean and the variance are not constant.

Nonstationarity of time series has always been regarded as a problem in econometric analysis. It has been shown in a number of theoretical studies (Granger & Newbold 1974; Phillips 1986) that, the statistical properties of regression analysis using nonstationary time series are dubious for they result in spurious regressions. These spurious regressions are characterized by high R^2 and t-ratios (t-tests are misleading) but low Durbin Watson statistics, indicating first order autocorrelation (Gujarati 1995). Hence, economists do not perform regressions on time series data which are subject to stochastic or deterministic trends (Charemza & Deadman 1997).

4.4.2.1 Cointegration analysis

Cointegration analysis is used with non-stationary data to avoid spurious regressions (Banerjee *et al.* 1993b). It is a sequential process that requires use of stationary series. A time series (X_{ti} ; where i = 1,…,n) is said to be strictly stationary if the joint distribution of X_{t1},…, X_{tn} is the same as the joint distribution $X_{t1+\tau}$,…, $X_{tn+\tau}$ for all t_1,…,t_n, and τ . The distribution of the stationary process remains unchanged when shifted in time by an arbitrary value τ (Maddala & Kim 1998). In practice, it is more usual to deal with weak or covariance stationarity, restricting attention to means, variances and covariances of the process (Charemza & Deadman 1997).Then, a stochastic process is said to be stationary if:

$E(X_t)$ = constant = μ ; $Var(X_t)$ = constant = σ^2 and $Cov(X_t, X_{t+1}) = \sigma_j$

Thus, the means (μ) and the variances (σ^2) of the process are constant over time, while the value of the covariance (σ_j) between two periods depends only on the gap between the periods, and not the actual time at which this covariance is measured.

A) Testing for stationarity

The first step in cointegration analysis is to test for unit roots in the individual data series. There are several ways of testing for the presence of unit roots (Maddala & Kim 1998; Patterson 2002; Hayashi 2000). We discuss three tests; the Dickey-Fuller (DF), the Augmented Dickey-Fuller (ADF) and the Philips-Perron (PP) which have achieved widespread usage in applied time series econometric literature.

The Dickey-Fuller test (1979) is applied to the first-order autoregressive (AR) model that includes both the drift and the linear time trend, as:

$$\Delta x_t = \beta_0 + \beta_1 x_{t-1} + \beta_2 t + \varepsilon_t \qquad (4.1)$$

Where Δx_t is change in the concerned series between two time periods, *t;* the β_i are the estimated coefficients; x_{t-1} is the lagged value of concerned series; t is the trend (1,…,n) and ε_t is the error term. To test for the presence of the unit root, we test the null hypothesis H_0: $\beta_1 = 0$ against H_a: $\beta_1 < 0$, with the left - sided critical region and referring to the critical values provided in the special Dickey-Fuller Statistics table.

The Augmented Dickey-Fuller test (Dickey & Fuller 1981) controls for serial correlation by adding lagged first differences to the auto-regressive equation. This test is based on the t-statistic for $\alpha = 1$ in the regression given by:

$$x_t = \mu + \beta t + \alpha x_{t-1} + \sum_{j=1}^{p} c_j \Delta x_{t-j} + \varepsilon_t \qquad (4.2)$$

where x_t is the series concerned at time *t*; t is the trend; j is the lag period ((j = 1,…,p); μ , α and *c* are estimated coefficients and the ε_t is the error term. Typically, rejection of the null hypothesis could be taken as strong evidence for trend stationary, whilst non-rejection could infer that the series is non-stationary (Brooks & Rew 2002). However, a major problem with

this conclusion is that the power of the test with the presence of structural break is low (Perron 1988) and thus the test may suggest that the series in question is non-stationary when in fact it is not.

One possible weakness in the DF and ADF tests has been that their underlying distribution theory assumes that residual errors are statistically independent and have a constant variance (Deb 2003). Therefore, care must be taken to ensure that the error terms are free from serial correlation and heteroscedasticity in these tests. Alternative approaches by Phillips (1987), Perron (1989) and extended by Phillips and Perron (1988) developed test statistics, which involves less restrictive assumptions on the error process. In this process, a non-parametric correction of the test statistics is carried out to take care of the serial correlation in case the underlying data generating process (DGP) is not an autoregressive [AR(-1)] process. In this case, the hypotheses: $H_0 : \beta_1 = 0$ and $H_0 : \beta_1 = \beta_2 = 0$ are tested for significance against the critical values of the DF tables.

Stationarity is necessary for hypothesis testing and for making inferences. The classical regression analysis based on time series data implicitly assumes that the underlying time series are stationary. The small sample t tests, F tests and the Chi square tests are based on this assumption (Niemi 2003). To make non-stationary data amenable to meaningful regression analysis, the data have to be stationary. Differencing or de-trending non-stationary series using a time trend often achieves stationarity.

Testing for cointegration

Cointegration simply means that although there may be short-run developments that can cause changes in two series, y_t and x_t, there is a long-run equilibrium ($y_t = y_{t-1} = y_{t-2} = \ldots = y^*$) represented by a linear combination which ties the individual series together. This process will stay in equilibrium until it is shocked. Thus, two series y_t and x_t are said to be cointegrated if both series are individually integrated of order one (indicates one difference is necessary to make the series stationary) designated as I(1), and a linear combination of the two series is integrated of order zero, I(0).

Testing for cointegration is a second step in cointegration analysis. Tests for cointegration are performed among a set of time series data. Cointegration deals with the relationship among groups of variables, where each has a unit root. The null hypothesis to be tested is no co-integration, i.e. spurious regression against an alternative hypothesis of presence of cointegration.

Two broad approaches for testing for cointegration have been developed. The first approach due to Engle and Granger (1987) is based on assessing whether single equation estimates of the equilibrium errors appear to be stationary. The second approach due to Johansen (1995) and Stock and Watson (1988), is based on the vector autoregression (VAR) approach. This study applies the ECM method developed by Engle and Granger.

Testing for cointegration using the Engle Granger approach involves two sequential steps. First, a given regression model in levels is run and the resultant residuals saved.

$$y_t = \alpha + \beta x_t + \varepsilon_t : y_t, x_t \sim I(1). \quad (4.3)$$

Second, an Augmented Dickey-Fuller test on the residuals is performed. We then test for unit roots in the residuals.

$$\Delta\hat{\varepsilon}_t = \phi\ \hat{\varepsilon}_{t-1} + \sum_{j=1}^{p} u_j \Delta\ \hat{\varepsilon}_{t-p} + error \quad (4.4)$$

where $\Delta\hat{\varepsilon}_t$ is the change in saved residuals at time t; j is the lag length (j = 1,…,p); ϕ and u are estimated coefficients and $\hat{\varepsilon}_t$ is the saved residual at time t. If the null hypothesis H_o: ϕ = 0 is rejected, it means that the residuals have a unit root and therefore y_t and x_t are not cointegrated. The levels regression is spurious. If the residuals are I(0), then y_t and x_t are cointegrated.

This single equation method of estimating cointegration relationships is, however, based upon a restrictive assumption of a single cointegrating relationship, which can be estimated with the ordinary least square procedure. However, with the case of more than two variables, there may be more than one equilibrium relationship in the model.

The concept of cointegration is fundamental to the understanding of long-run relationships among economic time series. Intuitively, cointegration among a set of variables implies that there exist fundamental economic forces, which make the variables move stochastically together over time (Urbain 1992). These movements in variables are related in a predictable way to the discrepancy between observed and equilibrium states. The ECM then corrects for any disequilibrium between variables that are cointegrated because the sequence of the discrepancy between the observed and the equilibrium states tends to decay to its mean, which is zero (Engle & Granger 1987).

4.4.2.2 Error Correction Modelling

The Granger representation theorem states that if a set of variables are cointegrated (1,1), implying that the residual of the cointegration regression is of the order I(0), then there exists an error correction mechanism (ECM) describing the relationship. This theorem is a vital result as it implies that cointegration and ECMs can be used as a unified empirical and theoretical framework for the analysis of both short- and long-run behaviour.

The ECM can be specified in a single-equation or a multi-equation context. The single equation approach would follow a single-step (Banerjee *et al.* 1993a) or two-step Engle-Granger procedure. The Johansen's approach is used with multivariate time series models where one can estimate variable relationships over time in the context of a vector autoregressive regression (VAR), where all variables are treated as endogenous. The main weakness in Johansen's modelling approach is largely the unknown small sample properties

(Toda 1995). Higher requirements in Johansen's estimation method for the number of observations than in the Granger procedure usually necessitates the use of quarterly or monthly time series data, which are not always readily available. Problems in identifying multiple cointegration vectors with theoretical economic relationships are also possible when using the Johansen method.

ECMs offer a means to incorporate the levels of the variables *x* and *y* alongside their differences. This means that ECMs convey information on both the short-run and long-run dynamics (McKay *et al.* 1999). Thus, the ECM allows an analyst to estimate both short term and long term effects of explanatory time series variables. For example, Keele and de Boef (2004) gives a bivariate single-equation error correction model as:

$$\Delta Y_t = \alpha_0 - \alpha_1(Y_{t-1} - \beta_1 X_{t-1}) + \beta_0 \Delta X_t + \varepsilon_t \qquad (4.5)$$

In equation (4.5), current changes in Y at time t (ΔY_t) are a function of current changes in X at time t (ΔX_t) and the degree to which the series are out of their equilibrium in the previous period ($Y_{t-1} - \beta_1 X_{t-1}$). Specifically, β_0 captures any immediate effect that X has on Y, described as contemporaneous effect or short-term effect. The coefficient β_1 reflects the equilibrium effect of X on Y. It is the causal effect that occurs over future time periods, often referred as the long-term effect that X has on Y. Finally, the value of α_1 dictates the rate at which the long-term effect occurs.

While the bivariate model given in equation (4.5) is a convenient expositional device, this study adopts a generalised single cointegrating relationship involving several variables, where the regressors are taken to be at least weakly exogenous.

$$\Delta Y_t = \alpha_0 - \alpha_1(Y_{t-1} - \beta_i Z_{t-1}) + \beta_0 \Delta Z_t + \Delta D + \varepsilon_t \qquad (4.6)$$

Where Z is a vector of regressors and β_i reflect the equilibrium effect of the individual Z regressors on Y. D is a dummy variable while α_0 is an estimated coefficient in the regression and Δ is the difference operator.

The single-equation ECM model can be estimated consistently by ordinary least squares, and appears to perform well empirically (Banerjee *et al.* 1993b; Hallam & Zanoli 1993) but economic theory is usually silent on the lag distribution and provides little guidance for the modelling of the short-run dynamics of functions. The data themselves often provide most of the guidance (Niemi 2003). In this study the 'general to specific' approach advocated by Hendry (1986) is applied.

The Hendry's approach to economic modelling starts with a model with several regressors and then whittles it down to a model containing only the important variables (Gujarati 1995). The main feature of this 'general to specific' methodology is the abandonment of any attempt to identify a suitable parsimonious model at the outset. Instead, there is deliberate 'over fitting'. The decision to whether or not a particular explanatory

variable should be included in the model can only be made if it is included in the general model (Harvey 1981).

When estimating an ECM, the properties of OLS estimators of the parameters and standard errors and together with any associated test procedures, are sensitive to the violation of the standard assumptions about the disturbances and the exclusion of relevant regressors (Gerrard & Godfrey 1998). Hypothesis testing about the individual partial regression coefficients and the overall significance of the sample regression presumes, however, that the model chosen for empirical analysis is adequate. This is in the sense that it does not violate one or more assumptions underlying the classical normal linear regression model.

Therefore, the validity of the estimated model is tested using the standard diagnostic tests – the Jarque-Bera (JB) test for normality and the Durbin-Watson (D-W) test for first order serial correlation. The Breusch-Pagan-Godfrey (BGP) test is computed to detect the presence of heteroskedasticity and the Ramsey's RESET test is used to detect equation specification errors. We highlight on the two tests: the Jarque Bera and the Ramsey's RESET tests.

Given the theoretical background to and the estimation approaches of supply response, we next examine the expected farmer responses to maize market liberalisation.

4.5 An application of cointegration and error correction modelling approaches to maize supply response in Trans Nzoia District

In this section, we describe the data used in the supply response model. This is followed by the supply response model specification and estimation. Finally, three tests are applied to the observed supply response: (1) we test whether the observed supply response is asymmetric (2) we test whether the contemporaneous maize and fertiliser price are better estimators of supply response than the lagged prices and, (3) we test whether supply response was sensitive to trading regime (pre-liberalisation as opposed to post-liberalisation).

4.5.1 Data

The success of any econometric analysis depends on the availability of appropriate data. This section discusses the nature, sources, and limitations of the data used in estimating maize supply response in Trans Nzoia District.

The empirical analysis of this study was conducted with a sample of annual data covering the period 1980 to 2003. The Ministry of Agriculture, Trans Nzoia Office (various Annual Reports) provided data on area under maize, maize output, maize and fertiliser prices. The Meteorological Office, Kitale station provided data on annual rainfall. The Consumer Price Index (CPI) was obtained from World Bank development indicators statistics. The price data series were deflated by the CPI for Nairobi lower income group, which is used as a surrogate for the rural areas with 1995 as the base year.

Production is an aggregate of estimated maize produced in the district measured in kilograms. Area under maize is an aggregate area under pure maize and/or area under maize-based mixed cropping patterns such as maize and various pulses estimated for the entire district measured in hectares. Yield was estimated as the ratio of production to area under maize, measured as kilograms per hectare. The price of fertiliser and maize represent the gazetted prices during the pre- market liberalisation era and the average market price per unit of the post-market liberalisation era. The unit price was quoted for 90 kg-bag for maize and for 50 kg-bag for fertiliser.

Due to lack of time series data for many economic variables particularly at district level in Kenya, it was not possible to obtain some other data considered important in modelling supply response. Such data include average household income and other non-price factors like expenditures on road infrastructure and agricultural technological advancements, credit and extension services. In addition, given the multiple objectives of farmers who are spatially distributed under different economic environments and that data used are aggregated over many diverse farmers with different objectives, the expected supply response to price incentives may be mixed.

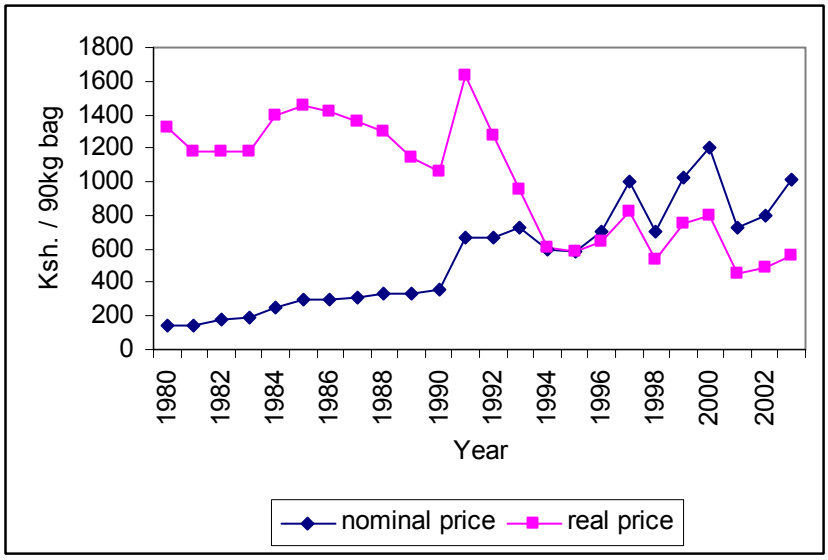


Fig. 4.2 Evolution of nominal and real producer maize price in Trans Nzoia

Fig. 4.2 shows that real prices were higher before than after maize market liberalisation. Nominal prices were higher after than before maize market liberalisation. Both real and nominal price variability was low before 1991 when the fertiliser market was liberalised and the Kenya Shilling was devalued. Both real and nominal price variability increased and in particular after maize market liberalisation in 1994. Both real and nominal maize prices appear to be increasing after 2001. Overall, real maize price have declined while nominal prices have risen.

4.5.2 Supply Response Model Specification

Maize supply response is hypothesised to be influenced by both price and non-price factors. Given that data on both maize production and area under maize were available, we chose to use production as the dependent variable. This is the variable that is most important from a policy perspective (attainment of self-sufficiency). We hypothesised that maize response (production) is influenced by both price and non-price factors such that:

$$P = f(\text{price, non-price factors}) \quad (4.7)$$

where P = production (kg) of maize. This model was estimated in a log-linear ECM framework consistent with the general model in equation (4.6).

Price factors. Specifically, the main price factors considered to influence maize response were the price of maize and fertiliser. Before market liberalisation, maize prices were fixed prior to planting. After market liberalisation, the farmers' decision prices were those of the preceding year. For the commercial-oriented farmers, a change in the price of maize is likely to influence production in two ways, through: (1) change in input use, and (2) change in area under maize. For instance, an increase in the price of maize may positively influence production of maize. If the price of maize increases, farmers may spend part of the increased income, *ceteris paribus,* to purchase productivity-enhancing inputs such as fertilisers and hybrid seed that may boost production. The increased maize prices may also induce timeliness in farm operations such as land preparation and weeding in the following season. Alternatively, if the price of maize increases, a farmer is likely to increase area under maize. Increased area under maize may increase production, *ceteris paribus*. The option of increased area under maize presupposes an active land market. However, this may not always be the case as in some parts of the district land per household might be limiting (Rees *et al.* 1998a).

However, when price of maize decreases, there is a tendency for farmers to reduce the amount of productivity-enhancing inputs and timeliness of maize production activities for the following season is hampered (Mose *et al.* 2002). In certain circumstances, when the price of maize decreases, a farmer is likely to decrease area under maize assuming there are alternatives for the use of the land (enterprise substitution). The latter case also presupposes that minimum household maize consumption is met or there is an active well-functioning maize market. The effects of price changes on production may not be obvious in the case of subsistence – oriented farmers since differences in price may have little role on decisions regarding production.

