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Unlocking the Potential of High-Value Legumes in the Semi-Arid Regions: Analyses of the Pigeonpea Value Chains in Kenya

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INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS
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Acronyms

FAO Food and Agriculture Organization

FAQ fair, average quality

Ha hectares

ICRISAT International Crops Research Institute for the Semi-Arid Tropics

IPDM Integrated Pest and Disease Management

KARI Kenya Agricultural Research Institute

Kg Kilograms

KRA Kenya Revenue Authority

Ksh Kenya shillings

MRLs maximum residue levels

NGOs nongovernmental organizations

NIE New Institutional Economics

PMG producer marketing group

UK United Kingdom

UoN University of Nairobi

USA United States of America

USAID United States Agency for International Development

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EXECUTIVE SUMMARY

Pigeonpea is an annual or short-lived perennial crop widely cultivated in the semi-arid tropics. It is grown by farm households for both food and cash. Pigeonpea grains provide an inexpensive alternative source of protein in human diets; its woody stems are used as wood-fuel, and the leaves and hulls make a nutritious fodder for cattle. Being a legume, pigeonpea improves soil fertility by fixing nitrogen, and its deep roots make it drought tolerant and adaptable to semi-arid areas. This study uses a value chain analysis approach to identify the opportunities and challenges that prevail at different stages in the pigeonpea subsector in Kenya, spanning a full range of economic activities ranging from provision of inputs and services to production, value addition and product development, marketing and consumption. This approach overcomes the limitations of traditional static subsector analyses and focuses on economic interlinkages and interdependencies that affect the systemic competitiveness of the pigeonpea economy. This approach is considered to provide new insights and better understanding of the policy-relevant issues that matter for improving productivity and competitiveness of pigeonpea in the new globalized markets.

Pigeonpea production in Kenya has been steadily increasing in the past decade. Comparison of trends during the period 1996–2005 showed a 183% increase in production, 28% increase in area under the crop and a 54% improvement in yield. The increase in production, acreage and yield may be attributed to use of improved technologies. However, poor access to seeds and susceptibility of some pigeonpea varieties to field pests are the major constraints to utilization of improved varieties. Despite these constraints, pigeonpea competes favorably with other legumes grown in the dry areas (e.g., beans, green gram and cowpea).

About 60% of pigeonpea growers in Kenya take their produce to pigeonpea markets, selling about two-thirds of their total production. The crop is marketed either as dry grain, processed (split) dry grain (*dhal*) or green (vegetable) pigeonpea. Most market participating farmers sell at the farm-gate. Dry grain is marketed through six marketing channels: rural open-air retail markets, rural retail shops, urban open-air retail markets, urban retail shops, urban supermarkets, and the export market. *Dhal* on the other hand is marketed through three channels namely, urban retail shops, urban supermarkets, and export. Lastly, vegetable pigeonpea is also marketed through three main channels, i.e. rural open-air retail markets, urban open-air retail markets, and export. These channels involve myriad players and hence tend to have high marketing costs.

Recent studies show that there are good domestic, regional and export trade opportunities for pigeonpea. However, the domestic market for dry pigeonpea is thin and volatile. Regional trade serves to smooth the variability in local production. Unlike other legumes that are mainly traded locally, pigeonpea can be exported to India and other overseas markets including the USA, Canada, Europe, the Middle East and South Africa. The Indian market has been attractive to East African exporters because of its large size in terms of volumes demanded, low expectations on product quality, and low import duty. On the other hand, export to other markets is driven by the higher and relatively stable prices compared to the traditional Indian export market.

Kenya's export of frozen fresh peas to high-value European markets has great potential for expansion in the pigeonpea subsector. Nonetheless, it is constrained by inconsistent supply, limited investments in postharvest handling and packaging to ensure strict quality standards, and insufficient market research to identify consumer preferences in the niche markets.

For the pigeonpea subsector in Kenya to become competitive and expand, productivity will need to be increased, production timed, marketing costs reduced, and quality standards established and strictly complied with. Introducing simple, easily administered quality standards that are based on end-user needs will enable farmers, traders, and exporters to exploit quality-conscious niche markets in Europe and North America. Expansion of domestic production will also require targeting international markets, particularly India, where demand is growing. However, these markets are highly competitive and require careful timing in terms of planting, harvesting, and marketing. For instance, the Indian market is open to Kenya only during a small window in August/September and closes in October/November when the crop in India is harvested and increased supplies lead to falling prices. Targeting of the Indian market should therefore aim at Kenyan pigeonpea reaching India during the off-season period when import prices are relatively high. This calls for the planting of early-maturing varieties. Furthermore, the high domestic wholesale prices make Kenyan pigeonpea exports less competitive in the international markets. These high domestic prices are fuelled by underdeveloped, fragmented, and extended marketing channels which drive up transaction costs and wholesale prices to processors and exporters. Therefore, institutional innovations that link producers more directly with exporters and processors or shorten the extended supply chain are needed in order to reduce transaction costs. Such innovation includes formation of farmer organizations which can facilitate farmers' access to improved technologies and create opportunities for forward contracting. Contracting offers exporters and processors access to larger and reliable supplies.

There is a strong synergy between the input and output markets. Increasing productivity and output market competitiveness will require a regular supply of improved seed. Pilot marketing of small seed packs in the eastern and southern African regions has borne positive results, encouraging farmers to purchase small quantities of seed at prices higher than grain price. Farmer organizations, community seed production and marketing units, and rural agro-dealers play an important role in the functioning of the seed distribution system in rural areas. Consequently, building their capacity can greatly improve smallholder farmers' access to improved seed. Furthermore, this would also stimulate private sector investment in seed systems development and increase demand for improved seed.