The price of fertiliser is a production cost to farmers. A change in the price of fertiliser may lead farmers to adjust the rate of fertiliser use or the area under maize production. In case of an increase in fertiliser price, farmers may apply a reduced amount of fertiliser used to the same area under maize as in the previous season. This option may lead to a decline in yield, which eventually leads to less production. Alternatively, a rise in the price of fertiliser may lead farmers to apply fertiliser to less area under maize while maintaining the same rate of application as in the previous season. This option may lead to lower production arising from reduced area under maize, *ceteris paribus*. Conversely, a decrease in the price of fertiliser is

expected to lead to an increase in the area under maize or increase in the intensity of fertiliser use. Consequently, this scenario leads to more production, *ceteris paribus*.

Non-price factors. Rainfall is the only non-price factor whose data was available. Maize production in Trans Nzoia is rainfed. Although the amount of rainfall was expected to have an influence on production and area planted, the district experiences ample and well distributed rainfall throughout the year with an average of only one dry year in a decade (Jaetzold & Schmidt 1982b). Accordingly, amount of rainfall may not result in much variability in area planted and the maize subsequent production.

Dummy variables. A close observation of the maize price data indicates that in 1992, the price was much higher than all other years. This was due to low maize production that arose from low and erratic rainfall at planting and excessive rains at harvest. Therefore, we controlled for the effects of the extraordinary year by a dummy variable.

The specified maize supply response was estimated using the cointegration analysis and the ECM approaches. Finally, because cointegration analysis requires that the series considered be integrated of the same order, the final selection of the variables that were used to estimate the supply response of maize production was determined by examining the time series properties of the data.

4.6 Results

4.6.1 Time series data properties

As a first step towards modelling in the cointegration framework, we investigated the univariate properties of the time series data and estimated the order of integration of the concerned variables. The results of the ADF and PP unit root tests in both levels and differences are given in Table 4.1. The trend was included in the estimation of the ADF and PP tests. All the variables (series) are in logarithms.

Table 4.1 Properties of the time series data (1980-2003)

Variable[1]	Levels		First differences		I (d)
	ADF test	PP test	ADF test	PP test	
Maize production (lnprod)	-3.04	-2.99	-6.86	-7.12	I(1)
Real price of maize (lnrmzpr)	-2.56	-2.51	-5.32	-5.71	I(1)
Real price of fertiliser (lnrdappr)	-2.12	-2.16	-4.57	-4.57	I(1)
Yield (lnyld)	-5.09	-5.10	-3.44	-16.67	I(0)
Rainfall (lnrain)	-5.83	-5.77	-4.83	-25.62	I(0)

Critical values for ADF and PP tests: 1% = -4.416, 5% = -3.622 and 10% =-3.249; I (d) refers to the order of integration. [1] *all variables are in logarithms*

As shown, the null hypothesis for the existence of a unit root is accepted for all series except for yield and rainfall amount at the level form. When the sequential procedure of the ADF and PP tests are applied to the first difference, these sequences are found to be stationary. We therefore, infer that the variables are all integrated of order 1 i.e. I (1). Consequently, the

results show that except for yield and rain, all the other variables are non-stationary in levels but stationary when they are differenced once. We reconsidered our model specification and included only variables that were I(1). We then proceed to examine the cointegrating relationship of the re-specified model.

4.6.2 Supply response in Error Correction Framework

Since the variables in the agricultural supply response model are cointegrated, an error correction representation is more appropriate to capture the short- and long-run dynamics in the model. We set up the agricultural supply response model in a single equation error correction framework. The single-equation approach (Banerjee *et al.* 1993b) overcomes the problem of small sample bias (Sobhee 2003) by jointly estimating and determining the short run and long run elasticities in the ECM.

To achieve a parsimonious error correction model, Hendry's approach was adopted. The approach entails estimating a general model and then re-estimating the model by subsequently dropping highly non-significant variables. The approach resulted in the model presented in Table 4.2, with the difference in maize production (dlnprod) as the dependent variable.

Table 4.2 Single-equation error correction model estimates

Explanatory variable	coefficient	t -value	p-value
C	10.68**	2.91	0.011
Lagged production *[lnpro(-1)]*	-0.66**	-2.82	0.013
Lagged real price of maize *[lnrmzpr(-2)]*	0.50**	2.72	0.016
Lagged real price of fertiliser *[lnrdappr(-2)]*	-0.83**	-2.84	0.012
Difference in real price of maize *[dlnrmzpr(-1)]*	0.53***	2.98	0.009
Difference in real price of fertiliser *[dlnrdappr(-1)]*	-1.05**	-2.80	0.013
Difference in 1993 maize price dummy *[dmzduma93(-1)]*	-0.28**	-2.31	0.035

R^2 (Adj R^2) = 0.735(0.629)
N = 22
F(statistic) = 6.94 (P<0.01)
Durbin-Watson stat = 2.07
Ramsey RESET test: F-statistic = 0.21 (P>0.05)
Breusch-Godfrey LM test: F-statistic = 0.60 (P>0.05)
White's Heteroskedasticity test: F-statistic =0.40 (P>0.05)
Jarque-Bera test: F-statistic = 0.10 (P>0.05)

*** significant at 5 pecent level; *** significant at 1 percent level

The estimated results indicated that the signs and magnitudes of the estimated coefficients are broadly in line with theoretical expectations and the diagnostic test statistics are quite satisfactory. The estimated coefficients represent elasticities in the short run since the model is in a log-linear form. However, the long run elasticities are computed from the estimated coefficients. The long-run fertiliser price elasticity is estimated as the ratio of the lagged price of fertiliser and the coefficient of lagged production. Similarly, the long run own price

elasticity was estimated as the ratio of the lagged price of maize and the coefficient of lagged production.

From the model, it was estimated that the price elasticity for maize was 0.53 in the short run (SR) and 0.76 in the long-run (LR). This means that a 10 percent increase in the price of maize would result in a 5.3 percent increase in maize production in the SR and 7.6 percent increase in maize production in the LR. The strong elasticity for maize underscores the importance of maize as a staple food and as a source of income. The model also estimated that the price elasticity for fertiliser was -1.05 in the SR and -1.26 in the LR. Specifically, the ECM shows that both price of maize and price of fertiliser have an impact on the LR relationship on maize supply response as expected.

The estimation results indicate that most of the estimated coefficients are significantly different from zero at the 5 percent level, and the R^2 indicate that a large part of the observed variation in the difference in the production of maize is explained by the model. All tests for model adequacy yield satisfactory results. The D-W test for residual autocorrelation does not reject the null hypothesis of no autocorrelation in the residuals. According to the BPG test, heteroskedasticity does not pose any problem at the 5 percent significance level and the Ramsey RESET test does not reject the assumption of correct functional form and the data is normally distributed according to the JB test.

4.6.3 Testing for asymmetric supply response to price incentives

Agricultural supply is defined as the response of agricultural output to changes in prices, all other factors held constant (Mamingi 1996). An implicit idea in supply response is that a price increase and a price decrease lead to the same output change (Mamingi 1996). The agricultural supply in this sense is said to be symmetric or reversible, as a price decrease will bring the supply to its original level. Tweeten and Quance (1969), Wolffram (1971) and Jaforullah (1993) offer empirical approaches of estimating asymmetric supply response.

In this section, we investigate whether supply response to maize and fertiliser price between 1980 to 2003 is asymmetric. During this period, real fertiliser and maize prices trended downwards. During the pre-liberalisation period (1980-1994), inter-year price variability for both fertiliser and maize was less than during the post-liberalisation period (1995-2003). During the entire period real seed prices increased.

Estimating irreversible or asymmetric reactions requires an adequate splitting of the relevant independent variable into a positive and a negative component (Wolffram 2005). Which method is used to split the variable, depends on the reaction of the decision maker on variations in the independent variable.

Based on the assumption that long –term irreversibility exists, equation 4.11

$$y_t = a_0 + a_1 x_t \qquad (4.11)$$

can be transformed to split the independent variable (x) in a positive and negative component using cumulated first differences of the independent variable. Using this method to split an

independent variable (Wolffram 1971), equation 4.1 will be transformed into equation 4.12 as:

$$y_t = a_0 + {}^{+}a_1 x_t^{+} + {}^{-}a_1 x_t^{-} \qquad (4.12)$$

Here, y_t symbolizes the dependent variable with level data, x^+ the positive and x^- the negative component of the split independent variable. Houck (1997) modified Wolffram's approach by cumulating the positive and negative first differences (see appendix 4.1). Therefore, based on Houck (1997), if a variable Y depends upon the values taken by X and that both are time series variables, the hypothesis to be examined is that one-unit increases in X from period to period have a different absolute impact on Y than do one-unit decreases in X. Such a relationship can be written as:

$$\Delta Y_i = a_0 + a_1 \Delta X_i' + a_2 \Delta X_i'' \qquad (4.13)$$

for $i = 1,2, \ldots, t$, where $\Delta Y_i = Y_i - Y_{i-1}$; $\Delta X_i' = X_i - X_{i-1}$ if $X_i > X_{i-1}$ and = 0 otherwise; $\Delta X_i'' = X_i - X_{i-1}$ if $X_i < X_{i-1}$ and = 0 otherwise.
Other variables, segmented or not could be added to this basic specification, and a_0 might be zero, positive or negative. Asymmetric response occurs in ΔY if $a_1 \neq a_2$. This basic specification was applied to the base run symmetric response y_t and x_t model estimated earlier (Table 4.2).

In modelling supply response asymmetry, the cumulative lagged increase in price of maize and the cumulative lagged decrease in price of maize replace the lagged real price of maize in the base solution. Similarly, the difference in the cumulative lagged increase in price of maize and the difference in the cumulative lagged decrease in price of maize replace the difference in lagged real price of maize in the base solution. Table 4.3 provides the estimated results.

Table 4.3 Maize price asymmetry: single-equation error correction model estimates

Explanatory variable	coefficient	t -value	p-value
C	7.88	1.38	0.192
Lagged production *[lnpro(-1)]*	-0.48	-1.52	0.155
Cumulative lagged increasing price of maize [*cumpmR(-2)]*	0.98***	4.12	0.001
Cumulative lagged decreasing price of maize *[cumpmF(-2)]*	0.57***	3.95	0.002
Lagged real price of fertiliser *[lnrdappr(-2)]*	-0.30	-0.68	0.512
Difference in cumulative lagged decreasing price of maize [dcumpmR(-1)]	0.19	0.59	0.563
Difference in cumulative lagged decreasing price of maize [dcumpmF(-1)]	1.06***	3.24	0.007
Difference in real price of fertiliser *[dlnrdappr(-1)]*	-0.42	-1.02	0.330
Difference in 1993 maize price dummy *[dmzduma93(-1)]*	-0.38***	-5.20	0.000

R^2	= 0.798
N	= 21
F(statistic)	= 892 (P<0.001)

*** significant at 1% level

Table 4.3 shows that increases and decreases in price of maize have a significant impact on supply response in the long-run. The impact is larger for price increases than for price decreases. In the short-run, only the maize price decreases have a significant impact on supply response. In this model, the fertiliser price variable has no effect on both short- and long-run supply responses. However, the model fit is good as shown by the high R^2. We test for supply response asymmetry by checking whether there is a significant difference between the coefficients of positive and negative maize price changes both in the short- and long-run using the F-test statistic.

Null hypothesis: coefficient positive price changes = coefficient of negative price changes.

Alternative hypothesis: coefficient positive price changes are not equal to coefficient of negative price changes.

The F-test results (Table 4.4) indicate that in the long run, the hypothesis that increasing and decreasing price coefficients are equal is rejected at the 10 percent level of significance. Therefore, the test provides evidence of a weak price asymmetry in maize supply response in the long-run.

Table 4.4 Test of supply response asymmetry

	Variables	F-value (1,12)	Prob > F
Long-run	*cumpmR(-2) and cumpmF(-2)*	3.47	0.087
Short-run	*dcumpmR(-1) and dcumpmF(-1)*	2.78	0.121

However, the F-test that the price coefficients are equal in the short run is rejected at the 10 percent level of significance and we could conclude that the maize supply response is symmetric in the short-run.

The observation that the splitting of the maize price variable the fertiliser price variable non-significant implies that the fertiliser price variable is sensitive to model specification. Therefore, when we re-estimate the base-run model (Table 4.2) after dropping the fertiliser variable, the maize price variable does not significantly influence maize supply response in the long run but it does in the short run. Table 4.5 presents the results of the estimation.

Table 4.5 Single-equation error correction model re-estimated

Explanatory variable	coefficient	t -value	p-value
C	5.88*	1.75	0.10
Lagged production *[lnpro(-1)]*	-0.40*	-1.75	0.10
Lagged real price of maize *[lnrmzpr(-2)]*	0.03	0.18	0.86
Difference in real price of maize *[dlnrmzpr(-1)]*	0.32*	2.06	0.06
Difference in 1993 maize price dummy *[dmzduma93(-1)]*	-0.35***	-4.04	0.001
R^2	= 0.735		
N	= 22		
F(statistic)	= 10.29 (P<0.01)		

4.6.4 Testing whether contemporaneous price is a better estimator of production response

In this section, we test whether it is the contemporaneous or past prices in the pre- and post-liberalisation periods that predicted supply response better. Contemporaneous prices act as proxies to expected prices whereas past prices are proxies for current prices. Two likely farmer response scenarios were examined to provide information on whether farmers responded to: (1) contemporaneous prices before market liberalisation and past prices after market liberalisation, or (2) past prices before and after market liberalisation.

Table 4.6 Test for maize response to contemporaneous price before and past price after market liberalisation

Explanatory variable	coefficient	t -value	p-value
C			
Lagged production *[lnpro(-1)]*	-0.66	-3.45***	0.004
Pma1b2 (-1))	0.39	3.41***	0.004
Lagged real price of fertiliser *[lnrdappr(-2)]*	-0.63	-2.27**	0.038
Dpma1b2	0.27	1.37	0.19
Difference in real price of fertiliser *[dlnrdappr(-1)]*	-0.93	-2.97***	0.01
Difference in 1993 maize price dummy *[dmzduma93(-1)]*	-0.29	-2.12**	0.05
R^2	= 0.638		
N	= 22		
F(statistic)	= 5.20 (P<0.001)		

Key

-** significant at 5% level; *** significant at 1% level

-*Pma1b2* refers to contemporaneous price of maize before market liberalisation and past price after market liberalisation; *Dpma1b2* refers to the first difference of the contemporaneous price of maize before market liberalisation and past price after market liberalisation

The results (Table 4.6) show that in the short-run the current maize price before market liberalisation and past price after market liberalisation have positive significant effect

(P<0.05) on maize supply response. The results also show that in the long-run, the current maize price before market liberalisation and past price after market liberalisation have positive but non-significant effect (P<0.05) on maize supply response.

We compare this result with the results in Table 4.2, where past prices have been used both in the pre-and post liberalisation period. On the basis of model fit, we conclude that the results of the model in Table 4.2 are better. In conclusion therefore, past prices both in the pre- and post-maize liberalisation periods estimate the maize supply response better.

4.6.5 Testing for differences in supply response before and after market liberalisation

Market liberalisation was expected to enhance supply response through increased use of productivity-enhancing inputs such as fertiliser and improved seed. Increased fertiliser and improved seed use could result from increased availability (increased private trader participation) and increased household income (higher maize prices and lower fertiliser/seed prices). The increased fertiliser use could be manifested in increased maize response. However, contrary to expectations, real maize prices have decreased while real seed prices have increased over time. From the base solution, we found that farmers have responded to changes in the price of both maize and fertiliser. However, we do not know whether there are differences in maize response during the two periods: pre- and post-market liberalisation. In order to estimate the effect of marketing era on supply response

The model where past prices are a better predictor of supply response was used to test for differences in supply response before and after market liberalisation. Therefore, to test for a difference in supply response before and after market liberalisation, the model shown in Table 4.2 was re-estimated by splitting the maize price variable into two price variables: before (P_t^b) and after (P_t^a) market liberalisation defined as

P_t^b = actual price before market liberalisation and zero, otherwise

P_t^a = actual price after market liberalisation and zero, otherwise

Table 4.7 presents results of the re-estimation of ECM model in Table 4.2.

Table 4.7 Supply response before and after market liberalisation: single-equation ECM estimates

Explanatory variable	coefficient	t -value	p-value
C	13.54***	3.19	0.007
Lagged production *[lnpro(-1)]*	-0.79***	-3.23	0.007
P_t^b (-2)	0.41	1.32	0.21
P_t^a (-2)	0.29	0.70	0.50
Lagged real price of fertiliser *[lnrdappr(-2)]*	-1.09***	-3.33	0.005
d P_t^b (-1)	0.45*	1.86	0.086
d P_t^a (-1)	0.50***	3.84	0.002
Difference in real price of fertiliser *[dlnrdappr(-1)]*	-1.25**	-2.95	0.011
Difference in 1993 maize price dummy *[dmzduma93(-1)]*	-0.23*	-1.96	0.07
R^2 (Adj R^2)	= 0.762		
N	= 22		
F(statistic)	= 7.49 (P<0.001)		

* significant at 10% level; ** significant at 5% level; *** significant at 1% level

To determine whether there are differences in supply response before and after market liberalisation, the coefficients of P_t^b and P_t^a were tested for equality both in the short- and long-run. The F-test of these hypotheses indicates that in both the short- and long- run, the hypotheses that these coefficients are equal is not rejected at the 10 percent level of significance. Therefore, the tests provide evidence of no differences in maize supply response in the short- and long-run, before and after market liberalisation.

4.7 Discussion, conclusions and policy implications

The results reported in this chapter were motivated by the need to estimate the maize supply response in Trans Nzoia; a major maize producing district in Kenya, using cointegration and error correction modelling approaches. Following the "general to specific" approach, a supply response model is derived at the aggregate level for the period 1980 -2003.

Several conclusions emanate from our findings. First, farmers in Trans-Nzoia District respond strongly to price incentives. This is evidenced by the short-run elasticity of supply to fertiliser price of -1.05 and a long-run elasticity of -1.26 with the short-run elasticity of supply to maize price of 0.53 and the long-run elasticity of 0.76.