Lastly, a policy framework should target: (1) strengthening efforts for upscaling available varieties, (2) reviewing variety testing and approval systems to reduce delays in accessing new germplasm, (3) understanding existing informal seed supply systems and their importance as a source of low-cost but good quality seed to resource-poor farmers, (4) developing systems that allow for marketing of affordable certified seeds, and (5) promoting of contract farming and group marketing strategies to ensure consistent supply and strengthen market power of small producers.

1. INTRODUCTION

Pigeonpea (C*ajanus cajan* (L) Millspaugh) is one of the major grain legume (pulse) crops of the tropics and subtropics. At the global level, it accounts for almost 5% of the total world pulse production. The crop originated in India from where it moved to Africa more than 4,000 years ago (van der Maesen 1980, cited by Joshi et al. 2001). India is both the leading producer and consumer of pigeonpea. However, the crop is also widely grown in eastern and southern Africa. During the decade covering 1995 to 2005, eastern and southern Africa had an estimated annual pigeonpea-growing area of 428,000 hectares (ha) of which about 38% was in Kenya (FAOSTAT, 2007). During the same period, India had an annual average of about 3.4 million ha under pigeonpea cultivation. The other major growers of pigeonpea are Myanmar, Bangladesh, Puerto Rico, Trinidad, Dominican Republic, Jamaica, and Panama.

Pigeonpea is the third most important legume in Kenya, after beans and cowpea (Mergeai et al. 2001). It is mainly cultivated by smallholder farmers in the arid and semi-arid lands, primarily as a source of food and cash. Pigeonpea provides multiple benefits to the rural poor. First, its protein-rich edible peas can be consumed both fresh and dry and provides a cheap source of protein for the poor farmers in the drylands. Second, its leaves and hulls are used as livestock feeds and the stems as fuel wood. Third, it has the ability to fix atmospheric nitrogen (and make iron-bound phosphorus soluble) into available forms for the current crop and subsequent ones. This is significant because most soils in semi-arid regions are deficient in nitrogen and phosphorus (Siambi et al. 1992, Jones et al. 2002).

The principal pigeonpea-producing districts in Kenya are Machakos, Makueni, Kitui, Meru, Embu and Mbeere (Table 1). Pigeonpea's deep root system enables it to exploit moisture from deeper soil layers, making it well suited for these drier districts of Kenya. Nonetheless, productivity remains low, mainly due to non-use of improved varieties and complementary practices. Consequently, marketable volumes have been low. In addition, the pigeonpea marketing system is lengthy and fragmented, thus reducing the margins earned by growers (Obare et al. 2006).

Table 1. District-level production of pigeonpea in Kenya.

	Year 2002		Year 2003	
District	Area (ha)	Production (t)	Area (ha)	Production (t)
Machakos	62400	22464	69200	36144
Makueni	45700	11250	44000	27450
Kitui	34750	23715	34750	23715
Mwingi	17200	7740	13615	5147
Mbeere	6618	5323	7608	6511
Tharaka	4100	2214	3590	1939
Meru North	3580	3222	7180	6138
Meru Central	1360	734	1380	1022
Meru South	500	78	512	253
Embu	375	258	375	258
Marsabit	370	267	370	267
Moyale	30	10.8	30	10.8
Isiolo	6.5	2	6	3.4
Central districts	482	196	465	177
Coastal districts	336	206	577	319
Rift Valley districts	262	127	262	127
Total	178,069.5	77,806.8	183,920.0	109,481.2

Source: District Development Plans for 2002 & 2003.

This paper employs a value chain analysis approach and provides a critical review of the pigeonpea subsector in Kenya. It examines both the supply and demand side factors that affect pigeonpea production, value addition, marketing and trade, and utilization in Kenya. The paper transcends the usual subsector analysis to identify the existing pigeonpea value chains and assess the farm and postharvest aspects affecting the flow of pigeonpea along the various value chains. It is based on an empirical study that analyzed the production and marketing constraints and opportunities facing the pigeonpea industry. The study was motivated by lack of empirical data needed to facilitate formulation of strategies to strengthen pigeonpea value chains and to increase competitiveness and participation of producers in high value markets, especially export. The specific objectives of the study were to: (1) assess production conditions and trends, (2) evaluate the use of improved varieties and complementary inputs and services, (3) understand the structure and performance of pigeonpea markets; (4) map the value chains and identify factors that affect local and global competitiveness, and (5) identify priority interventions that strengthen value chains and facilitate commercialization to harness the full potential of the pigeonpea subsector.

The study is organized as follows: Chapter 2 presents the conceptual and empirical framework. Chapter 3 reviews and describes the pigeonpea input supply systems, available technologies, production trends, and on-farm productivity and competitiveness. The structure and the functioning of pigeonpea markets and value chains are presented in Chapter 4. Trade, consumption, and utilization patterns are highlighted in Chapter 5, while Chapter 6 focuses on policy and institutional issues that affect the pigeonpea subsector. Finally Chapter 7 concludes by highlighting the key findings and policy implications for harnessing existing and emerging technological and market opportunities for developing this subsector.