Second, maize response to maize price was symmetric in the short run but asymmetric in the long-run. There are no fixed assets in maize production and even with technological advances like high-yielding maize varieties; adoption of these varieties and other agronomic practices are pre-requisites to any expected asymmetric supply response.

Third, there were no differences in maize supply response during the pre- and post-liberalisation period. This implies that the observed modest supply response cannot be wholly attributed to market liberalisation *per se* and hence market liberalisation may not have fully attained its objectives.

Fourth, the lagged maize and fertiliser price gave a better model fit than the contemporaneous prices. This implies a sluggish flow of market information on prices to farmers and that farmers are not guided by contemporaneous prices in planning future maize production activities.

Therefore, in order to achieve or sustain the objective of food self-sufficiency, policies to address the potential problem of rising fertiliser prices due to high transport costs and storage should be put in place. Specifically, complementary interventions to improve infrastructure, information flow, access to inputs and credit, and improved production technology to farmers could make them more responsive.

Finally, the application of novel concepts of co-integration and error correction mechanism has contributed to a better understanding of short-run and long-run dynamics in maize production response. This application can be extended to better understand the short-run and long run dynamics in area and yield response of maize, and in other agricultural commodities including dairy production in Kenya hitherto estimated using the Nerlovian approach.

Appendix 4.1 Maize price variable segmentation based on Houck's procedure

	Variable	Splitting variable according to Houck						
Year	X	ΔX	X'	X''	CX'	CX''	CX' **(-2)**	CX'' **(-2)**
1980	2.5783							
1981	2.4684	-0.1099	0	-0.1099	0	-0.1099		
1982	2.4670	-0.0014	0	-0.0014	0	-0.1113		
1983	2.4680	0.0010	0.0010	0	0.0010	-0.1113	0	-0.1099
1984	2.6346	0.1666	0.1666	0	0.1676	-0.1113	0	-0.1113
1985	2.6767	0.0421	0.0421	0	0.2097	-0.1113	0.0010	-0.1113
1986	2.6516	-0.0251	0	-0.0251	0.2097	-0.1364	0.1676	-0.1113
1987	2.6116	-0.0400	0	-0.0400	0.2097	-0.1764	0.2097	-0.1113
1988	2.5675	-0.0441	0	-0.0441	0.2097	-0.2205	0.2097	-0.1365
1989	2.4381	-0.1294	0	-0.1294	0.2097	-0.3499	0.2097	-0.1765
1990	2.3607	-0.0774	0	-0.0774	0.2097	-0.4273	0.2097	-0.2206
1991	2.7905	0.4298	0.4298	0	0.6395	-0.4273	0.2097	-0.3500
1992	2.5489	-0.2416	0	-0.2416	0.6395	-0.6689	0.2097	-0.4273
1993	2.2510	-0.2979	0	-0.2979	0.6395	-0.9668	0.6395	-0.4273
1994	1.8072	-0.4439	0	-0.4439	0.6395	-1.4107	0.6395	-0.6689
1995	1.7630	-0.0442	0	-0.0442	0.6395	-1.4549	0.6395	-0.9668
1996	1.8653	0.1023	0.1023	0	0.7418	-1.4549	0.6395	-1.4107
1997	2.1101	0.2448	0.2447	0	0.9865	-1.4549	0.6395	-1.4549
1998	1.6883	-0.4217	0	-0.4217	0.9865	-1.8766	0.7418	-1.4549
1999	2.0090	0.32068	0.3206	0	1.3071	-1.8766	0.9865	-1.4549
2000	2.0763	0.06738	0.0673	0	1.3744	-1.8766	0.9865	-1.8767
2001	1.5235	-0.5528	0	-0.5528	1.3744	-2.4294	1.3071	-1.8767
2002	1.5762	0.0528	0.0528	0	1.4272	-2.4294	1.3744	-1.8766
2002	1.71480	0.1386	0.1386	0	1.5658	-2.4294	1.3744	-2.4294
Total							11.3965	-17.7637

Where: X = ln of the maize price per kg; ΔX = first difference of X; CX' **(-2)** = cumulative increasing price, X' lagged twice and CX'' **(-2)** = cumulative decreasing price, X'' lagged twice

Note: Increasing phase of price is given as: $X' = X_t - X_{t-1}$, if $X_t > X_{t-1}$; otherwise $X' = 0$

Decreasing phase of price is given as: $X'' = X_t - X_{t-1}$, if $X_t < X_{t-1}$; otherwise $X'' = 0$

CHAPTER 5

MAIZE PRODUCING HOUSEHOLDS: A COMPARATIVE ANALYSIS

5.1 Introduction

In this chapter, we compare maize producing households in terms of their production and marketing behaviour before and after market liberalisation. Market liberalisation was expected to change the farmer incentive structure thereby influence farmer decisions regarding production and marketing (Karanja *et al.* 1998; Wangia *et al.* 2000). Specifically, market liberalisation was expected to increase both input and maize marketing efficiency through increased trader competition. Trader competition would result from the expected entry of private traders in both input and maize markets (Karanja *et al.* 1998).

Therefore, we argue that the changes observed in maize production and marketing is largely due to market liberalisation. The expected increase in number of input traders could enhance competition and input availability. Increased competition would reduce input prices, encourage their use and subsequently increase farm productivity. The increased number of maize traders could increase farmer choices of market outlets thereby facilitate easy disposal of maize. In sum, both the expected increased efficiency in both input and maize markets could enhance land productivity thereby increase household and national food security.

This chapter examines the changes that have occurred among farming households in terms of maize commercialisation, on-farm enterprise diversification and participation of households in the maize market using the difference-in-difference approach (Maluccio, 2005) and probit regression analysis. Next we analyse farmer perceptions of the impacts of market liberalisation on area under maize, external input use, diversification and household participation in off-farm activities.

The remaining portion of this chapter is organised as follows: Next we present the theoretical considerations on market commercialisation and diversification followed by the hypothesis of the study. Then, the methodological framework of the study is presented covering sampling procedures and empirical estimation approaches. In section 5.4, we present results and discussion of the study followed by farmer perceptions of market liberalisation in section 5.5. Finally, conclusions and policy implications conclude the chapter.

5.2 Theoretical considerations

A liberalised market model approximates a perfectly competitive market model. The economics literature asserts that in a perfectly competitive market model, the price mechanism allocates household resources efficiently (Varian 2003). Thus, when the market was liberalised, it was expected that production could become more efficient compared to the pre-liberalisation times when prices were distorted. In particular, market liberalisation was expected to change the households' maize commercialisation structure and on-farm

diversification of enterprises. In the following section, we highlight the theories of agricultural commercialisation and on-farm enterprise diversification as a prelude to the analysis that follows.

Agricultural commercialisation

Hypothesis 1: Market liberalisation would result in increased maize commercialisation.

Agricultural commercialisation is a broad concept which may involve changes in the input- and / or in the output-markets. In the output market, it may occur with increased market surplus, and in the input market, it may occur with increased use of purchased inputs (von Braun 1995; Smith 2005). As the degree of commercial orientation increases, mixed farming systems give way to specialised production (Pingali & Rosegrant 1995) so as to respond to changes in market prices and quality inputs. In effect, commercialisation involves a reduction in the number of farm enterprises compared to the case in semi-subsistence production (Pingali & Rosegrant 1995). Commercialisation may require an improvement in the efficiency of food markets if households have to rely on market purchases for a greater proportion of their own food consumption. Increased specialization in production results in increased productivity either through concentrating on crops best adapted to local agro-ecological conditions or acquisition of crop-specific expertise.

Market liberalisation was expected to increase farmer access to productivity-enhancing inputs with increased entry of private traders. This could encourage external input use leading to surplus production. In this study, we consider the proportion of total household maize production that is sold and the extent of external input use (fertilisers and improved seed) as indicators of commercialisation.

On-farm enterprise diversification

Hypothesis 2: Market liberalisation will lead to a decline in on-farm enterprise diversification.

On-farm enterprise diversification involves having more than one farm enterprise which could be crop(s), livestock type(s) or a combination of them (Boehlje & Eidman 1984). Many factors dictate the type of enterprises that households operate on farm. Some of these factors include agro-ecological conditions (Jaetzold & Schmidt 1982a; Barrett *et al.* 2001), and resource endowments such as land, labour and off-farm employment (Brons 2005). On-farm enterprise diversification may also occur in situations where markets for food crops do not function well. In such circumstances, households may wish to be self-sufficient in food production that meets their preferences. This 'multi-product' objective must be met through farm diversification (Culas 2003). Omamo (1998), observed that in remote areas of Kenya where physical access to markets is very costly and causes (household-specific) factor and product markets failures, households diversify their production patterns to satisfy diversified consumption patterns.

Another motivation for diversifying is based on the idea that returns from various enterprises may not move up and down in tandem, so that when one activity has low returns, the other activities would likely have higher returns. Therefore, enterprise diversification is frequently used as a risk management strategy. However, Barrett and Reardon (2000) argue that diversification across crops is less likely attributable to risk management- since the yields of different crops are highly, if not imperfectly covariate – than to economies of scope due to soil and water management and to heterogeneous land quality (fertility, drainage and slope).

Market liberalisation was expected to create an environment whereby farmers would be encouraged to produce surplus production for the market. This could be achieved through increased external input use and through competitive maize prices. This in turn could discourage on-farm diversification and encourage enterprise specialization.

5.3 Data and methodological frameworks

In this section, we present the data sampling procedure, the common methods and related issues on measuring interventions. Next, we present the empirical estimation approaches for diversification, the difference-in-difference approach for measuring average impact and finally, logistic regression for assessing the factors that affect impact of the policy change.

5.3.1 Sampling procedures

A household forms the basic decision-making unit for production and consumption. For this reason, it has received much attention in relation to agricultural policy analysis (Holden *et al.* 1996). A household has different meanings to different people. For some researchers, a household is a group of people sharing the same stock of food (Ellis 2000). Within the household, resources are pooled, income is shared and decisions are made jointly by adult household members. For others (Abdulai & CroleRees 2001), a household is defined as the smallest group of persons; usually, but not exclusively related – who form a more or less independent production and consumption unit during the cropping season. This study adapts the definition by Ellis because it approximates the reality of the maize producing households in North Rift.

This study used panel data to shed light on changes in maize production and marketing that have taken place since market liberalisation. In absence of a comprehensive data base on maize producing households before market liberalisation, this study used the Maize Database Survey (MDB) which was collected from 200 households in 1992. The main objective of the MDB survey was to characterise the maize production systems in Kenya. Details of the sampling procedure of the households for the MDB survey are documented in Hassan *et al.* (1992). In order to monitor changes on maize production and marketing that had taken place since the market was liberalised, we re-traced and interviewed the MDB households in 2003. However due to natural attrition and out-migration, the current study managed to trace 161 households. Therefore, the panel of these households is used to provide insights on changes in commercialisation, diversification and market participation in North Rift.

5.3.2 Empirical estimation procedures

In this section, we present the empirical procedures used in this study. First, we provide the different approaches used in estimation of diversification. Second, we outline the methods used to estimate the average impact of market liberalisation on selected key variables. Thirdly, we present the method used to establish the household and farm factors that influence the household participation in maize markets.

A) Measuring diversification

For comparability on extent of diversification in various farms across diverse regions, diversification can be measured in a number of alternative ways (Clarke 1993). In the case of on-farm enterprise diversification and depending on the limitations of the data, measurements of diversification in production can be examined using variables of area (land under production), net income (net revenue) and/or total income (production income). In this study, we use land area as the measure for diversification because the data were available. There are different types of indices to measure diversification. While each of these indices has an intuitive appeal, it should be noted that not all of them have the same merits. Therefore, in the following section we consider each of them briefly as outlined by Culas (2003).

Suppose we define A_i = the crop hectarage in activity *i*, and $\sum A_i$ = Total farm hectarage cropped, and let $P_i = A_i / \sum_{i=1}^{N} A_i$, denoting proportions; then the following diversification measures are considered[14]:

$M_1 = \max_i P_i$ (*index of maximum proportion)*, where (i=1, 2,…, n)

$M_2 = \sum_{i=1}^{N} I(P_i)$ (*number of enterprises*), where I denotes a zero-one indicator.

$M_3 = \sum_{i=1}^{N} P_i^2$ (*Hirschmann-Herfindahl index*)

$M_4 = \sum_{i=1}^{N} P_i \log \frac{1}{P_i}$ (entropy *index*)

[14] These measures are the similar as those measures defined for measuring the market concentration according to Clarke (1993). However, it depends on how one defines the market diversification and the market concentration.

Where: The index of maximum proportion (M_1) is defined as the ratio (proportion) of the farm's primary activity to its total activities. Thus, if the farm's activities are ranked from largest to smallest to its total activities, the index of maximum proportion should be the farm's largest activity. But, when the farm has only one activity (specialised), say i = 1, then $P_i = 1$ and that $M_1 = 1$. Thus, for increasing diversification M_1 should decrease.

The number of enterprises (M_2) is the simplest index in which we count the number of activities the farm operates. If the farm has no activity, then $I(P_i)$ will assign the value of zero and that M_2 is zero. But, when the farm has n activities, say i = 1,...., n, then $I(P_i)$ will assign the value of 1 for each of those n activities and that M_2 is n. Thus, for increasing diversification M_2 should increase. The weakness of this index is that it gives no weight at all to the distribution of the farm's employment over the activities.

The Hirschman-Herfindahl index (M_3) is obtained by squaring the shares of a farm's activities. It therefore gives particular weight to the farm's principal activities. The weighting means that a farm's secondary activities are given only limited weight in calculating the index. This index is insensitive to minor secondary activities. This is desirable since it focuses attention on the major activities of the farm. This index takes the value of one, when a farm is completely specialised in its primary activity, and should approach zero as N gets large. Thus, for increasing diversification M_3 should decrease.

The entropy index (M_4) weights the shares of a farm's activity by a log term of the inverse of the respective shares. It takes the value of zero when the farm is completely specialised, and it will approach its maximum when diversification is perfect[15]. Thus, for increasing diversification M_4 should increase. This index gives less weight to larger activities than the Hirschman-Herfindahl index.

B) Measuring impact: Difference-in- difference estimator

In the case of changes in government policy (e.g. case of market liberalisation), it is difficult to isolate a true control sample for comparison with a "treatment" group as information on the policy change permeates across the population. As a result, "experimental controls" are virtually impossible and "quasi-experimental controls" must suffice. The "before" scenario cannot necessarily be assumed as an accurate counterfactual to the "after" scenario, due to the fact that the context for agricultural production is constantly changing. A more effective approach for the establishment of "quasi-experimental controls" may be the double difference approach, if the groups are under similar conditions.

Following Maluccio (2005), the double difference estimator compares the change in outcomes in the treatment group before and after the intervention to the change in the outcomes in the control group. By comparing changes, the estimator controls for characteristics that do not change over time within the treatment and control groups, as well as characteristics that change over time in the same way between the groups. The change in

[15] According to Samuelson (1967), the entropy index will be maximized when optimal diversification is undertaken by a risky averter and when returns are independent and have equal means

the control group is an estimate of the true counterfactual, that is, what would have happened to the treatment group if the intervention had not been implemented. In this study, the net sellers of maize are considered as the treatment group whereas the net buyers/autarky are considered as the control group.

The first difference is achieved by comparing the treatment and control group at baseline, thereby accounting for any inherent differences in means between groups. The second difference measures the change over time between the treatment and the control.

Table 5.1 Calculation of the double-difference estimate of average programme effect

Measurement	Intervention group (net sellers)	Control Group (net buyers/autarky)	Difference across groups
Follow-up (2003 survey)	I_1	C_1	$I_1 - C_1$
Baseline (1992 survey	I_0	C_0	$I_0 - C_0$
Difference across time	$I_1 - I_0$	$C_1 - C_0$	Double difference $(I_1 - C_1) - (I_0 - C_0)$

The difference in difference approach technique yields what is often referred to as the "average programme impact". The columns distinguish between groups with and without the program (denoted by I for intervention and C for control) and the rows distinguish between before and after the programme (denoted by subscripts 0 and 1). Before program (market liberalisation) one could expect the average for the two groups to be similar, so that the quantity $(I_0 - C_0)$ would be close to zero. After the programme has been implemented, one would expect differences between the groups as a result of the programme. Because of the random effect of the programme, we expect the difference $(I_1 - C_1)$ to measure the effect directly attributable to the programme. Indeed, $(I_1 - C_1)$ is a valid measure of the average programme impact under this experimental design. A more robust measure of the effect, however, would account for any preexisting observable or unobservable differences between the two randomly assigned groups: this is the double difference obtained by subtracting the preexisting differences between the groups, $(I_0 - C_0)$, from the difference after the programme has been implemented, $(I_1 - C_1)$. Using the difference-in-difference estimator, the impact of market liberalisation on personal and household characteristics, on-farm enterprise diversification and commercialisation were analysed. The comparison is necessary for assessing the real impact attributable to market liberalisation (the intervention) rather than attribute the impact to common trends such as changes in household food preferences.

C) Measuring impact and market participation: probit regression

Household participation in a maize market can be as a net buyer or net seller. Non-participation in maize market implies a case of autarkic households. It is hypothesized that household participation or non-participation in maize markets is influenced by both personal and farm household specific characteristics. In order to identify the personal and farm household characteristics that influence household participation or non-participation in maize markets, we used a multinomial probit regression model. The multinomial probit regression uses maximum likelihood estimation technique. The model assumes that individuals select one of several mutually exclusive alternatives. The random utility of individual i, i = 1, ..., N , for choice j;
j = 1, …, N, is formulated as

$$u_{ij} = \alpha_j + x_i'\beta_j + \varepsilon_{ij} \qquad (5.1)$$

where: x_i is a (k × 1) vector of explanatory variables for individual i, which may contain both individual specific characteristics and alternative specific attributes faced by individual i;

$\varepsilon_i = (\varepsilon_{i1}, \varepsilon_{i2}, \varepsilon_{i3})'$ is a vector of stochastic terms which is assumed to be distributed as normal, identical and independent across the N individuals, with zero mean.