2. CONCEPTUAL AND EMPIRICAL METHODOLOGY

2.1 Conceptual framework

Value chain analysis examines the full range of activities required to bring a product or service from its conception to its end use, the firms that perform those activities in a vertically coordinated chain, and the final consumers of the product or service. The activities include design, production, marketing, and support to get the final product or service to the end consumer (Kaplinsky and Morris 2000). Value chain analysis is sometimes used interchangeably with subsector analysis. If a subsector analysis is envisaged as examining all the firms, channels, and markets related to a specific product or service, a value chain analysis focusing on a single vertical chain of firms leading to a particular consumer market could be considered complementary to the subsector approach. However, a value chain analysis often includes additional analytical elements beyond subsector analysis, such as inter-firm cooperation, governance, and geographic coverage that extends to global markets.[1] Some analysts also make useful distinctions between supply chains and value chains. Hence, a supply chain is defined as a set of linkages between players where there are no binding market relationships while the concept of a value chain refers to a particular type of supply chain where participants actively seek to support each other to improve systemic efficiency and competitiveness (KIT et al. 2006). However, we only use the less strict definition of the value chain concept as the level of cooperation among different players in pigeonpea supply chains in Kenya is not well developed.

[1] Because of lack of information, the aspects related to governance, inter-firm cooperation, and geographic distribution were not fully covered in this study. Despite the more comprehensive coverage given, the subsector analysis does not also attempt to provide an exhaustive coverage of all firms.

In this study, we adopt a broader concept of a value chain to assess the constraints and opportunities that underpin the pigeonpea subsector in Kenya. We assess the state of use of improved inputs and other services, production conditions, the structure and functioning of markets and trade to identify key constraints and weak linkages that determine overall competitiveness of the pigeonpea subsector. We deal with production and marketing conditions under imperfect markets where linkages among players are underdeveloped, and asymmetric information and mistrust are pervasive. Therefore, the strict definition of value chains is not adopted and we use the term *market chains* interchangeably with value chains.

Pigeonpea competes for inputs (especially land and labor) in the producing areas with maize, green gram, and cowpea among other crops. Farmers will engage in pigeonpea production only if it remains relatively competitive. At the margin, a farmer will choose pigeonpea instead of an alternative enterprise only if net returns (i.e., gross returns less the costs of variable inputs) are higher for pigeonpea. That is, other things being equal, pigeonpea will be grown only when it has higher gross margin than the competing crop. This can be shown as:-

$$GM = TR - TVC \quad \text{.....} \quad (1)$$

Where;
GM = Total Gross Margin
TR = Total Revenue
TVC = Total Variable Cost
TR was calculated as:

$$TR = Q * P \quad \text{.....} \quad (2)$$

Where;
Q = Total production in kg
P = Price (Ksh kg^{-1}).

The variable costs include costs of land (if rented), manure and/or fertilizers, seeds, field chemicals, storage chemicals, oxen hire, and labor. These variable costs were divided into two categories, i.e., the intercrop-dependent costs (joint costs) and the intercrop-independent costs (non-joint costs). The joint costs included land rent, manure and/or fertilizer, field chemicals (unless specified that it was only applied to a particular crop), hiring oxen, and labor costs (except harvesting and threshing). These joint costs were assumed to be evenly distributed across the crops that were intercropped. On the other hand, the non-joint costs comprised of seed, storage chemicals, and harvesting and threshing labor costs.

The total variable costs of producing and marketing pigeonpea include standard production costs, marketing costs, and transaction costs. According to the new institutional economics, transaction costs include the costs of identifying, negotiating, and concluding an exchange (Williamson 1985; Nabli and Nugent 1989, Hubbard 1997). These costs may be decomposed into three types of transaction costs. First, *information costs*, which are the costs encountered prior to the transaction and include costs related to searching for and screening potential trading partners. Second, *negotiation costs*, which include the costs of arranging the trade, drawing the terms of exchange, and reaching an agreement on exchange (including the costs of bargaining). Last, *enforcement costs*, which include the ex-post costs of monitoring and enforcing compliance with the terms of exchange, including the costs of conflict prevention, dispute settlement and mal-adaptation under the new exchange contract[2] (Williamson 1985; Martinetz, 2002).

[2] Ex-post mal-adaptation costs include the cost of adapting and adjusting future exchanges to the terms of the new contract and preventing transactions drifting out of alignment.

Transactions costs could arise at the production level in the case of finding input suppliers, negotiating the terms of purchase, and verifying the quality of input and the sale price. They can also arise from asymmetric information in the process of acquiring credit and hiring labor, which requires monitoring and supervision of hired workers. At the marketing level, transaction costs arise in the process of finding a buyer, negotiating the sale price, and verifying the quality of product and reliability of weights. These production- and market-level transaction costs are exacerbated by incomplete information, geographical spread of the farmers, frequency with which exchange takes place, and the degree to which the assets needed to complete the exchange are specific to the transaction.

The marketing of commodities typically involves many intermediaries: assemblers, wholesalers, retailers, and the ultimate end users (i.e., consumers). The performance of the marketing system of any commodity depends on the organization of its marketing channels. In particular, the number of players involved and the degree of coordination and information sharing within the channel will determine the marketing costs and margins.

2.2 Empirical methods

The study entailed a detailed review of literature together with collation and analysis of secondary data. The secondary data comprised of FAO aggregate data on national output, data on export volumes of pigeonpea from Kenya obtained from various published documents, district level production data from major pigeonpea-producing areas in Kenya, and information from published sources on availability and use of improved technologies.