The empirical model for the estimation of market participation is specified as in (5.1) with J=3, which represent the three alternative cases in market participation: net seller, net buyer and autarky. In this study, the x_{is} include the age of household head, measured in years; distance to the nearest input market, measured in kilometres; household size; gender of household head (male = 1, otherwise = 0); number of household members working off-farm; and area under maize, measured in acres. The estimation was done separately for both 1992 and 2003 data sets and results compared.

A positive sign of the coefficient implies that the explanatory variable in the regression analysis increases the probability of the household participating in the maize market as either a net buyer or does not participate in the market relative to the base outcome (the net seller), and a negative one decreases it. The goodness-of-fit of the model can be assessed by means of the model chi-square. It tests the null hypothesis that the coefficients for all the terms in the model, except the constant, are zero. If the null hypothesis is rejected ($P<0.05$), the model is meaningful. In addition to the model chi-square, the percentage of correctly classified observations gives an indication of the goodness-of-fit of the model.

5.4 Results

In this section, we present descriptive results for household and farm characteristics, commercialisation, and on-farm diversification for the two time periods. Second, we provide the average impacts of market liberalisation on on-farm diversification and commercialisation. Next we provide probit regression results on which factors have contributed to some households changing positions in the market from participation in 1992

to non-market participation in 2003 and vice versa. Thereafter, we provide multinomial regression results on factors that influence the choice of households in the market to participate as net sellers, net buyers or autarky. Finally, we offer farmer perceptions on the impacts of market liberalisation on household maize production, on-farm diversification, external input use and off-farm employment.

5.4.1 Descriptive statistics Results

The descriptive results provide evidence on the mean levels and ranges for selected variables on household and farm characteristics, on-farm diversification and commercialisation before and after market liberalisation. This is a first step in establishing whether there are differences in these variables in the two- time periods.

A) Household and farm dynamics

Table 5.2 provides the descriptive results of the farm and household characteristics for the two periods. The results (Table 5.2) indicate that the mean age of the household head was 44 years for 1992 and 55 years for 2003. Except for age of household heads, there are considerable variations in other characteristics as measured by the coefficient of variation (CV) both in 1992 and 2003.

Table 5.2 Changes in farm and household characteristics

Variable	1992				2003				Change by 2003 as % of 1992
	mean	min	max	CV	mean	min	max	CV	
Age	44.4	21	71	0.25	54.9	30	82	0.20	23.6
HH size	8.0	1	23	0.48	7.5	1	16	1.36	-0.06
Farm size	8.32	0.1	100	1.35	9.1	0.1	86.5	1.36	9.4
Maize area	2.6	0.13	16	0.96	2.3	0.1	20	1.13	-11.5
Maize production	24	1	310	1.45	29.8	0.3	330	1.29	18.8
Distance	32.5	3	68	0.75	27.6	3	68	0.72	-15.1

Overall, area under maize, distance to the market and household size decreased over time while during the same time age of household head, maize production and farm size increased. The reduction in area under maize goes against the expectation of maize market liberalisation. It was expected that liberalisation would increase area under maize partly because of an expected decline in input prices and increase in maize prices. To the contrary, nominal fertiliser prices have increased over the years and maize prices have fluctuated greatly from year to year (Karanja 2002). The ensuing uncertainty in maize production could partly explain the reduction in area under maize. Furthermore, the reduction in area under maize could imply

that enterprise competitiveness for resources may not have significantly changed in favour of maize.

However, the modest increase in maize production levels in 2003 and 1992 could partly be explained by an increase in the use of external inputs. Similarly, a reduction in the distance travelled to the input markets reflects the increasing role of private traders as envisaged with market liberalisation.

B) Diversification

Table 5.3 provides results of on-farm diversification based on the four different approaches discussed earlier in section 5.3.3 for comparison purposes. The table indicates that the proportion of the major land area devoted to a single enterprise (usually maize) decreased while the total number of crops per household increased. The Hirschman-Herfindahl (HH) index is closer to zero while the entropy index is increasing.

Overall, the diversification measures show that diversification has increased with market liberalisation. Both the entropy index and number of crops have increased whereas the Herfindahl index and the index of maximum proportion have decreased. This is consistent with increased diversification. This could be a pointer to the uncertainty that the small-scale households face regarding food security as maize prices fluctuate from year to year. The results go contrary to expectations that market liberalisation would discourage diversification and encourage specialization.

Table 5.3 Changes in diversification

Measure	1992	2003	Change by 2003 as a
	Mean (s.e.)	Mean (s.e.)	% of 1992
Maximum proportion (acres)	0.81 (0.02)	0.67 (0.02)	-17.3
Number of crops	2.0 (0.08)	3.2 (0.08)	60.0
Hirschman-Herfindhal index	0.75 (0.02)	0.56 (0.02)	-0.25
Entropy Index	0.18 (0.01)	0.33 (0.01)	0.83

Further analysis suggests that some crop enterprises were expanding while others seem to be disappearing after market liberalisation. Tea, wheat and Napier grass are the expanding enterprises (Fig. 5.1). Only four of the sampled households grew tea in 1992 on a total of 0.8 hectares. By 2003, tea was grown by 18 households with a total of 6 hectares. In 1992, three households grew wheat on a total of 5.2 hectares but in 2003, 11 households grew wheat on a total of 14.4 hectares of land. Seven households grew Napier grass on 4 hectares in 1992 but this expanded to 46 households who had 9.3 hectares by 2003. Pyrethrum production declined from 12 households growing a total of 2.4 hectares in 1992 to only five households growing it on 1.2 hectares by 2003.

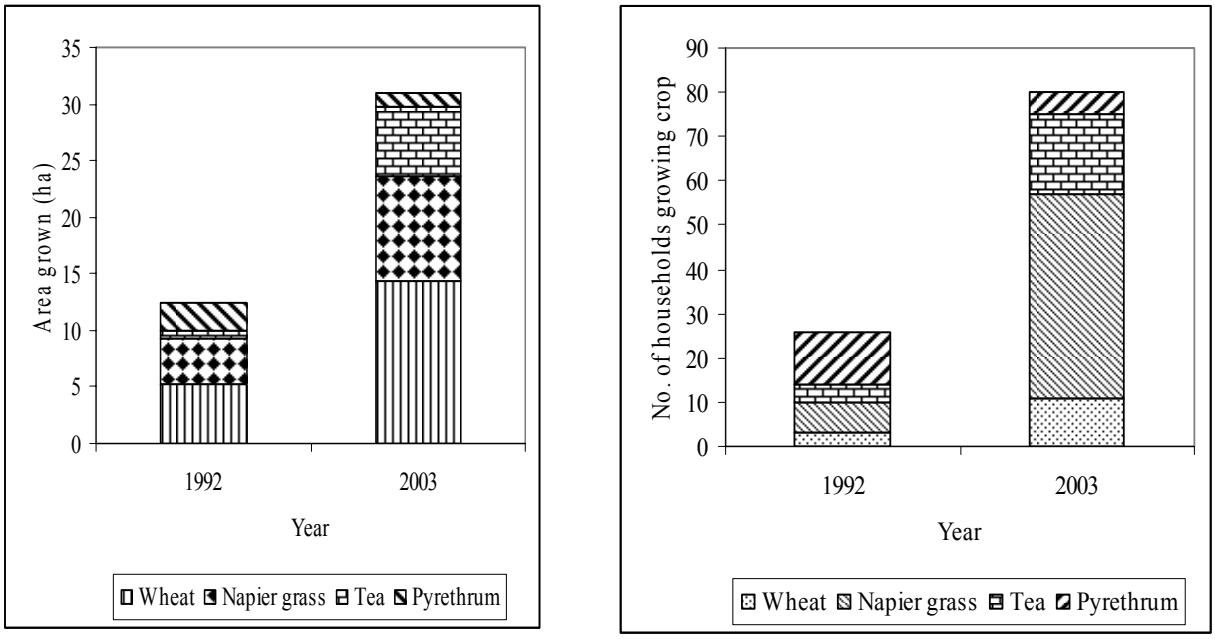


Fig. 5.1 Changes in expanding/contracting enterprise patterns

The observed changes in enterprise patterns could mainly be attributed to institutional and marketing factors. Tea is a major cash crop with stable market price and great institutional support (interlocked credit systems) - suitable for resource poor farmers. Pyrethrum, a crop used to manufacture natural insecticides and currently facing competition from artificial insecticides, is fast disappearing due to problems of marketing the crop. As a consequence of inadequate world demand, farmers have not been paid for pyrethrum deliveries made to the factory in recent years. These farmers have opted to replace it with other crops such as Napier grass and potatoes. Farmers use Napier grass to feed cattle under semi-intensive to intensive dairy systems. While, the estimated number of dairy cattle in Trans Nzoia ranged from 95,000 to 105,000 head between 1991 and 2003 (Ministry of Agriculture 2003), Fig. 5.2 shows that milk sales in Trans Nzoia (1991-2003) have trended upwards. The result could probably provide additional evidence of increased area under Napier grass. The trends in milk sales in Trans Nzoia reflect the situation in the wider North Rift.

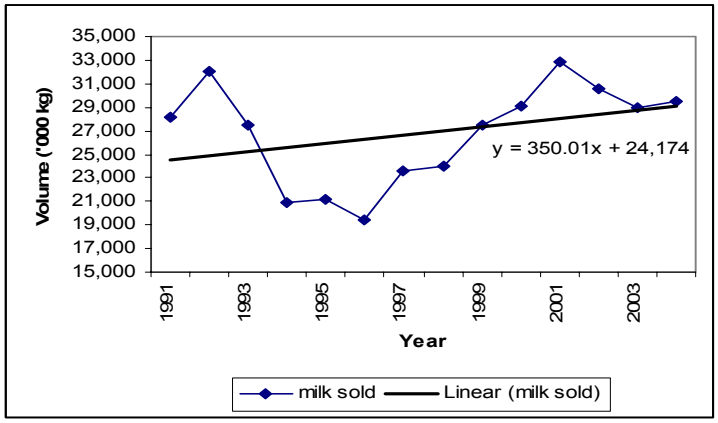


Fig. 5.2 Trends in milk sales (1991-2003)

C) Commercialisation

Table 5.4 shows descriptive results for farm commercialisation in terms of both basal and topdress fertilisers, household maize sale levels and proportion of maize produced that is sold.

Table 5.4 Changes in farm commercialisation

Variable	1992	2003	Change by 2003 as % of 1992
	mean (s.e.)	Mean(s.e.)	
Basal fertiliser[1]	67.6 (5.2)	99.1 (4.4)	46.6
Topdress fertiliser[1]	22.7 (3.9)	53.3 (5.0)	134.8
Maize sales[2]	12.2 (2.6)	15.9 (2.7)	30.3

[1] refers to 50 kg per hectare and [2] refers to 90-kg bag per year

Both the amount of basal and topdressing fertiliser use increased among households between 1992 and 2003. Despite the increase, fertiliser use is below the blanket recommendation of 60 kg P_2O_5 and 60kg N per hectare which is equivalent to 130kg DAP/ha and 240kg CAN/ha (Rees *et al.,* 1998b). Maize sales have also increased during this period.

Fertiliser use: Further data analysis indicate that 13 percent and 53 percent of the sampled households did not use phosphatic (basal) and nitrogenous (topdressing) fertilisers, respectively, in 2003 as compared to 30 percent and 77 percent who did not use basal and topdressing fertilisers, respectively in 1992. Seventy five percent of these households which did not use fertilisers were located in the relatively remote locations of Meteitei, Kapomboi and Lelan. In addition to these areas, non-use of nitrogenous fertilisers was observed in the areas with low production potential of Kamwosor, Kapkangani and Kaplelemet. It is only two percent and 13 percent of the households who applied at least the recommended basal and nitrogenous fertiliser use, respectively in 2003.

Hybrid seed use is quite widespread in the region. In 1992, about 98 percent of the households used hybrid seed with less than five percent using local or recycled seed. The

result compares with 90 percent of the households who used hybrid seed and 30 percent who used recycled[16] / or local maize seed in 2003. Some farmers use combinations of both hybrid and local or recycled maize seeds. The results mirror the fact that hybrid maize seed is the most adopted of the maize production technology package which includes fertiliser use, timely land preparation and timely weeding (Rees *et al.* 1998a). However, with market liberalisation farmers have complained of high fertiliser prices and seed quality adulterations. This complaint could partly explain the increased number of households using recycled or local seed in whole or part of their maize fields.

Maize sales: Households vary in terms of volume of maize sold. The volume of maize sold is influenced by several factors such as level of production, household subsistence requirements, price of maize and available marketing outlets. As shown in Table 5.4, the total maize sales and proportion of maize production sold increased with market liberalisation. Further analysis shows that the number of households selling maize increased from about 44 percent in 1992 to 70 percent in 2003. The distribution of amount of maize sold varied both in 1992 and 2003 but also within each year (Fig 5.3). Whereas the proportion of households selling more than five bags of maize increased modestly between 1992 and 2003, the increase in the proportion of households selling less than five bags increased four-fold. The increased amount of maize sold could partly be explained by increased fertiliser use which has increased land productivity over the two-year period.

[16] The term recycled hybrid maize refers to second or later generations of hybrid maize seed that is harvested by the farmer and saved for seed instead of the farmer purchasing new hybrid seed the following year. Yields from recycled seed are generally lower than from hybrid seed.

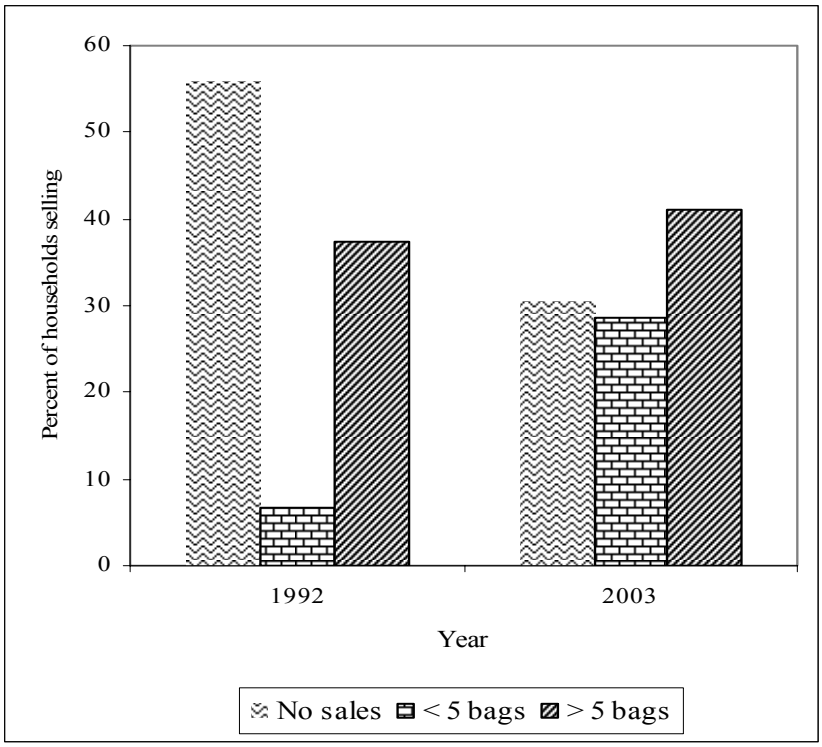


Fig. 5.3 Distribution of volume of maize sales by percent households

Market outlets: The maize market outlets have changed over the two-year period (Table 5.6). As expected, the major outlet during the pre-liberalisation period was NCPB. Other less important outlets were farm-gate and periodic/permanent markets. During the post-liberalisation era, NCPB played a peripheral role with traders who buy maize at the farm-gate being the most important outlet. Private traders who operate stores within the household's vicinity, normally in local / urban market centres are key maize outlets. Households prefer selling to the farm-gate for various reasons such as minimising transaction costs and also partly due to the fact the transaction is cash-based.

Table 5.6 Maize sales outlets by percent households

Amount sold	% households selling in 1992 (n=70)	% households selling in 2003 (n=111)
NCPB	52.9	3.6
Farm-gate (boda boda and with vehicles)	24.3	49.4
Periodic/permanent markets	17.1	-
Cooperatives	5.7	1.8
Millers	-	1.8
Trader with maize stores	-	29.7
Direct consumers	-	13.5

We investigated the changes in the link between households and the maize market. We grouped households into two categories based on their participation in the market: participants and non-participants. Market participants were considered as households who either buy or sell, or those who both sell and buy maize in the course of the cropping year. Non-participants are those households which neither buy nor sell maize in the course of the year. Table 5.7 shows that overall, market participants have increased but the number of non-market participants has decreased over the years.

Table 5.7 Household participation in maize markets

		2003		
		Participants	Non-participants	Total
1992	Participants	88	15	103
	Non-participants	49	9	58
Total		137	24	161

This result indicates that in 2003 an increasing number of households depended on the maize market either for income and / or food compared to 1992. In a number of cases, household positions with regard to market participation have changed since the market was liberalised signifying possible changes in household specific characteristics. For instance, about 84 percent of the non-market participants in 1992 had become market participants in 2003. This result compares with only 15 percent of the market participants in 1992 who had become non-market participants in 2003. During the two periods, 55 percent of the households remained as market participants whereas only 6 percent remained as non-market participants.

In order to assess the possible drivers for these trends we ran a probit regression model with market participation as the dependent variable (market participant =1; otherwise =0), and household and farm characteristics as explanatory variables both for 1992 and 2003. Table 5.8 presents the results of households that have switched positions in market participants during the two years: market participants in 1992 but non-market participants in 2003, and non-market participants in 1992 but participants in 2003.