Information from these secondary sources was augmented with collection and analysis of two primary data sets: farm-level production and post farm-level marketing data. The farm-level data was comprised of production data from 400 randomly sampled households from Mbeere and Makueni districts first in the year 2003 and then 2005. The post farm-level data included information from a rapid market survey conducted on 44 marketing intermediaries in Machakos district and in the city of Nairobi in the year 2006. Appendix 1 gives the numbers of intermediaries in the vegetable and dry pigeonpea business interviewed during the survey. These intermediaries included rural open-air retailers, rural retail shopkeepers, rural assemblers[3] rural wholesalers/transporters, urban wholesalers, urban whole grain processors/exporters, urban vegetable pigeonpea exporters, urban open-air retailers, urban retail shopkeepers, and urban supermarkets. The rural market intermediaries were sampled from Machakos district while the urban market intermediaries were sampled from both Machakos town and in Nairobi. Due to difficulties associated with ascertaining the total population of each category of market intermediaries, only representative and convenient respondents were purposively selected for the interviews.

Marketing costs were taken to include both transaction costs and standard marketing costs (e.g., transport, assembly, grading/sorting). Measured transaction costs included the reported costs of finding a buyer/seller, costs of monitoring/inspecting the quality of grain being traded, and the costs of negotiating prices. Where exchange is through contractual arrangement, the costs of reaching an agreement and monitoring and enforcing the terms of the contract all constitute transaction costs. The standard marketing costs considered in this study included the costs of assembling the produce, grading/sorting, transportation, and storage, among others. Lack of detailed data prevented us from computing each of these costs separately.

[3] Rural assemblers sometimes perform the brokerage activities as well, and are hence commonly referred to as "brokers". Strictly speaking, however, they mainly assemble produce from farmers and sell it to the next intermediaries with very minimal brokerage activities.

The estimation of participants' net marketing margins was therefore stated as marketing margin less total costs, i.e.:

Net Marketing Margins = Marketing Margin – Total Costs …….. (3)

Marketing Margin = Selling Price – Buying Price ……... (4)

Total Cost = Standard Marketing Costs + Transaction Costs…..…….. (5)

The standard marketing costs included transport costs incurred during both buying and selling activities, i.e., transport from seller to store and from store to the buyer. In addition, marketing costs included costs paid for labor to clean the grain, storage costs, loading and offloading costs, security/watchman costs, council charges, shelling costs (for vegetable pigeonpea), processing costs, packaging costs, custom clearing costs for exporters, and bank charges (Appendixes 2, 3 and 4). Most of these costs have associated indirect or implicit costs in completing transactions. For instance, the cost of assembling produce in the rural areas is a standard marketing cost. However, it entails searching for a seller, negotiating the price, and inspecting the quality of the produce offered for sale, which are all components of transaction costs. Likewise, transportation cost (which is standard marketing cost) often encompasses costs of inspecting that the consignment received has same weight, volumes, and content as the one dispatched (which are transaction costs). Despite the difficulties in disentangling these costs, an attempt was made to elicit the direct cash outlays as well as the indirect costs in terms of time used and phone calls made to acquire information, find buyers/sellers, negotiate, and conclude transactions.

3. PIGEONPEA TECHNOLOGIES, PRODUCTION PRACTICES AND ON-FARM COMPETITIVENESS

3.1 Pigeonpea technologies

Pigeonpea can be classified into three major types depending on the length of time taken to reach maturity and its growth characteristics: (1) the short-duration type that takes 100-120 days to mature and has a determinate growth habit; (2) the medium-duration group taking 150–200 days to mature and having indeterminate growth characteristics, and (3) the long-duration group that takes more than 220 days to mature, with an indeterminate growth habit (Mergeai et al. 2001, Silim 2001). Most of the local varieties grown by farmers belong to the second and third types (Silim 2001). They are mostly intercropped with cereals (e.g., maize and sorghum) and other food legumes (e.g., beans, green gram and cowpea) (Omanga et al. 1996). These local varieties have lower yields than improved varieties under the normal conditions (Silim 2001). They also tend to be susceptible to pests, especially Fusarium wilt, which in some areas has forced farmers to abandon pigeonpea production altogether (Shiferaw et al. 2005). However, they are more drought tolerant than the short- and medium-duration improved varieties.

In recent years, ICRISAT, the Kenya Agricultural Research Institute (KARI), and the University of Nairobi (UoN) have developed and tested a number of short-, medium-, and long-duration improved varieties. This has resulted in the release of two short-duration types called ICPL 87091 (under the release name *KARI Mbaazi I*) and Kat 60/8, and one long-duration type called ICEAP 00040 (under the release name *KARI Mbaazi II*) (Table 2) (Silim 2001). These improved varieties are higher yielding and more resistant to Fusarium wilt.

Table 2. Pigeonpea varieties released in Kenya.

Variety name	Year of release	Release name	Varietal traits
ICPL 87091	1997	KARI Mbaazi I	• Short duration • Multiple harvests • Cream-colored seed • Small-sized seeds • Uniform maturity • Yield of 2.5 t ha^{-1}
Kat 60/8	2000	Kat 60/8	• Medium duration • Suitable as vegetable • Uniformly green pods
ICEAP 00040	2004	KARI Mbaazi II	• Long duration • White-colored seed • Large-seeded • Very resistant to Fusarium wilt • Partially resistant to pests • Uniform maturity • Yield of 3.2 t ha^{-1}

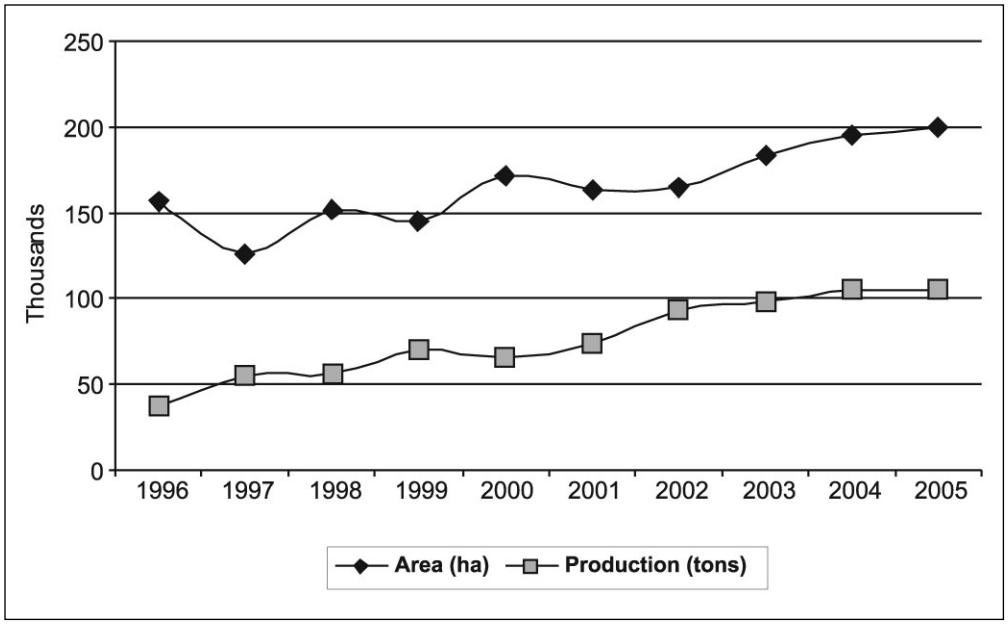
Source: Said Silim, personal communication, 2006.

Additional lines at various stages of testing by ICRISAT and partners include ICEAP 00068, ICEAP 00554, ICEAP 00557, and ICP 6927 for medium duration and ICEAP 00020 and ICEAP 00053 for long duration. Attempts are also being made to adapt the improved varieties to broader environmental conditions through an ongoing breeding program. The breeding program aims at identifying medium- and long-duration varieties with resistance to Fusarium wilt. The two traits (resistance to Fusarium wilt and early maturity) have successfully been incorporated into the short-duration types. The improved short-duration types have been evaluated for desirable agronomic traits (Silim 2001).

3.2 Pigeonpea production practices and productivity

The most important pigeonpea-producing districts in Kenya include Machakos, Makueni, Kitui, Mwingi, and Mbeere (Table 1). All these major pigeonpea-producing districts are located in the semi-arid Eastern Province of Kenya. Pigeonpea is usually planted at the onset of the September/October short rains. Farmers do not use fertilizer on the crop, although in some cases they apply manure. Weeding is done using hand hoes or oxen-drawn plows. Most of the short- and medium-duration varieties are harvested as green/fresh vegetable, usually between February and April. The long-duration types are, on the other hand, mostly harvested as dry grain in August and September. However, some farmers also harvest the long-duration types as vegetable pigeonpea, usually during the June/July period.

According to FAO statistics, pigeonpea production in Kenya increased from about 37,000 metric tonnes in 1996 to about 105,000 metric tonnes in 2005, amounting to about 184% increase in the ten-year period. During the same period, acreage under pigeonpea increased from about 156,000 ha to 200,000 ha, representing an increase of 28%. Yield, on the other hand, improved by 122% during the same period (Table 3). These statistics indicate that the sector recorded significant growth in both acreage and production, as further illustrated by Figure 1.



Source: FAOSTAT, 2007.

Figure 1. Pigeonpea production trends in Kenya (1996–2005).

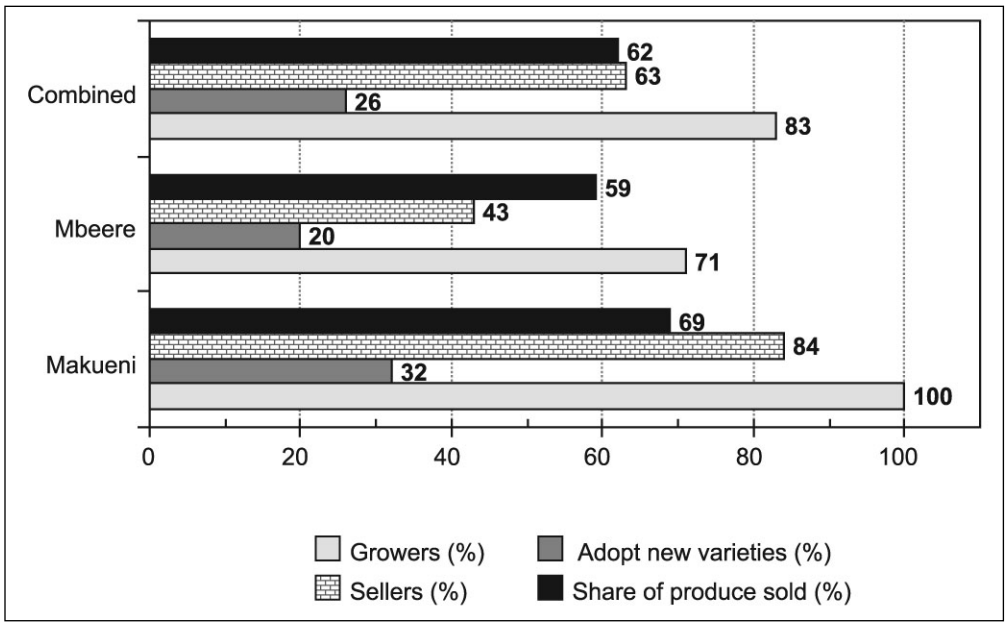
Table 3. Pigeonpea area, production and yield in Kenya (1996–2005).