Table 5.8 Factors influencing households' changed position in marketing participation between 1992 and 2003

Variable	participants 1992 but non-participants 2003		Non-participants 1992 but participants in 2003	
	Coefficient	Standard error	Coefficient	Standard error
Constant	0.161	0.572	-0.810	0.526
Total farm size (ha)	-0.011	0.046	0.065**	0.0307
Area under maize (ha)	0.156	0.137	-0.359**	0.176
Age of household head (years)	-0.010	0.011	0.010	0.010
Distance to nearest urban market (km)	-0.013*	0.007	-0.005	0.005
Household size	-0.062*	0.033	0.009	0.030
Gender (male=1; female=0)	0.180	0.322	-0.187	0.222
No. of members employed off-farm	-0.084	0.223	0.159	0.159
Basal fertiliser (kg/ha)	-0.010***	0.003	0.003*	0.002
Topdress fertiliser (kg/ha)	0.006	0.004	0.001	0.003
Number of observations	161		161	
Wald chi2(9)	16.25		12.88	
Prob > chi2	0.062		0.168	
Logpseudolikelihood	-42.397		-91.83	

The results show that the probability of a household switching position from participant in 1992 to non-participant in 2003 increased if the household was located closer to the nearest urban market, had smaller family size and was using less basal fertiliser per hectare.

The results also show that the probability of a household switching position from a non-participant in 1992 to a participant in 2003 increased if household had a large farm size, less area under maize and applied more basal fertiliser per hectare.

5.4.2 Impact of household participation in maize markets: double difference estimation results

In this section, we examine the impact of market liberalisation on personal and farm household characteristics, diversification and commercialisation.

Table 5.9 shows that there are no differences in age between participants and non-participants during each period. However, in 1992 the heads of households for both groups were significantly ($P<0.05$) younger than they were in 2003. The average impact of market liberalisation on age was positive 2.41. This implies that younger farmers are more responsive to market liberalisation partly because they are able to access market information more easily than the older farmers who have on average have less formal education.

In 1992 and 2003, market participants were located farther away from input market centres than non-market participants. In 2003, both market participants travelled shorter distances to the input markets than in 1992. The decline in distance travelled could be attributed to the increased number of traders with market liberalisation. In order to increase market share for the maize and input trade, private traders have penetrated areas initially not served by state marketing agencies. The fact that market participants are farther away from input markets implies that there is need to look for more cost-effective ways of reducing

transport costs for inputs if the objective of market liberalisation of increasing market surplus is to be sustained.

In 1992, market participants had significantly ($p<0.05$) larger areas under maize than non-market participants. However, there were no significant differences between these groups in 2003. There were no significant differences in number of household members working off-farm between participants and non-participants in 1992 and 2003. However, significantly more household members worked off-farm in 2003 than they did in 1992. This could partly be explained by changes in age, education and increased opportunities arising from market participation in form of trade such as milk hawking and maize trading.

There were no significant differences in household and farm size among participants and non-participants in each period and between the two periods. Similarly, there was neither significant change in gender of household head across market participants nor across period.

A) Impact of market liberalisation on household and farm characteristics

Table 5.9 Mean impact of market liberalisation on household and farm characteristics

Measurements	Year	Participants	Non-participants	Difference across groups	T-stat	Difference across time		T-stat		Double difference
						Participants	Non-participants	Participants	Non-participants	
Age of head (years)	1992	44.07	44.98	-0.91	-0.51	11.49	5.93	-7.84***	-2.46**	5.55
		(1.11)	(1.34)	(-1.79)		(1.47)	(-2.41)			
	2003	55.6	50.92	4.64	1.92*					
		(0.96)	(1.88)	(2.42)						
Distance (km)	1992	35.30	27.52	-7.78	1.95*	-6.12	-8.98	2.08**	1.77*	2.86
		(2.47)	(3.00)	(3.98)		(2.93)	5.06)			
	2003	29.18	18.54	-10.64	2.44**					
		(18.54)	(3.00)	(4.35)						
Farm size (ha)	1992	3.09	3.75	-0.66	-0.89	-0.47	-0.46	-0.83	-0.32	-0.01
		(0.34)	(0.78)	(0.74)		(0.56)	(1.41)			
	2003	3.56	4.21	-0.65	-0.59					
		(0.42)	(1.13)	(1.10)						
Maize area (ha)	1992	1.14	0.80	0.34	2.15**	0.20	-0.03	1.45	-0.16	0.23
		(0.10)	(0.12)	(0.16)		(0.14)	(0.21)			
	2003	0.95	0.83	0.11	0.49					
		(0.09)	(0.14)	(0.23)						
Household size	1992	7.69	8.48	-0.79	-1.27	0.25	0.44	0.62	0.45	-0.19
		(0.33)	(0.59)	(0.62)		(0.40)	(0.98)			
	2003	7.46	8.04	-0.58	-0.93					
		(0.25)	(0.49)	(0.63)						
Gender of head	1992	0.65	0.62	0.03	0.38	0.01	-0.004	0.13	-0.04	0.01
		(0.05)	(0.06)	(0.08)		(0.06)	(0.12)			
	2003	0.64	0.63	0.02	0.16					
		(0.04)	(0.10)	(0.11)						
Off-farm employment (number)	1992	0.52	0.38	0.14	1.25	-1.13	-1.37	-7.05***	-6.31***	0.24
		(0.07)	(0.08)	(0.12)		(0.16)	(0.22)			
	2003	1.65	1.75	-0.10	-0.31					
		(0.13)	(0.27)	(0.32)						

Note: * = significant at 10% level, ** = significant at 5% level, ** = significant at 1% level.

B) Impact of market liberalisation on commercialisation

Table 5.10 presents the average impact of market liberalisation on commercialisation in terms of basal and topdress fertiliser use. Results (Table 5.10) indicate that the rate of both basal and topdressing fertiliser use in maize was significantly ($P<0.05$) higher after than before maize liberalisation. However, there were no significant differences in the rate of fertiliser use between market and non-market participants in both years. This could be attributed to increased physical accessibility as traders are physically closer to farmers.

Overall, the mean impact of market liberalisation on both basal and topdressing fertiliser use is positive. However, the mean impact for basal fertiliser use is higher than for topdressing fertilisers. For increased yield, both fertilisers are important. The differential impact of the rate of fertiliser use on the two different fertiliser types points to possible inadequate farmer information on fertiliser use.

C) Market liberalisation impact on diversification

Table 5.11 indicates that all the four approaches to estimate diversification were unanimous that on-farm diversification has increased with market liberalisation among households. There are no significant differences among participants and non-participants regarding enterprise diversification on-farm before and after market liberalisation.

However, overall there is a modest increase in the number of crops grown by households between the two periods even though there are no significant differences between participants and non-participants in each period. Similarly, the area devoted to the largest enterprise has decreased signifying increased diversification. This result suggests that households wish to attain household food sufficiency in a wide range of foods is pertinent in this area regardless of whether they are participants or non-participants in maize market. In the next section, we present and discuss results of the factors that contribute to household participation in maize markets either as participants (net buyers or net sellers) or non-participants (autarky) in the maize market.

Table 5.10 Mean impact of market liberalisation on commercialisation

Measure (kg/ha)	Year	participants	non-participants	Difference across groups	T-stat	Difference across time		T-stat		Double difference
						participants	Non-participants	participants	Non-participants	
Basal fertiliser	1992	64.41	73.25	-8.85	-0.82	-34.94	-24.72	-4.51***	-1.56	10.22
		(6.14)	(9.34)	(-10.77)		(7.75)	(15.82)			
	2003	99.34	97.97	1.37	0.11					
		(4.88)	(9.67)	(12.35)						
Topdress fertiliser	1992	22.38	23.20	-0.82	-0.10	26.89	21.19	-3.62***	-3.95***	5.70
		(4.92)	(6.36)	(8.11)		(7.43)	(5.36)			
	2003	49.27	76.19	-26.92	-1.93*					
		(5.27)	(14.13)	(13.91)						

Note: * = significant at 10% level, ** = significant at 5% level, ** = significant at 1% level.

Table 5.11 Mean impact of market liberalisation on diversification

Measurements	Year	participants	Non-participants	Difference across groups	T-stat	Difference across time		T-stat		Double difference
						participants	Non-participants	participants	Non-participants	
Maximum proportion	1992	0.82	0.76	-0.06	1.71*	-0.17	-0.02	6.65***	0.37	-0.15
		(0.02)	(0.03)	(0.03)		(0.03)	(0.05)			
	2003	0.65	0.74	-0.09	-3.11**					
		(0.02)	(0.04)	(0.04)						
Number of enterprises	1992	1.99	2.16	-0.16	-0.94	1.21	0.76	-9.06***	-2.68***	0.45
		(0.09)	(0.16)	(0.17)		(0.13)	(0.28)			
	2003	3.20	2.92	0.29	-1.22					
		(0.09)	(0.20)	(0.24)						
Hirschman-Herfindahl Index	1992	0.76	0.71	0.05	1.16	-0.21	-0.07	7.49***	1.17	-0.15
		(0.02)	(0.03)	(0.04)		(0.03)	(0.06)			
	2003	0.55	0.65	-0.10	-2.13**					
		(0.02)	(0.04)	(0.04)						
Entropy Index	1992	0.17	0.21	-0.03	-1.19	-0.17	-0.07	-8.19***	-1.49	-0.10
		(0.02)	(0.02)	(0.03)		(0.02)	(0.04)			
	2003	0.34	0.27	0.07	2.06**					
		(0.01)	(0.03)	(0.03)						

Note: * = significant at 10% level, ** = significant at 5% level, ** = significant at 1% level.

5.4.3 Factors influencing impact of household participation in maize markets: Multinomial regression analysis

Multinomial probit regression analyses were used to establish the extent to which farm and household characteristics explain the impacts of market liberalisation on participation of households as participants or non-participants in maize markets. Three regression analyses were estimated based on the empirical model presented in equation 5.1. First, a separate regression analysis on the impact of selected household and farm characteristics on market participation as a net buyer or non-participation (neither buyer nor seller) relative to a net seller before market liberalisation (1992) was estimated. Second, a similar regression analysis was performed for the data after market liberalisation (2003). We present the results of the analyses in Table 5.12.

The results indicate that distance to input markets, household size and area under maize influence household participation as net sellers or non-participants in the maize market before and after market liberalisation. In 1992, households that had larger family size, were located farther from the market and devoting a smaller land area to maize were more likely to be net buyers relative to net sellers in 1992. However, in 2003 households that had larger family size, were located closer to the market and devoted a smaller land area to maize were more likely to be net buyers relative to net sellers in 2003.

The results also show that households near the market centres and devoted small area to maize production were more likely to be autarkic in both years. While households with larger households were more likely to be autarkic in 1992, household size did not have a significant impact on the likelihood of a household being autarkic in 2003.

Table 5.12 Factors influencing impact of household participation in maize markets: Probit regression results

Variable	1992		2003	
	Coefficient	Standard error	Coefficient	Standard error
-outcome_2 (net buyer)				
Constant	0.315	0.808	0.433	0.974
Age of household head (years)	0.017	0.016	0.005	0.015
Distance to nearest urban market (km)	-0.023***	0.007	-0.025***	0.091
Household size	0.116**	0.046	0.111	0.070
Gender (male=1; female=0)	-0.447	0.355	0.307	0.349
No. of household members employed off-farm	0.018	0.227	0.027	0.136
Area under maize (ha)	-1.230***	0.325	-1.910***	0.400
-outcome_3 (autarky)				
Constant	0.089	0.040	0.888	1.000
Age of household head (years)	0.020	0.016	-0.025	0.016
Distance to nearest urban market (km)	-0.021***	0.007	-0.032***	0.011
Household size	0.123***	0.004	0.114*	0.065
Gender (male=1; female=0)	-0.537	0.335	0.088	0.389
No. of household members employed off-farm	-0.295	0.245	0.016	0.129
Area under maize (ha)	-0.680**	0.328	-0.657*	0.360
No. of observations	161		161	
Wald chi2 (12)	41.57		37.65	
Prob>chi-square	0.000		0.000	
Log pseudolikelihood	-150.34		-128.02	

Note: * = significant at 10% level, ** = significant at 5% level, ** = significant at 1% level.

-Net seller is the base outcome.

Further analysis shows that households that were closer to the input market had a higher probability of being net buyers of maize or autarkic than those located farther from the input markets in both years. This result could be partly explained by the fact that households close to the markets could be engaged in production of high-value crops like vegetables. They could also be involved in off-farm employment opportunities available in the urban centres such as petty trade and construction work. The results echo the findings of Salasya (2005) and Karugia (2003) who reported a positive relation between adoption of fertiliser use and distance from the market in central and western Kenya. These inputs enhance chances of households participating in the maize market as net sellers due to increased maize production.

Similarly, households that devoted less area to maize production had a higher probability of being net buyers or autarkic than those who devoted more land to maize production. The larger the land devoted to maize, the higher the chances that a household participated in the maize market as a net seller. With a larger area devoted to maize production, chances are high that domestic production could be made and the surplus sold in the market.

Households that had larger sizes were more likely to be autarkic or net buyers relative to net sellers in 1992. They were only more likely to be autarkic relative to net sellers in 2003.

Households with smaller sizes are more likely to be net sellers than autarkic or net buyers because total domestic consumption is smaller for households with smaller family sizes.

Overall, the model-fit for each of the models estimated was satisfactory as measured by the chi-square statistics which was highly significant ($p<0.01$)

Marginal effects

Further analysis shows that an increase in distance to the nearest input market by 1 percent decreases the probability of both the net buyer and autarkic household from being a net seller by 0.003 percent in 1992 compared to 0.004 percent in 2003. Similarly, an increase in the area under maize by 1 percent decreases the probability of a net buyer being a net seller by 0.2 percent in 1992 and 0.4 percent in 2003.

To complement the results of the expected average impacts of market liberalisation on maize market participation, we sought farmers' perceptions on impacts of market liberalisation on selected variables of interest. In the next section, we present the results of this analysis.

Farmer Perceptions on market liberalisation

Farmer perceptions on policy issues are important (Porter & Prysor-Jones. 1998). The perceptions provide feedback on the effects of policy on their farming activities. For instance, farmer perceptions on market liberalisation would elucidate their decisions regarding input use and choice of product marketing outlets. Previous studies on market liberalisation in Kenya (Karanja *et al.* 1998; Argwings-Kodhek 1999) have focused mainly on quantifying the effects of market liberalisation with little information on farmer perceptions. Therefore, the current study augments the quantitative changes with farmer perceptions to improve the understanding of the effects of market liberalisation on maize production and marketing. Farmer perceptions were sought on the impacts of fertiliser/seed market liberalisation on fertiliser/seed availability, use and price. For maize liberalisation, farmer perceptions were sought on levels of fertiliser use. In addition, farmer perceptions were sought on area under maize, hired labour use, levels of maize production and sale, extent of on-farm diversification, levels of household income and labour use off-farm.

The results were organised on a scale of one to four where one meant the impacts were positive (increased); two, the impacts were negative (decreased); three, the farmers were indifferent (fluctuated) about the impacts; and four, there was no discernible change. Tables 5.13 through 5.15 present the results of farmer perceptions on the changes on selected variables as a result of fertiliser, seed and maize market liberalisation, respectively.

Table 5.13 Farmers' perceptions on the impacts of fertiliser market liberalisation on some selected attributes in North Rift

Attribute	Direction of change (Percent)			
	Increased	Decreased	fluctuated	No change
Fertiliser availability (n=137)	56.2	19.0	14.6	10.2
Availability of preferred fertiliser type n=136)	46.3	28.7	14.0	11.0
Fertiliser price (n=138)	64.5	10.9	18.1	6.2
Area under maize (=139)	7.2	39.6	2.9	50.4
Enterprise diversification (n=136)	49.3	8.8	5.9	36.0
Hired labour use (n=135)	18.5	39.3	1.5	40.7
Participation in off-farm activities (n=136)	30.9	20.6	2.7	44.9

Source: household survey, 2003

Table 5.13 shows that market liberalisation has generally led to increased fertiliser availability and price as well as enterprise diversification on-farm. The increase in fertiliser price probably reflects the decline in area under maize or the large proportion of households who witnessed no change in area under maize. Fertiliser types preferred by farmers have increasingly become available. Conversely, market liberalisation has generally either decreased or not changed the area under maize and use of hired labour. The changes in household participation in off-farm activities are not clear.

Table 5.14 Farmers' perceptions on the impacts of seed maize market liberalisation on some selected attributes in North Rift

Attribute	Direction of change (Percent)			
	Increased	Decreased	fluctuated	No change
Availability of preferred variety (n=152)	53.3	25.0	9.2	12.5
Recycled maize use (n= 132)	37.9	32.6	2.3	27.3
Price of seed (n=155)	60.0	12.9	19.4	7.7
Area under maize (n=156)	12.2	37.2	1.3	49.4
Hired labour use (n=148)	10.8	45.9	2.0	41.2
Enterprise diversification (n=149))	47.7	9.4	6.0	36.9

Source: household survey, 2003

Table 5.13 shows that price of seed and availability of the preferred seed varieties have increased with market liberalisation. Changes regarding the use of recycled seed are mixed. Use of recycled seed is common with farmers close to seed growers. They attribute the use of recycled seed to the high price and perceived poor quality of the hybrid seed sold.

Table 5.15 Farmers' perceptions on the impacts of maize market liberalisation on some selected attributes in North Rift

Attribute	Direction of change (Percent)			
	Increased	Decreased	fluctuated	No change
Area under maize (n=154)	22.1	26.0	5.2	46.8
Hired labour use (n=154)	24.0	28.6	9.1	38.3
Quantity of maize sold (n= 156)	25.0	44.0	10.9	19.9
Price of maize sold (n= 155)	30.3	40.0	23.2	6.5
Enterprise diversification (n=151)	41.7	19.2	6.0	33.1
Participation in off-farm activities (n=152)	25.0	18.4	3.9	52.6

Source: household survey, 2003

Farmer perceptions on impacts of market liberalisation on selected attributes were variable (Table 5.15). Farmers witnessed more variability in the price of maize than with other variables. Generally, the proportion of households reporting increased enterprise diversification and participation in off-farm activities was higher than those reporting decreased enterprise diversification and participation in off-farm activities.