Year	Area (ha)	Production (t)	Yield (t ha^{-1})
1996	156,492	37,080	0.237
1997	126,452	54,596	0.432
1998	151,697	56,273	0.371
1999	145,311	70,651	0.486
2000	171,842	65,604	0.382
2001	164,001	73,463	0.448
2002	164,453	93,203	0.567
2003	183,612	98,280	0.535
2004	195,307	105,571	0.541
2005	200,000	105,000	0.525

Source: FAOSTAT, 2006.

The increase in pigeonpea production can be attributed, at least in part, to the active and targeted research investments by ICRISAT and its partners that have resulted in the generation of improved pest- and disease-resistant varieties and hence improved yield (Table 4 and Figure 2). However, part of the increased production has resulted from area expansion. Part of this expansion has been to new (nontraditional) growing areas such as Central Kenya, Rift Valley, and Western Kenya (Freeman et al. 1999; Table 1). The yield increase attributable to the use of complementary inputs (especially fertilizer) is minimal since most pigeonpea farmers do not use fertilizers (Mergeai et al. 2001). Other factors that have contributed to production increase include (1) improvement in field pest management approaches including the application of insecticides[4], and (2) adoption of improved agronomic practices such as monocropping. However, a future increase in pigeonpea production is expected to come mainly from the use of improved varieties that are disease-, pest- and drought tolerant.

[4]. Our survey finds that 67% of farmers in major pigeonpea-producing districts have adopted improved pest management practices.



Source: Household survey, 2003.

Figure 2. Technology uptake and market participation for dry grain pigeonpea.

Table 4. Level of intensification in pigeonpea production in some selected districts.

	Mbeere		Makueni		Total	
Pigeonpea production issue	2003	2005	2003	2005	2003	2005
Households growing pigeonpea (%)	71 (240)	35 (210)	100 (160)	96 (190)	83 (400)	64 (400)
Households growing improved pigeonpea varieties (%)	20 (171)	42 (74)	32 (160)	60 (183)	26 (331)	55 (257)
Area under pigeonpea (ha/household)	0.19 (171)	0.78 (74)	1.38 (160)	1.40 (183)	0.77 (331)	1.22 (257)
Area under local pigeonpea variety (ha/household)	0.65	0.48	1.30	0.71	0.72	0.64
Area under improved pigeonpea variety (ha/household)	0.30	0.30	0.21	0.69	0.57	0.57
Percent pigeonpea area under improved varieties (%)	16	41	20	56	18	51

Values in parentheses are number of observations
Source: Household surveys, 2003 and 2005.

Although pigeonpea yields have increased over the years, they still vary widely by region, ostensibly due to use or non-use of improved technologies. Mergeai et al. (2001) find that yields from farmers' fields under extensive production with local cultivars were 0.222 t ha^{-1} in Makueni and 0.356 t ha^{-1} in Mbeere districts. The yields improved to 0.4 t ha^{-1} in Makueni district (81% increase) and 0.534 t ha^{-1} in Mbeere district (50% increase) for farmers who planted improved varieties. ICRISAT (2004) finds yields of up to 0.700 t ha^{-1} for farmers planting improved varieties in Mbeere; district. FAO statistics indicate that national yield increased from 0.237 t ha^{-1} in 1996 to 0.525 t ha^{-1} in 2005.

There is evidence that farmers are willing to invest in inputs that enhance yield, such as pesticides and improved varieties (Mergeai et al 2001). A major constraint facing poor farmers, however, is the unavailability of improved variety seeds and the high cost of such seeds when available. In addition, survey data indicates that improved pigeonpea varieties tend to require comparatively more spraying than the local varieties. The coupling of improved varieties with the need to use pesticides might have significant implications on adoption of the improved varieties, especially among the poor smallholder farmers.

3.3 Seed distribution systems and utilization of improved pigeonpea varieties

There are two main pigeonpea seed distribution systems in the semi-arid lands of Kenya, namely, the formal and the informal systems. The formal seed supply systems can further be divided into (1) regular seed supply, and (2) emergency/relief system. The latter is the most important seed source for farmers during and after weather-induced shocks (e.g., drought and floods) that result in severe deficiency in seed availability. The formal system, on the other hand, involves the flow of seeds through the (1) Ministry of Agriculture (MoA) and related nongovernmental organizations (NGOs) and their programs; (2) private seed companies. The informal seed supply system is the dominant system of seed distribution in all the growing areas. This system involves local grain stores, neighbors, relatives, and friends. Most pigeonpea farmers source their seeds through this system and only turn to the formal system during emergency or hardship.

The system adopted in providing farmers access to seed depends on the prevailing local circumstances. Emergency seed relief interventions have been used to improve accessibility of farmers to seed, especially during drought, floods, and social conflicts and, in some cases, to promote new improved varieties. Such seeds can be distributed using direct seed distribution or seed vouchers and fairs (Jones at al. 2002, Trip 2000).

Access to improved seeds during normal times has been a major problem in all pigeonpea-growing areas due to the undeveloped seed markets (Tripp 2000). Major seed companies have fairly well-established networks of stockists (about 5000 for Kenya Seed Company) across Kenya. Nevertheless, it is still difficult to find improved grain legume seeds being sold by seed stockists. A major contributing factor is the fact that pigeonpea is a self-pollinated crop where outcrossing is limited. Consequently, farmers can maintain the productivity of new varieties for 3-5 years while using saved seed. The use of saved seed makes production of improved pigeonpea seeds uneconomical, thus undermining the incentive for private sector investment in commercial production and marketing of such seeds. Additionally, local markets for improved seed tend to be thin, limiting the ability of commercial seed companies to exploit economies of scale.