It could be concluded that the variations in perceptions on the impacts of market liberalisation reflect the heterogeneity of the farming households. For instance, for households that participate in input and output markets, area under maize will change with changes in the relative input-output prices. This scenario presupposes that land is not constraining. An increase in the input-output price ratio will lead to decreased area under maize, *ceteris paribus*. For subsistence households who do not participate in the input and output markets, no change in area under maize is expected *ceteris paribus*. Similarly, subsistence households may participate in off-farm activities (hiring out labour) to meet production shortfalls whereas semi-subsistence households may hire out labour to meet their income shortfalls. The income earned would be used to purchase farm inputs for their own farms.

5.6 Discussion, conclusions and policy implications

This chapter sought to compare and contrast maize production and marketing of small-scale producers using a two year panel data. The 1992 and 2003 data represented the household characteristics before and after market liberalisation, respectively. In particular, the study sought to identify changes in households' maize commercialisation and on-farm enterprise diversification.

The household mean area under maize declined by 11.5% from 1.02 hectares in 1992 to 0.92 hectares in 2003. During this period, the mean number of crops grown per household increased by 60% from two to 3.2. Based on farmer perceptions, the reduction in area under maize could be attributed to high input price and fluctuating maize prices. However, during the same time both basal and topdressing fertiliser use increased dramatically both in terms of number of households and rate of fertiliser use. This was attributed to increased accessibility of households to fertiliser traders. Therefore, households input use in 2003 was less variable in than in 1992. The descriptive analyses therefore show that diversification has increased over time. Similarly, maize commercialisation has increased. Both area under maize and area

under the largest on-farm enterprise witnessed the greatest negative changes whereas number of crops grown by average households and fertiliser use on maize witnessed dramatic positive changes.

The share of households selling maize increased from 44 percent in 1992 to 70 percent in 2003. The increase was mainly in the category of households selling less than five bags. This type of maize sellers are mainly semi-subsistence oriented. They sell maize to meet basic household subsistence demands. During the same period, non-market participants declined more than two-fold. This scenario suggests a tendency by households toward relying on markets for either purchase or sale of maize, an indicator of increased commercialisation.

Maize market outlets have changed significantly after market liberalisation. In 1992, about 53 percent of the households sold maize to NCPB and by 2003 the number had declined to about only four percent. This scenario contrasts with the doubling of the share of the households selling maize to private traders from 24 percent to 49 percent.

Area under maize, location of the households relative to the maize markets and size of household were the main factors influencing household participation as net buyers or not participating relative to net sellers of maize. While households with higher area under maize and travelled longer distances to the market increased the probability of these households participating in markets as net sellers, larger household size decreased the chances of households participating in maize markets as net sellers. For these households to increase their incomes from maize production there is need to improve infrastructure so as to reduce production costs in form of transport. From the results it could be concluded that market liberalisation has increased the probability of households to participate in markets as net sellers.

Given the main findings of the study, we could conclude that while there is a modest increase in commercialisation, there are still impediments to its full realization. For example, despite the fact that there is a modest increase in fertiliser use with market liberalisation, the fertiliser use levels are low. Besides, the number of households still not using fertiliser is substantial. This scenario points to the possibility of impediments to fertiliser use. Policies to address fertiliser use bottlenecks could encourage its use which may lead to surplus production. Second, increased on-farm diversification despite efforts to promote specialization is a pointer to farmers' inadequate trust on relying on the market for household food needs. Such production systems perpetuate subsistence production and may lock households from the benefits of comparative advantage inherent in specialization. Efforts necessary to encourage food market development may be a possible solution.

CHAPTER 6

GENERAL DISCUSSION AND CONCLUSIONS

6.1 Introduction

In Kenya, market liberalisation has been implemented since the late 1980s and early 1990s. The aim of market liberalisation has been to improve the efficiency of both agricultural input and output markets. Market efficiency was expected to improve the incentive structure of rural household producers through competitive input and output prices. Consequently, farmers would respond by increasing production and marketed surplus. Improved agricultural production is a necessary condition for improving economic growth as agriculture is the main driver of economic growth in Kenya.

This study set to understand how rural households, input and output traders have responded to market liberalisation. In particular, the study focused on the marketing of four commodities: fertiliser, hybrid seed maize, maize and milk. The response of traders to market liberalisation influences farmer response to production of maize and milk through input availability, and input and output price levels. Results from the study would improve an understanding of the impact of market liberalisation on the income of rural household in this region. It would also contribute to the general knowledge on the impact of market liberalisation given different farmer circumstances.

This chapter synthesises the major findings of the study. In section 6.2 data and methods are discussed while section 6.3 examines the current status of the market liberalisation process and discusses the main findings of the study. In section 6.4, we provide the innovative aspects of the study. In particular, the study's contribution to knowledge on the distribution of margins among various market participants, firm size distribution, and integration of wholesale maize markets, on-farm commercialisation and diversification after market liberalisation are presented. Conclusions of the study are offered in section 6.5 while policy implications and outlook are given in section 6.6.

6.2 Data

This study uses three data sets: 1992 maize data base (MDB) survey, 2003 household and trader surveys, and several sets of secondary data.

The 1992 MDB survey collected data aimed at characterising maize production systems in Kenya from 1407 households nationally (Hassan *et al.* 1992). Of these households, 200 were located in North Rift - our study area. The data collected from the rural households included household and farm characteristics, activities household was engaged in, input prices and use. They also included output level levels realised and marketing of the outputs.

In the 2003, we retraced and interviewed the same households that were studied in 1992. Only 161 of the 200 households interviewed in 1992 were available. We used a similar questionnaire to that of 1992 to collect data on maize production and marketing activities

from these households. In addition, we interviewed fertiliser, seed, maize and milk traders in the study region using a multi-stage sampling procedure. Specifically, we collected data on history of traders, levels of investment, volumes traded, marketing costs, purchase and selling prices and trader perceptions on market liberalisation. The data were used to analyse the structure, conduct and performance of the four commodities.

Besides the primary data collected, the study used several secondary data sets. First, data on world fertiliser and maize price were collected and in comparison with Kitale retail fertiliser price and producer maize price were used to determine distribution of fertiliser and maize margins before and after market liberalisation. Second, time series data on wholesale monthly maize price covering January 1992 to April to 2004 were obtained for six markets from the Ministry of Agriculture. The data were used to analyse the extent of the integration of wholesale maize in Kenya. Specifically, wholesale price movements were traced and price causality among pairs of markets determined. These data sets were supplemented with another data set on maize trade flows within the East African region. Third, yearly data on prices of maize and fertiliser, rainfall, maize production and Consumer Price Index covering 1980 and 2003 were collected and used to estimate the maize supply response of the farm households.

It is possible to have errors in data collected from secondary sources. This in particular points to data for variables such as area under maize production and maize production levels. These data are often not objectively measured and may be biased due to individual subjectivity. The frontline extension staff of the Ministry of Agriculture collect the data. The final district level figures are an aggregate of estimates made by these frontline extension staff in designated areas within the district. Assuming the errors even-out, the time series data give a general picture of farmer response which is considered useful for policy analysis.

Aggregate yearly or monthly prices mask important price differences that are observed within short market intervals. Weekly prices for wholesale maize prices could have been used but absence of long-term consistent price data limits more comprehensive analysis that could give better information on market integration. Furthermore, inadequate data for markets in deficit and often remotely located markets limits the comparison of the study on market integration with these regions.

6.3 Synthesis of main findings

In this section we present the synthesis of the main findings for the study.

6.3.1 Status of market liberalisation

The markets for the four commodities were liberalised. It could be said that the process has been partial as the government has not totally disengaged from commercial activities. Government purchase of maize and milk takes place although not to the same scale as before market liberalisation. In recent years, the Kenya Cooperative Creameries (KCC) is being revamped and the National Cereals and Produce Board (NCPB) continue to participate in

maize marketing further distorting maize prices. Government continued participation in maize trade is justified on grounds of stabilizing producer prices (Nyoro and Mwangi, 2006). The government also continues with its regulatory role and to some extent facilitates commodity trade. For instance, NCPB has been exempted from the State Corporations Act. This implies that it can compete with private traders without necessarily being cushioned by the ex-chequer. The government also facilitates trade through commodity quality control. For instance, the Kenya Bureau of Standards (KeBS) is charged with quality control in fertiliser and maize grain while Kenya Dairy Board (KDB) and Kenya Plant Health Inspectorate Service (KEPHIS) are charged with milk and seed quality control, respectively.

6.3.2 Maize wholesale market integration

Knowledge on market integration is important to policy makers. Information on market integration can guide the government in prioritizing investment that could allow easy flow of food from surplus often-accessible regions deficit often-inaccessible regions. Furthermore, examination of price movements can be used as a signal to famine early warning systems.

Results obtained by analyzing price movements for six maize wholesale markets in Kenya indicate that the wholesale markets are fairly well integrated. In particular, three long-run relations were observed for Nairobi, Kitale and Eldoret. Nairobi is a major deficit market and therefore demand centre while the latter two are in a major maize surplus region. The existence of market integration is attributed to the increased number of private traders, relatively good transport infrastructure, adequate storage facilities and an improvement in market information using the mobile phone technology. It was also observed that Kenya maize wholesale market is better understood when one considers both the internal and external supply sources of maize. This is because the maize sold in the wholesale markets are obtained from both domestic and import sources. It was also observed that although in the short run, each maize market reacts to at least one of the cointegrating relationship, price adjustments do not occur instantaneously and completely. This could be partly attributed to information bottlenecks, variable infrastructure and inadequate transport facilities such as railway wagons.

Causality for most markets was bi-directional. This indicates that both supply and demand conditions influence price movements. As a result, there was no central market. Therefore, the government may not use a single market to effect a desired policy change such as price stabilization. While these results could reflect the situation in areas along the major accessible areas, they may not be generalized across the country. In particular, they may not be generalized to remote areas of northern Kenya where transport infrastructure and communication is still poor.

6.3.4 To what extent do traders exploit farmers?

By understanding the types of the existing commodity markets, the structure –conduct-performance model of industrial organisation is used to shed light on the extent to which traders exploit farmers.

The characteristics of the perfect competitive model are used as a yardstick to measure farmer exploitation by traders. Any deviations from the model signal varying degrees of farmer exploitation (as outlined in Chapter 3). Farmer exploitation may take two forms. First, by restricting supply into the market, traders create a temporary shortage. Assuming demand is unchanged, the end result is increased prices. Second, traders may take advantage of farmers' limited information on market conditions by offering them low prices. As a result, the increased input prices and low output prices "eat" into the farmers' profit margins.

If traders exploit farmers, then the incentives arising from market liberalisation do not reach the intended recipients. In such a case, farmers may not respond to the price incentives due to squeezed profits resulting from high input prices and low output prices. Consequently, poor response leads to low productivity, low production and low economic growth.

In this thesis, several characteristics of the SCP model are used to assess the extent of farmer exploitation. They include the number of market participants, barriers to entry and exit and levels of marketing margins due to traders. These characteristics are supplemented by the qualitative information about market performance.

Evidence from the traders' survey indicates that there has been rapid entry of traders into the commodity markets. In the four markets, over 68 percent of the traders emerged after market liberalisation of the respective commodities. Farmer perceptions of increased input availability resulting from increased number of traders confirm this trend. Futhermore, the HH indices for traders in all commodities are low (<0.15). Low HH indices (HH<0.30) signal a competitive market structure. Thus the high number of traders has led to increased competition which is manifested in their conduct.

The traders have devised various strategies in order to maintain their market shares or increase profits. They have invested in physical assets and market information in addition to differentiating their products and offering price incentives. Specifically, traders across the four commodities have invested mainly in storage and transport to offer time and place utility to their customers. A few traders especially in the fertiliser and seed business are vertically integrated. In addition, traders perform non-core often location-specific trading functions such as providing market information on how to use fertiliser and seed. They also provide credit to customers mainly on the basis of trust. In some cases, the large traders, in particular for fertiliser and seed, provide subsidised transport to their customers.

Considering marketing margins and marketing costs as indicators of trader performance, results indicate that both big and small traders incur similar trading margins and have comparable marketing costs. In all cases, trader margins are less than 20% of the purchase price of the wares they trade in. For instance, fertiliser traders in the lowest quartile

group realised a marketing margin of about 10% of the fertiliser purchase price whereas for the largest traders (quartile 4), the margin was 7%**.**

Nonetheless, structurally, most of the traders are family businesses that diversify the trading activities and rarely specialise. This is partly because of the seasonality of the fertiliser, seed and maize businesses. Despite rapid entry of traders into the market, several barriers to entry limit them from realising the full benefits of a free market for households through reduced competition. The major barriers to entry across traders of the four commodities include lack of initial capital, storage and transport. In addition, imperfect information among farmers means that they cannot make optimal decisions, in particular on what to produce, how much, when and where to sell their products. In most cases, traders take advantage of the information asymmetry by buying cheap during the harvest season and selling dear back to farmers during the lean periods.

In order to enhance trader competitiveness by reducing their financial constraints, Omamo and Mose (2001) suggest provision of credit to small-scale traders as a feasible option. In addition, the authors suggest that the traders should be given entrepreneurial skills and basic information on input use. Furthermore, stronger government participation in quality control (e.g. setting standards) or industry self regulation may contribute to market development for the four commodities.

6.3.5 Smallholder response to price incentives

Several conclusions emanate from our findings. First, farmers in Trans-Nzoia District respond clearly to price incentives. This is evidenced by the short-run elasticity of supply to fertiliser price of -1.05 and a long-run elasticity of -1.26 and the short-run elasticity of supply to maize price of 0.53 and the long-run elasticity of 0.76.

The study further sought to establish whether the supply response was symmetric, and whether there were differences in supply response during the pre- and post-liberalisation periods. It further sought to establish whether the contemporaneous or past prices were a better estimator of supply response.

Results indicate that maize response maize price was symmetric in the short run but asymmetric in the long run. This means that maize price increase leads to a similar response as with maize price decrease in the short run. A plausible explanation to this finding is the absence of fixed assets in maize production in the short run. However with increased adoption of complementary inputs such as fertiliser and other agronomic practices that are necessary to realize high response from technological advances in form of high-yielding maize varieties increases, the supply response becomes asymmetric in the long-run. The results also show that there were no differences in maize supply response during the pre- and post-liberalisation period. This implies that the observed modest supply response cannot be wholly attributed to market liberalisation *per se* and hence market liberalisation may not have fully attained its objectives.

The lagged maize and fertiliser price gave a better model fit than the contemporaneous prices. This implies a sluggish flow of market information on prices to farmers and that farmers are not guided by contemporaneous prices in planning future maize production activities.

Given the modest supply response, policies to address low levels of fertiliser use need to be addressed if the objective of achieving or sustaining the stated objective of food self-sufficiency is to be realised. Specifically, complementary interventions to improve infrastructure, information flow, access to inputs and credit, and improved production technology to farmers could make them more responsive.

6.3.6 Impacts of market liberalisation

By comparing the production and marketing activities of maize producing households using two data sets viz. 1992 and 2003, we make inferences on the impacts of market liberalisation on crop diversification and the degree of commercialisation.

The different diversification measures used show that crop diversification has increased between 1992 and 2003 among households. At the same time, relative importance of crops in terms of area grown has changed over time. This scenario probably indicates the changes in the prevailing market conditions. For instance, while area under Napier grass, wheat and tea has increased, area under pyrethrum has decreased. Area under pyrethrum has decreased because of problems of marketing the crop; hence farmers are not paid promptly for deliveries made to the factory. Area under tea has increased partly because of stable tea prices in addition to institutional support in terms of interlocked credit given to tea farmers. Area under Napier grass has increased as a result of increasing demand for fodder from dairy farmers.

During this period, the degree of commercialisation has increased. On the input side, both the number of households using fertiliser and the mean rate of fertiliser application in maize production increased with market liberalisation. This result supports increased fertiliser use reported at the national level (Jayne *et al.* 2006). On the output side, the number of households participating in maize markets increased dramatically from 44 percent in 1992 to 70 percent in 2003. During this period, the role of private traders increased in response to the declining role of the public sector. While about 53 percent of the households sold maize to NCPB in 1992, only about 4 percent did so in 2003.

Farmer perceptions indicate that volume of sales traded has generally increased. However, their perceptions were mixed about quality of goods sold but were unanimous that prices had increased. Increased on-farm diversification despite efforts to promote specialization is a pointer to farmers' inadequate trust in relying on the market for household food needs. Such production systems perpetuate subsistence production and may lock out households from the benefits of comparative advantage inherent in specialization. Efforts necessary to encourage food market development may be a possible solution.

Despite the observed increase in commercialisation, there are still impediments to its full realization. For example, despite the fact that there is a modest increase in fertiliser use with market liberalisation, the fertiliser use levels are still low. Besides, the number of households still not using fertiliser is substantial. The scenario of low fertiliser use point to the possibility of impediments to fertiliser access. Policies to address fertiliser use bottlenecks should be enacted in order to encourage use of fertiliser which in may lead to surplus production.

6.4 Innovative aspects of the study

By understanding firm size distribution, one is likely to understand the market power situation in an industry. It is the market power which signals the structure of the prevailing market situation. In effect, firm size distribution indicates the extent of industry competitiveness. On the one hand, highly concentrated firms point to monopolistic situations which are often uncompetitive and exploitative. On the other hand, less concentrated markets point to competitive market situations, which offer incentives for market development.

By examining firm size distributions, the study identified various constraints such as financial bottlenecks (initial and operating capital) and information that traders face. Finding solutions to these constraints is a first step toward market development under a liberalised trading regime. The study showed that the very small traders financed their businesses mainly through owners' equity or through informal sources like friends and family. Thus, developing a credit scheme such as micro-finance could alleviate the problem of start-up capital, a main constraint for all businesses. The study also showed that both large and small firms faced similar marketing margins. This in effect means that where markets are thin, it could still be feasible for small scale traders to operate.

The study identified that trader distribution though log-normally distributed, is uneven across regions both in terms of number of traders and volumes traded. The cause of this uneven pattern should be addressed. Furthermore, the low concentration of net suppliers (traders) in remote areas imply that (1) input prices are high and (2) output prices are low due to less competition and high costs. This is further supported by the finding that farmers farther away from main fertiliser markets pay slightly more money per unit pack of fertiliser than those close to the markets. These findings have implications on maize response as most production is concentrated in these areas.

A combination of the difference-in-difference (DiD) and farmer perceptions in estimating the impact of market liberalisation on the extent of commercialisation and on-farm diversification is an innovative approach not common in previous studies within the Eastern African region. The approach controls for the unobservable characteristics such as changes in food preferences while estimating the impact of the policy change.

6.5 Gainers and losers

Gainers and losers are a natural consequence of market liberalisation process as whenever there is a change, there are bound to be losers and gainers. This study gathered evidence to provide insights into who were the gainers or losers of market liberalisation.

By comparing the roles and activities of the market participants before and after market liberalisation, one gets some insights into who lost or gained as a result of market liberalisation. The major market participants are the government, farmers (producers), traders and consumers. The study uses the evidence on expected incomes of market participants, control or market power of traders, and access to food or inputs as indicators of the gain or loss.

In view of that, the government has lost revenue in form of taxes levied on maize and milk sales sold to NCPB and KCC following reduced sales to these institutions after market liberalisation (as shown in Chap. 2). However, after market liberalisation, the government rarely bails out these loss-making institutions. It therefore follows that the government has saved money in this respect. Reduced government participation in the four commodities implies that the private traders have increased their market shares after market liberalisation. The increase in private trader participation is partly due to the abolition of trade restrictions such as maize movement, and licensing. For instance, by 1990**,** KCC controlled about 95 percent of all milk sales while by 2003, KCC controlled less than 30 percent of all marketed milk. The private input traders (fertiliser and seed) have gained in terms of relative volume of goods sold after market liberalisation. Conversely, this means that the government supported institutions such as KFA have lost with market liberalisation.

Millers have gained with market liberalisation. At present, they buy cheaper maize directly from farmers than from NCPB, as was initially the case. Buying from NCPB unlike from farmers means that millers were buying maize more dearly (farmers price + NCPB trading margin) during the pre-liberalisation period (see chap. 2). Consumers particularly of sifted maize meal have gained through low real producer maize prices. This is because millers who buy maize more cheaply are able to pass on the low price to consumers. Similarly, at present, consumers access raw milk from hawkers more cheaply than from KCC.

It is not clear whether farmers have gained or lost with market liberalisation. An answer to this question requires one to analyse the current profitability of maize and milk relative to the pre-reform period. However, in the meantime, maize and fertiliser real prices have shown a declining trend, although the real price of seed has trended upwards. In terms of information, smallholder farmers and small-scale traders have lost with market liberalisation. They are no longer guaranteed of government information on market prices (de Groote *et al.* 2006). Also farmers in remote areas where fewer traders operate have lost with market liberalisation as they pay more for fertilisers (see chap. 3).

6.6 Policy implications and outlook

Agricultural commodity markets were liberalised with the main objective of increasing efficiency in production and marketing. A key finding of market liberalisation in Kenya is that of partial rather than complete liberalisation with the farmers, the private traders and the government as major participants. In particular, there has been increased private trader participation alongside a reduced role of government agencies in commercial activities. Given this scenario, a number of policy options are suggested to enhance market participation of each participant so as to further develop the input and output markets thereby improve production and marketing efficiency.

First, though they play a major role in commodity marketing, the private traders face a myriad of constraints: inadequate start-up and operating capital, inadequate entrepreneurial skills, and market information bottlenecks. These constraints have implications on private

trader market development and in particular, effects on volume of transactions and market penetration beyond the initial business premises. This scenario implies that most private traders deal in small quantities and cannot realize economies of scale. This in return could mean higher input prices and lower output prices contrary to the expectations of market liberalisation. Given the abundance of the private traders, this finding implies that providing an enabling environment to traders may invigorate their activities to serve farmers more efficiently. In particular, policies aimed at building local institutions (e.g. banks, information bureaus, entrepreneurships etc) to facilitate private sector traders to improve their access to credit and information may play a major role. Provision of credit may encourage more new entrants. It could also assist existing traders to expand their businesses in terms of volume transacted, number of clients reached and geographical coverage. This is possible when augmented with an efficient marketing information system. Efficient market information has positive effects for farmers, traders and policy makers. Up-to-date market information enables farmers to negotiate with traders and also facilitates spatial distribution of products from rural areas to towns and between markets. Provision of entrepreneurial skills will improve trader efficiency.

Second, maize farmers are responsive to price incentives. However, their fertiliser use levels are still low due to low profitability (low producer prices and high fertiliser prices) and inadequate information on fertiliser use. This implies that even higher farmer responses to price incentives are possible. Formation of efficiently-run farmer group marketing associations may encourage fertiliser use through reduced unit prices emanating from economies of scale in purchasing fertiliser. However, farmer apathy to farmer marketing associations needs to be tackled. Legislating policies that provide incentives for well-run farmer marketing associations and penalties to mismanaged associations may be a solution. Furthermore, the farmer associations may be focal points for extension services (given the declining access of individual farmers to extension services) and information on market conditions and prices.

Third, the government has a social responsibility to ensure food security to her citizens. Although the government participates in commercial activities, her role as a quality regulator in the various markets is important. Cases of sale of adulterated fertilisers and seed to farmers have been reported (Mose *et al.* 2002). Government quality control services are organized on commodity basis and with the proliferation of private traders, they are unable to adequately police all the traders due to personnel and logistic constraints. This shows a need for reforms in quality control services if the participation of private sector trading is to have a positive impact on production and marketing. In order to ensure quality inputs are delivered to farmers and quality products are delivered to consumers, the government has two possible options: to leave the individual traders self-regulate themselves or form one large umbrella quality control organization. Individual self-regulation may not be a wise option unless the government legislates for stiffer penalties. Ideally, a combination of policies that encourage self-regulation and establishment of a single umbrella quality control body may encourage

private sector market development by instilling trust of farmers/consumers on the wares of private traders and facilitate trade. In addition, policies that encourage government intervention in provision of infrastructure such as all-weather roads and electricity in rural areas may encourage private market development as they are the main farming areas.

Finally, regular monitoring and evaluation of the impacts of market liberalisation reforms is important in order to mitigate negative consequences that may arise with the ever changing economic conditions. Therefore, there is need to build up a database that will allow longitudinal studies, necessary for such monitoring and evaluation.

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SUMMARY

Starting late 1980s, agricultural commodity markets in Kenya were liberalised with a view to increase efficiency and spur economic growth. This study seeks to estimate the impact of market liberalisation on farming households and traders. Specifically, it seeks to establish whether wholesale maize markets are integrated; assesses the structure, conduct and performance of maize, seed, fertiliser and milk traders; and analyses the response of maize farmers to price incentives.

In chapter two we set the stage for the study by reviewing the market liberalisation processes for the four commodities studied. Second, we gather evidence of market efficiency by examining the distribution of marketing margins for fertiliser and maize. In the case of maize, we compare the Kitale producer price and World price (f.o.b. US) whereas in the case of fertilisers, we compare the Kitale retail price and World price (cif, Mombasa). Next, we examine the integration of wholesale maize markets for six markets using cointegration analysis. Thereafter we analyse for the direction of causality.

The review of the liberalisation process shows that the four commodities are partially liberalised as in some instances the state interferes with the marketing of these commodities. We identify four challenges / opportunities that have emerged with market liberalisation: interlocking transactions, information on markets and market prices, quality of inputs and competition from world markets. Interlocking transactions have waned with market liberalisation as it is difficult to ensure that farmers can respect their contractual obligation of delivering their farm produce specifically to those who provided them with the inputs. Similarly, it was observed that with the proliferation of both input and output traders, it is difficult for the public and often-resource-poor quality control agencies to keep track of quality standards for all commodities. Asymmetry in market information has increased with market liberalisation.

On the distribution of margins, there is a decreasing trend in the margin between the domestic prices and the world market prices. This trend implies an improvement in the distribution and marketing operations of both maize and fertiliser. When markets are spatially integrated, the difference in prices between any two markets is equal to the transaction costs. Although there are certain factors such as asymmetric information, number of traders and level of competition that can mitigate against full market integration, the six maize markets were found to be integrated. Further analysis showed an absence of a central maize market. The causality analyses showed mixed results. In most cases, causality was bi-directional. Both major supply and demand markets were sources of causality. The deficit status of Mombasa and Kisumu may explain the causality coming to them while the causality from them may reflect their positions as major ports, and hence indirect suppliers of maize shipped through them to other areas of the country.

In chapter 3, we analyse the structure, conduct and performance of traders with a view to understand whether the traders exploit farmers. The structure of each of the four

commodity markets is analysed by looking at the trader concentration, firm size distribution, barriers to entry and exit, product differentiation and market integration. The conduct of the traders is analysed by examining their competitive behaviour with regard to pricing, information, product differentiation in relation to their competitors. The performance of each of the four commodity traders is analysed by examining the levels of marketing margins and costs across different firm size groups.

Trader concentration levels are low (0.03 - 0.07) across the four commodity groups signifying a competitive market structure. Firms are log-normally distributed but with a tendency towards smaller firms. Spatially, there is a higher concentration of firms in accessible than in remote areas in terms of numbers and size. Traders who started business after market liberalisation across the commodities are small in size relative to the pre-liberalisation entrants. This is attributed to several entry barriers such as inadequate financial resources, inadequate transport and storage facilities, information asymmetries and inadequate business talents.

Various traders employ different tactics in order to retain or increase their market shares in business. The most common tactics employed across the different markets include differential pricing relative to their competitors, product differentiation and customer incentives such as offering subsidized transport and information.

By examining the levels of marketing margins and costs across quartiles of each commodity, the performance of the traders is examined. The results show that across the four commodities, differences ($p<0.05$) are observed between the first and last quartiles in terms of marketing margins and costs. The first quartile traders have higher buying and selling prices than the last quartile traders. Similarly, first quartile traders experience higher marketing costs than the last quartile, signifying that the larger traders enjoy economies of scale. Lack of significant differences ($p<0.05$) between marketing margins and marketing costs for each market signifies that traders do not exploit farmers. However, the traders cite inadequate transport, competition, inadequate working capital and lack of reliable market information as major constraints to efficient trade.

In Chapter 4, we examine the aggregate maize supply response for Trans Nzoia District to the changing market environment in Kenya. In order to assess the extent of the farmer responses to the price incentives, we use cointegration analysis and error correction modeling approaches with data covering the period 1980 to 2003. We difference the data to make it stationary as required when using cointegration analysis. There is a wide gap between the nominal and real prices of maize up-to 1994 when the maize market was liberalised. Thereafter, the prices appear to follow a similar pattern. Overall, the real prices show a decreasing trend whereas the nominal prices show an increasing trend. There is more variability in both real and nominal prices after market liberalisation.

The aggregate supply response results show that there is a positive short-run and long-run response to maize price. It is estimated that the price elasticity for maize is 0.53 in the short run and 0.76 in the long-run. This means that a 10 percent increase in the price of maize

would result in a 5.3 percent increase in maize production in the short run and 7.6 percent increase in maize production in the long-run. The strong elasticity of maize underscores the importance of maize as a staple food and a source of income. We subjected the supply response results to three tests: whether the supply is asymmetric, whether contemporaneous or past prices can be used to predict better the pattern supply response, and whether there are differences in supply response between pre- and post-market liberalisation periods.

The test results show that there is an asymmetric supply response to maize prices. The increases in maize price have a significantly higher impact on supply response than the decreases in prices in the long-run. This implies that supply is sticky downwards. In the short-run, only the maize price decreases have a significant effect on supply response. When we test for a better price estimator of supply response, we find that on the basis of model fit, the use of past prices in both periods estimates maize supply response better. This result could be attributed to the sluggish information flow to farmers and therefore their sluggish behaviour in supply response. We test whether there are differences between pre-and post-liberalisation supply response by splitting the maize price variable into two: before and after liberalisation, and testing the coefficients of the two newly created variables for equality. The F-test indicates that both in the short-and long-run, the hypothesis that these coefficients are equal is not rejected at the 10 percent level of significance. Therefore, the tests provide evidence of no differences in maize supply response in the short – and long-run, before and after market liberalisation.

In chapter 5, we compare maize producing households in terms of maize commercialisation, diversification and participation in maize markets using the difference- in -difference approach for two periods: before and after market liberalisation. We use data from the Maize Data Base Survey of 1992 for the pre-liberalisation period and Household Survey of 2003 for the post-liberalisation period. In both surveys, the same households provided data.

Three aspects of household and farm characteristics: average age of household head, farm size and quantity of maize produced has increased while three others: household size, maize area and distance to the input markets have decreased since 1992. On-farm crop diversification has increased since 1992 as measured by four different diversification indices: index of maximum proportion, number of enterprises, Hirschmann-Herfindahl index and entropy index. Wheat, Napier grass and tea have expanded in area while area under pyrethrum has decreased. In terms of number of households, the largest increase has been observed in Napier grass, followed by tea and then wheat.

Commercialisation is measured in terms of basal and topdress fertiliser application and maize sales. There are dramatic increases in the amount of both basal and topdress fertilisers used by households over the two periods. In terms of maize sold, the proportion of households selling less than 5 bags has increased while the proportion having no sales has decreased. There is also a significant shift in maize marketing outlet from mainly NCPB in 1992 to mainly private sector in 2003 as expected with market liberalisation. The proportion of market participants increased from 44 percent in 1992 to 70 percent in 2003. Some households

changed positions from being market participants and vice versa. We estimated a probit regression model in order to establish the factors for the observed household changes in market participation. The probit regression results indicate that the probability of household switching positions from a market participant in 1992 to a non-market participant in 2003 increased with proximity to input markets, smaller household sizes and less basal fertiliser use. The probability of household switching positions from a market non-participant in 1992 to a market participant in 2003 increased with increasing farm size and basal fertiliser use but with decreasing area under maize.

Double differencing results for households participating and not participating in maize markets show that the average impact of market liberalisation on household and farm characteristics shows that distance to the nearest input markets has decreased while area under maize has increased. During the same period, area under maize for participants was larger than for non-participants. More household members participated in off-farm employment in 2003 than they did in 1992. Further results indicate that there was a positive impact on both basal and topdressing fertiliser use over the two periods. It also shows that diversification on-farm increased.

Given the mixed response of households to market liberalisation, we seek to establish the factors influencing household participation in maize markets using multinomial probit regression analysis over three groups of households: autarkic, net sellers and net buyers of maize. Results shows that households closer to the market centres, with smaller farm sizes and larger household sizes are more likely to be autarkic or net buyers relative to net sellers in both years.

Further analysis indicates that a 1 percent increase in distance to the nearest input market increased the probability of a household being a net buyer or autarkic by 0.003 in 1992 and 0.004 in 2003. Similarly, a 1 percent increase in area under maize increased the probability of a net buyer being a net seller by 0.2 in 1992 and 0.4 in 2003.

Farmer perceptions indicate that fertiliser availability, price and crop diversification have increased with fertiliser market liberalisation while area under maize and use of hired labour has decreased. Seed price and seed availability have increased with seed market liberalisation. In conclusion, farmer perceptions on impacts of market liberalisation are mixed and reflect the heterogeneity of the farming households.

In chapter 6, we present a synthesis of the most important findings and innovative aspects of the study, and draw policy implications of the study. The study shows that the markets are partially liberalised. The government plays a regulatory role particularly in quality control but is also actively involved in maize marketing through its trading activities as NCPB. Maize wholesale markets are well integrated, a situation that could be attributed to the increased number of private traders with market liberalisation and location of the markets in terms of road infrastructure. In all the four commodity markets, traders do not seem to exploit farmers as the market structures are fairly competitive and, the marketing costs and margins are small. Larger traders offer the lowest prices and incur the lowest costs, a situation

that implies possibilities of trader exploitation of economies of scale. The study shows that maize farmers respond to price incentives. However, the supply response is asymmetric in the long run but symmetric in the short run. The results also show that past prices were a better estimator of supply response than contemporaneous prices. A comparison of maize production and marketing activities in 1992 and 2003 show that the use of fertiliser has increased in terms of the rate applied and number of farmers using it. The study also shows that the number of maize market participants increased from 44 percent to 70 percent over the same period.

Use of cointegration analysis in analysis of supply response and difference-in-difference approaches in estimation of impact of market liberalisation on on-farm crop diversification and commercialisation are innovative approaches applied to data in the East African context.

The study shows that there are gainers and losers of market liberalisation. The government has lost income by reducing its role as a main marketer in all the four commodities. The government loss has been a boost to private traders who have increased their market share of trade in the four commodities. Farmers have gained in terms of increased accessibility to inputs but lost in terms of increased input prices.

The main policy implications are that in order to consolidate the gains made with market liberalisation private traders need to be assisted financially and with market information. Also, the need to build up a database that will allow future studies on impacts of policy changes is important.

Wie wint, wie verliest? De effecten van marktliberalisatie op landbouw huishoudens in Noordwest Kenia

SAMENVATTING

Vanaf eind jaren tachtig zijn de landbouwmarkten in Kenia geliberaliseerd om de efficiëntie te verbeteren en de economische groei te bevorderen. Deze studie poogt het effect van deze liberalisatie op landbouwhuishoudens en handelaren te schatten. In het bijzonder gaat het na of graanmarkten geïntegreerd zijn; evalueert het de structuur, het gedrag en functioneren van de handelaren in maïs, zaad, kunstmest en zuivel; en onderzoekt het de respons van maïsboeren op prijzen.

In hoofdstuk 2 schetsen we de achtergrond van de studie met een overzicht van de liberalisatie van de vier markten. We brengen ook materiaal bijeen over de efficiëntie van de markt door naar de verdeling te kijken van de marges tussen aan- en verkoopprijzen van maïs en kunstmest. In het geval van maïs kijken we naar de producentenprijs in Kitale en de wereldmarktprijs (f.o.b. VS) en bij kunstmest vergelijken we de winkelprijs in Kitale met de prijs c.i.f. Mombasa. Vervolgens bestuderen we de integratie van zes markten voor maïs met een co-integratie analyse aangevuld met een analyse van causale verbanden.