Due to the aforementioned constraints, several types of seed interventions have been adopted in trying to improve seed supply in the semi-arid areas during normal times. These include community-based seed production programs promoted by the KARI-Winrock initiative; producer marketing groups (PMGs) promoted by ICRISAT, and small seed packs program of ICRISAT and partners. The major objective of these public-private seed supply initiatives is to improve farmers' access to improved seeds.

These problems are not limited to Kenya. Previous studies indicate that the problem of unavailability of improved pigeonpea seeds cuts across producing areas in Africa (Andren et al. 1991). However, the development of hybrid pigeonpea varieties, already underway in India, is likely to create a strong commercial incentive for seed companies to invest in the production and marketing of improved pigeonpea seeds. The hybrid variety has a 20-40% yield advantage over the open pollinated varieties.

Since hybrid vigor is associated with genetic diversity, crosses between the genetically diverse African and Asian gene pools could result in considerable yield improvement and create greater incentive for adoption of such varieties (Kimani 1991).

3.4 Integrated pest and disease management (IPDM)

Several pigeonpea pests and diseases affect pigeonpea production in Kenya. Among the common diseases Fusarium wilt, a fungal disease caused by *Fusarium udum*, is the most significant in terms of economic importance. The disease is estimated to cause annual losses of about US$ 5 million in Kenya. Consequently, the pigeonpea breeding program spearheaded by ICRISAT has targeted the development of varieties resistant to Fusarium wilt. Two such varieties released in 1997 and in 2004 are *KARI Mbaazi II* and the ICEAP 00040, respectively (Table 2).

Pigeonpea is also affected by a number of insect pests, which cause economic losses by lowering yield and reducing grain quality. The most significant insect pests in Kenya are those that attack the crop at the growth stages. These include the pod-sucking bugs, pod borers (*Helicoverpa spp.)*, and pod flies. These pests cause losses in both dry grain and fresh peas. The market for the latter is especially sensitive to insect damaged pods.

Some farmers control insect pests by chemical spraying, the most common pesticide used being *Karate* (Mergeai et al. 2001, ICRISAT 2004). In general, however, most farmers do not use chemical protection against pests due to the high cost, lack of awareness, lack of pesticide sprayers, and poor availability of effective pesticides (Mergeai et al. 2001, Freeman et al. 1999). Most farmers therefore use cultural practices to control pests. In future, commercializing pigeonpea production will require greater use of pesticides due to the build-up pests and diseases. This will in turn call for farmer training on pesticide safe use and removal of input marketing constraints. ICRISAT has also been promoting cost effective and eco-friendly biological control methods like use of *Tephrosia* leaves in controlling both field and storage pests.

3.5 Farm-level competitiveness of pigeonpea

Pigeonpea competes for limited farm resources (e.g. land and labor) with other crops, notably maize, sorghum, beans, cowpea and green gram. Pigeonpea production therefore entails opportunity costs, i.e., foregone income from growing alternative crops. In order to examine the competitiveness of pigeonpea, we computed its gross margins as well as those of competing enterprises using household data collected in 2005. The gross margins were calculated as returns to land and management and returns to land and family labor. The results of this exercise are presented in Table 5. As shown, pigeonpea has the third highest gross margin after chickpea and green gram in terms of returns to land, family labor, and management among all cultivated legumes. It is therefore a relatively competitive enterprise. Adoption of higher yielding and/or pest- and disease-resistant varieties could therefore make pigeonpea even more competitive. In addition, the gross margins do not take into account the other nonfood benefits farmers derive from pigeonpea. These benefits include the use of its leaves as livestock feed, use of woody stems as fuelwood, and soil fertility benefits from its ability to fix atmospheric nitrogen and its ability to replenish soil phosphorus by releasing iron-bound phosphorus. Pigeonpea's soil enrichment ability is especially important because most soils in semi-arid regions have widespread deficiencies of nitrogen and phosphorus (Siambi et al. 1992).

Table 5. Income and variable costs for selected crop enterprises from eastern Kenya (Ksh ha^{-1}).

Crop	No. of observations (N)	Gross income	Variable costs including family labor	Variable costs excluding family labor	Return to land and management	Return to land and family labor
Maize (first season)	313	4,114	4,090	2,518	24	1,596
Maize (second season)	328	6,020	4,641	2,968	1,379	3,053
Beans (first season)	219	4,103	4,036	3,176	67	927
Beans (second season)	278	5,559	5,242	3,950	317	1,609
Dry pigeonpea	355	8,555	6,176	4,343	2,379	4,212
Vegetable pigeonpea	342	6,644	3,828	2,024	2,816	4,620
Chickpea	28	5,446	1,898	1,086	3,548	4,360
Green gram	306	6,440	3,103	2,150	3,337	4,291
Cowpea	267	3,563	4,237	3,155	-673	408
Cotton	13	18,874	6,682	2,559	12,192	16,315

Source: Household surveys, 2003 and 2005.

The competitiveness of pigeonpea arises from its biological features and adaptation to the marginal conditions under which it is grown. Pigeonpea performs very well in hot and dry environments. Its drought tolerance and ability to make use of residual moisture during the dry season enables it to withstand drought-related shocks and generally do well even with limited rain.