Het overzicht van de liberalisatie laat zien dat de vier goederen slechts ten dele werden vrijgegeven omdat de staat bleef interveniëren in de markten. We geven vier kansen/bedreigingen aan die met de liberalisatie zijn ontstaan: koppelverkoop, markt- en prijsinformatie, kwaliteit van de productiemiddelen en concurrentie van de wereldmarkt. Koppelverkoop waarbij transacties van eindproducten werden gekoppeld aan die van productiemiddelen, zijn zeldzaam geworden. Het is moeilijker geworden om boeren te houden aan hun verplichtingen in dezen. Met de uitbreiding van het aantal handelaren in zowel productiemiddelen als producten is het ook lastiger geworden voor het publiek en de (vaak armlastige) controlediensten om de kwaliteit in het oog houden. Met de marktliberalisatie is ook de asymmetrie van de informatie toegenomen.

Er blijkt een dalende tendens te zijn in de marges tussen binnenlandse en wereldmarktprijzen. Dit wijst dus op een verbetering van de werking van de distributie- en handelskanalen van maïs en kunstmest. Wanneer markten ruimtelijk geïntegreerd zijn is het verschil tussen prijzen op de ene en die op de andere markt niet groter dan de transactiekosten van de handel ertussen. Ondanks de aanwezigheid van bepaalde factoren zoals asymmetrische informatie, aantallen handelaren en niveau van concurrentie, blijken de zes maïsmarkten geïntegreerd te zijn. De nadere analyse wees uit dat een centrale markt ontbreekt. De causaliteit loopt in verschillende richtingen en was in de meeste gevallen tweezijdig. Grotere aanvoermarkten, zowel als afzetmarkten bleken richtinggevend te kunnen zijn. De status van afzetmarkt van Kisumu en Mombasa kan verklaren waarom hun prijzen de andere markten

volgen, maar anderzijds maakt hun positie als aan- en doorvoerhaven hen weer tot leiders van het prijsniveau.

In hoofdstuk 3 gaan we in op de structuur, het gedrag en het functioneren van de handelaren om te bezien of handelaren de boeren soms uitbuiten. De structuur van elk van de vier markten is weergegeven door de concentratie van handelaren, bedrijfsgrootteverdeling, drempels bij toe- en uittreding, productdifferentiatie en marktintegratie. Het gedrag is geanalyseerd door te kijken naar welke prijzen zij hanteren, welke informatie zij hebben en welke productdifferentiatie zij toepassen in vergelijking met hun concurrenten. Het functioneren is beoordeeld door de handelsmarges en kosten van verscheidene bedrijfsgrootteklassen te vergelijken.

De concentratie van handelaren in de vier markten is laag te noemen (index van 0.03 - 0.07), zodat de structuur tamelijk competitief is. De bedrijfsgroottes zijn log-normaal verdeeld met een neiging tot meer kleine bedrijven. Ruimtelijk gezien blijkt er een concentratie te zijn (in aantal en grootte) in de toegankelijke gebieden ten nadele van de afgelegen streken. Handelaren die na de liberalisatie zijn begonnen zijn in het algemeen kleiner dan de bedrijven die al eerder actief waren. Dit kan worden toegeschreven aan de drempels voor toetreding als gevolg van geringe financiële middelen, transport- en opslagfaciliteiten, asymmetrische informatie en wellicht tekort aan handelstalent.

Handelaren houden er verschillende strategieën op na om hun marktaandeel te behouden of uit te breiden. Het meest gebruikte instrument is het beiden van een prijsvoordeel ten opzichte van de concurrenten, maar ook productdifferentiatie en het bieden van extra service aan de klanten in de vorm van transport en informatie.

Kijken we naar de handelsmarges en –kosten voor de vier kwartielen naar omzet, dan zien we significante verschillen tussen het eerste en het vierde kwartiel. De groep kleinste handelaren hanteren hogere aan- en verkoopprijzen dan de groep van grootste. Zij hebben echter ook hogere kosten wat wijst op schaalvoordelen ten gunste van de grote handelaren. Het ontbreken van significante verschillen in de netto handelsmarges betekent dat handelaren de boeren niet uitbuiten. Handelaren geven niettemin aan dat de doelmatigheid van hun werk wordt belemmerd door onvoldoende transport, door concurrentie, onvoldoende werkkapitaal en gebrekkige marktinformatie.

In hoofdstuk 4 gaan we na hoe het totale aanbod van maïs in het Trans Nzoia District heeft gereageerd op de veranderde marktomgeving in Kenia. Voor het vaststellen van de reactiecoëfficiënt op de prijsveranderingen gebruiken we co-integratieanalyse en het *error correction model* toegepast op prijsdata van 1980 tot 2003. We nemen eerste verschillen van de prijzen om de reeks stationair te maken. Terwijl de nominale prijzen een stijgende lijn vertonen, dalen de reële prijzen in deze periode. Na 1994, toen de markt werd vrijgegeven, fluctueren de prijzen meer dan ervoor.

Het geaggregeerde aanbod vertoont een korte- en een lange-termijn respons op veranderingen in de maïsprijs. We vinden een prijselasticiteit voor de korte termijn van 0,53 en voor de lange termijn van 0,76. Dit betekent dat een 10% toename van de prijs leidt tot

5,3% stijging in het aanbod op de korte en 7,6% stijging op de lange termijn. Deze forse elasticiteit onderstreept het belang van maïs als voedselgewas en als bron van inkomsten. We hebben de uitkomsten aan drie nadere toetsen onderworpen: of de reactie asymmetrisch is; of huidige dan wel vertraagde prijzen een betere verklaring bieden en of er verschillen zijn in de reactie voor en na de liberalisatie. De toetsen geven aan dat de reactie inderdaad asymmetrisch is: een prijsstijging heeft een groter effect op het aanbod op langere termijn dan een prijsdaling. Op de korte termijn lijken echter alleen prijsdalingen een duidelijk effect te hebben. Vertraagde prijzen blijken een betere verklarende rol te spelen dan de contemporaine prijzen. Dit wijst op een vertraging in de informatie aan de boeren, zelfs voor de liberalisatie en een vertraagde aanpassing van hun areaal op veranderde prijzen. Een toets op verschillen tussen de reactiecoëfficiënten voor en na de liberalisatie had als resultaat dat gelijkheid van de coëfficiënten noch voor de korte, noch voor de lange termijn kon worden verworpen.

In hoofdstuk 5 vergelijken we maïsproducerende huishoudens voor wat betreft hun commercialisatie, diversificatie en participatie in de maïsmarkt. We gebruiken de verschillen-in-verschillen benadering om huishoudens in twee perioden te vergelijken: voor en na de liberalisatie. Daartoe gebruiken we gegevens van dezelfde huishoudens in de *Maize Data Base Survey* in 1992 en de *Household Survey* van 2003.

Over deze periode blijkt, naast de leeftijd, ook de bedrijfsgrootte te zijn gestegen, alsmede de hoeveelheid geproduceerde maïs. Het maïsareaal blijkt echter te zijn afgenomen, net zoals de gezinsomvang en de afstand tot de markt. De diversificatie op het bedrijf is toegenomen. De diverse indices hiervoor, zoals aandeel belangrijkste gewas, aantal gewassen, Hirschman-Herfindahl index en de entropie-index geven dit alle aan. Vooral tarwe, *napier* gras en thee worden meer verbouwd, terwijl het areaal *pyrethrum* is gedaald. In termen van aantallen huishoudens is de stijging het sterkst bij *napier* gras, gevolgd door thee en dan tarwe.

Commercialisatie is afgemeten aan het gebruik van kunstmest en aan de mate waarin maïs is verkocht. Er is een grote toename in het gebruik van kunstmest, zowel voor basisbemesting als voor bijbemesting. Wat maïs betreft, is het aandeel huishoudens dat niets verkocht afgenomen, terwijl het aandeel dat weinig (minder dan 5 zakken) verkocht is gestegen. Werd er in 1992 nog hoofdzakelijk aan de NCPB verkocht, in 2003 was dit hoofdzakelijk aan de commerciële handel, zoals bij liberalisatie verwacht mocht worden. Het aandeel participanten in de markt nam toe van 44% in 1992 tot 70% in 2003. Enkele huishoudens schoven ook echter naar autarkie. We hebben een Probit-model geschat om de achterliggende kenmerken van deze verschuiving te bepalen. Een beweging richting autarkie bleek samen te hangen met kleinere gezinnen, nabijheid van de markt en minder kunstmestgebruik; de grotere marktparticipatie hangt samen met bedrijfsgrootte, kunstmestgebruik, maar ook met verlaging van het maïsareaal.

De resultaten van de *dubbele verschillen* benadering van participanten en niet-participanten voor en na de liberalisatie laten zien dat vooral de afstand tot de markt is afgenomen en het areaal onder maïs is gestegen. Dit areaal was voor participanten groter dan

voor niet-participanten. In 2003 hadden meer leden van het huishouden werk buiten het bedrijf dan in 1992. Voorts blijkt ook hier dat kunstmestgebruik en diversificatie zijn toegenomen. Gelet op de gemengde reacties op de liberalisatie zijn we ook nagegaan welke factoren van invloed zijn op marktparticipatie. Hiervoor is een multi-nomiale probit gebruikt over de klassen waarin de huishoudens zich in beide jaren kunnen bevinden. Vooral huishoudens met grote gezinnen, kleine bedrijven en dichtbij markten blijken in de categorie van autarkie of netto kopers in beide jaren te vallen. Een toename met 10% in de afstand tot de meest nabije markt doet de kans op autarkie (of netto koper) toenemen met 0.03% in 1992 en 0.04 in 2003. En 10% meer areaal onder maïs verhoogt de kans om netto verkoper te zijn met 2% in 1992 en 4% in 2003.

Desgevraagd gaven de boeren zelf aan dat de liberalisatie de beschikbaarheid van kunstmest heeft vergroot en heeft geleid tot hogere prijzen en meer diversificatie. Het maïs areaal is er door afgenomen evenals het gebruik van ingehuurde arbeid. De liberalisatie van de markt in maïszaad heeft positief uitgewerkt op de beschikbaarheid ervan, maar ook op de zaadprijs. Tot besluit kan worden gezegd dat de kijk van de boeren op de gevolgen van de liberalisaties nogal wat verschillen van inzicht laat zien en daarmee de verscheidenheid van de huishoudens.

In hoofdstuk 6 presenteren we een synthese van de belangrijkste bevindingen en nieuwe inzichten van de studie en trekken we conclusies ten behoeve van het te voeren beleid. De liberalisatie is slechts gedeeltelijk. De overheid speelt nog een regulerende rol bij kwaliteitscontrole en in de maïsmarkt door de activiteiten van de NCPB. De maïsmarkten zijn goed geïntegreerd, hetgeen kan worden toegeschreven aan de grote aantallen handelaren en de verbindingen tussen de marktsteden. In geen van de vier markten blijken handelaren de boeren uit te buiten. De structuur is tamelijk competitief en de netto marges zijn niet groot. Grote handelaren bieden betere prijzen en maken minder kosten per eenheid zodat duidelijke schaalvoordelen aantoonbaar zijn. De studie laat ook zien dat boeren positief reageren op prijsveranderingen. De reactie op lange termijn is echter niet gelijk waar het gaat om prijsstijgingen en –dalingen. Prijzen van het laatste jaar voldoen beter als verklaring voor aanbodsreacties dan prijzen van het lopende jaar. Vergelijking van zelfde boeren huishoudens in 1992 en 2003 laat zien dat het gebruik van kunstmest dramatisch is gestegen, zowel in hoeveelheid per bedrijf als in aantal toepassende bedrijven. Participatie in de maïsmarkt is toegenomen van 44% tot 70% .

Co-integratie analyse van de aanbodsreactie en de verschillen-in-verschillen benadering zijn nieuwe methodes die zijn toegepast om de invloed van liberalisatie op diversificatie en commercialisatie te meten.

De studie geeft aan dat er winnaars en verliezers zijn bij liberalisatie. Het terugtreden van de overheid heeft kansen gegeven aan de particuliere handel die haar aandeel in alle vier de markten zag stijgen. De boeren hebben baat gehad van de grotere beschikbaarheid van productiemiddelen maar zagen deze ook duurder worden.

De belangrijkste beleidsaanbeveling om de winst van de liberalisatie zeker te stellen, is dat de handelaren ondersteund zouden moeten worden met meer financiële dienstverlening en marktinformatie. Het is daarbij belangrijk een databank op te bouwen om het effect van de beleidsmaatregelen en andere veranderingen te kunnen onderzoeken.

LIST OF PUBLICATIONS

Mose, L.O. 1997. An Economic Analysis of the Determinants of Fertiliser Use in Small Maize Farms in Western Kenya" Msc. Thesis, University of Nairobi.

Mose, L.O. and K. Burger. Firm size distribution and performance of maize and fertiliser traders after market liberalisation: evidence from Kenya. Paper presented at the 26th International Conference of Agricultural Economists, Gold Coast, Australia. August 12-19th 2006.

Mugunieri, G.L., H.O. Nyangito and **L.O. Mose**. "Agronomic and socio-economic factors determining maize yield response to fertilisers in western Kenya" *African Crop Science Journal* (1997) 3(1465-1471).

Muyekho, F.N., Wanyama, J.M. and **Mose, L.O**. 'Socio-economic Implications of Improved Forage Species on smallholder farms in Kenya' *East African Agricultural and Forestry Journal* (1999) 65(2), 167-175.

Muyekho, F.N., **L.O. Mose** and D.T. Cheruiyot. Development and transfer of forage production technologies for smallholder dairying: Case studies of participatory evaluation of species and methods of establishment in western Kenya. Paper presented to an International Workshop on "Forage Demand and Adoption by smallholder keepers". Addis Ababa, Ethiopia, June 18th –20th 2001.

Nyangito, H.O., **L.O. Mose** and Mugunieri, G.L. "Farmer circumstances and their effect on fertiliser use in maize production in Western Kenya". 1997. *African Crop Science Journal* (1997) 3(1413-1420).

Omamo, S. W. and **Mose, L.O.** "Fertiliser trade under market liberalisation: Preliminary evidence from Kenya. *Food Policy* 26(2001) 1-10.

Onyango, R. M., **L.O. Mose**, J.O. Achieng and Ngeny, J.M. On-farm Research: Modifying Some Current Maize Production technologies to meet circumstances of smallholder farmers in parts of northern Rift Valley, Kenya. Towards Sustainable farming systems in Sub-Saharan Africa (pp 115-125). AAFSRET Secretariat and OAU/STRC-SAFGRAD Semi-Arid Food Grain Research and Development, Ouagadougou, Burkina Faso, August 21-23rd August 1996.

Training and Supervision Plan

Mansholt Graduate School (MGS)

Description	Institute / Department	Year	Credits
Courses			
Techniques for writing and presenting a scientific paper	Mansholt Graduate School	2002	1
Research Methodology	Mansholt Graduate School	2002	2
Bio-economic modelling	Mansholt Graduate School	2002	1
Mansholt Introduction course	Mansholt Graduate School	2002	1
Economics of Agricultural and Rural Development	Wageningen University	2002	4
Current Issues in Development Economics	NAKE	2003	2
Advanced Econometrics	Wageningen University	2003	4
Economic Models	Wageningen University	2003	4
Farm Household Economics	Wageningen University	2003	3
Capita Selecta Development Economics	Wageningen University	2003	4
Presentations at conferences and workshops			
"Maize production and marketing in Trans Nzoia District under a liberalised market" presented during the 8th KARI Biennial Scientific Conference, November, 11-15, 2002. Nairobi, Kenya		2002	1
"Spatial maize market integration in Kenya" presented during the PhD Day, May 31, 2006.Wageningen University, The Netherlands		2006	1
"Firm size distribution and performance of maize and fertiliser traders after market liberalisation: Evidence from Kenya". Paper presented at the International Association of Agricultural Economists' Conference, August 12-19, 2006. Gold Coast, Australia.		2006	1
Total (minimum 20 credits)			**29**

*One credit is equivalent to 40 hours of coursework
*NAKE refers to The Netherlands Network of Economics

CURRICULUM VITAE

Lawrence O. Mose was born on 20th January 1956 in Kisii, Kenya. He attended Egerton College from 1978 to 1981 when he obtained a Diploma in Farm Management (with Distinction). He was then employed as an Assistant Agricultural Officer with the Ministry of Agriculture, first working as a Farm Manager based at Horticultural Research Centre at Thika and then as a Technical Officer based at National Agricultural Research Centre, Kitale till 1985 when he proceeded to Nova Scotia Agricultural College, Canada, for further studies. In 1988, he obtained a Bachelor of Science degree (with honours), majoring in Agricultural Economics.

On his return, he worked as a Research Officer at the reorganized Kenya Agricultural Research Centre, Kitale. In 1991, he proceeded to Njoro, Kenya for a six-month certificate course in Crop Management Research organized by KARI/CIMMYT/Egerton University. In 1993, he joined University of Nairobi for a Master of Science degree in Agricultural Economics which he obtained in 1997 and was thereafter seconded to Tegemeo Institute of Agricultural Policy, Egerton University as a Research Fellow on a KARI/Michigan State University/Egerton University project for two years. In 1999, he then proceeded to the United Nations African Institute for Economic Development and Planning (IDEP), based at Dakar, Senegal where he obtained a certificate in 'a Specialisation Course on Agricultural Policy in Africa'.

Since his return, he has continued working as a socio-economist at KARI, Kitale. During his working life as a socio-economist, he has worked with many collaborative projects notably: Fertiliser Use Recommendation Project (1990-1991), Maize Data Base Project (1992-1993), Economic Policy Reform, Agricultural Incentives and Soil Degradation in Less Developed Countries (2000-2002), Soil Management Project (1999-2002) and Insect Resistance Maize for Africa (2000-2002). He has attended several national and international conferences and made several publications. From 2002, he has been working on his PhD research.