4. PIGEONPEA MARKETS, GRADING, QUALITY AND PROCESSING SYSTEMS

4.1 Nature of rural agricultural markets in pigeonpea-growing areas

The market liberalization policies of the 1980s and 1990s have opened a window of opportunity for smallholder farmers producing small surpluses for the markets in many developing countries. The removal of trade barriers and increased competition among traders has created some flexibility for farmers to choose suppliers of key inputs and buyers for their products. However, high transaction costs and problems of information asymmetry continue to constrain smallholder farmers' access to markets for products, inputs, and services. These constraints are exacerbated by poor infrastructure (e.g., roads, communication systems, electricity, etc) in rural areas and geographical dispersion of farmers and farms. Smallholder farmers in rural areas therefore tend to be poorly served by agricultural traders, making local markets thin and less competitive and prices highly dependent on seasons. Consequently, prices fall sharply at the time of harvest but only increase gradually as local supply declines.

Some rural markets tend to be dominated by a few buyers, resulting in lack of competition, low local effective demand, and covariate risks. Lack of competition limits opportunities for farmers to bargain for better prices and leads them to accept low prices (de Janvry et al. 1991, Kindness and Gordon 2001). In other rural markets, there tend to be many players in the marketing chain, the majority of who just move the produce without any value addition (Freeman and Jones 2001). In such markets, transaction costs tend to be high, thereby depressing farmers' margins. The high transaction costs arise from the high search and transport costs involved in procuring and selling produce. The search costs in rural markets tend to rely largely on personal visits by traders, which means that the traders have to travel extensively (Fafchamps and Gabre-Madhin 2006). The high search costs are exacerbated by the need for quality control that often entails the necessity of the trader's presence at the time of exchange.

Along the supply chain, processors and traders are constrained by low-quality grain, inadequate supply and high cleaning costs. Other marketing intermediaries face high assembly costs, high market risk, and cash

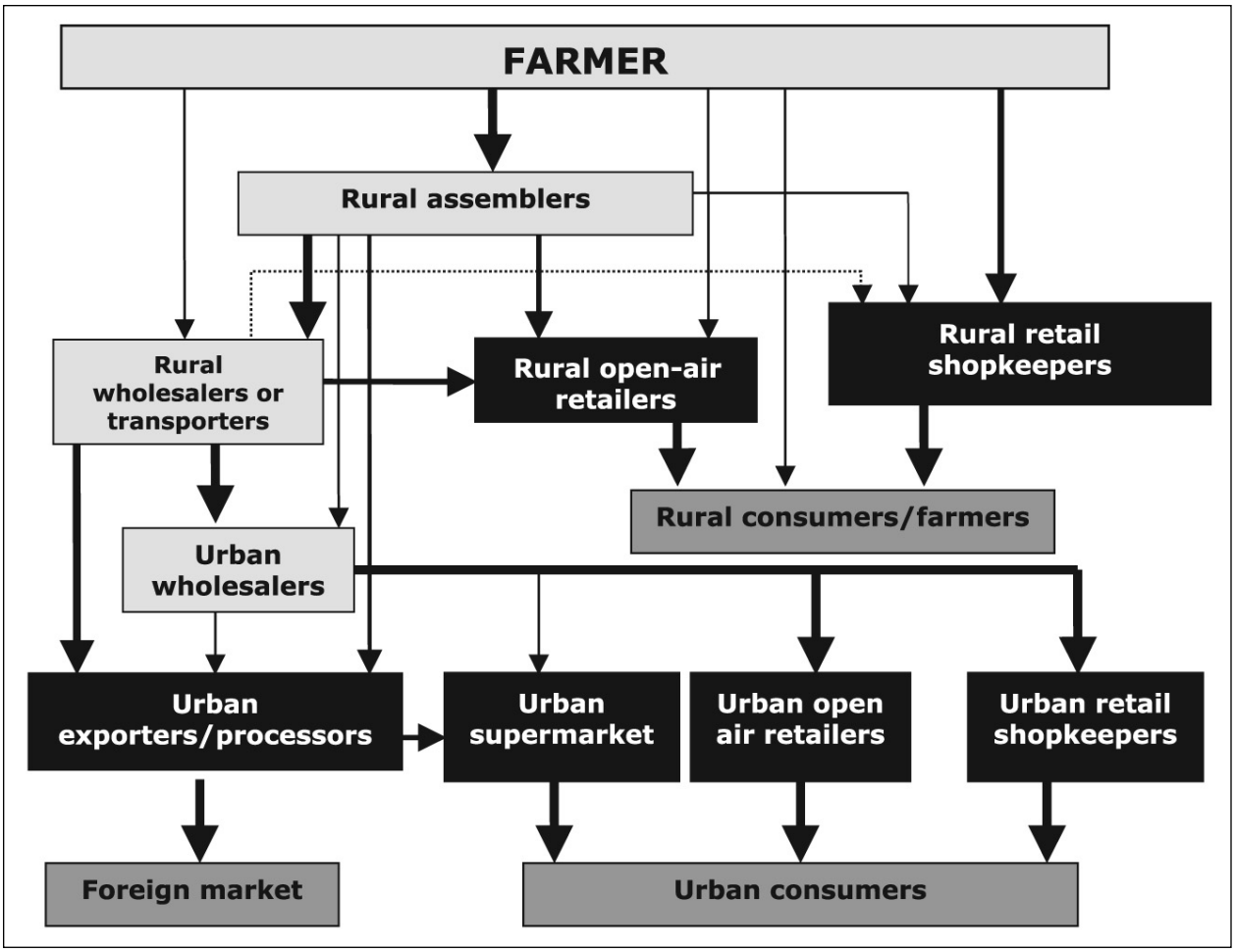
flow problems. These constraints indirectly deprive farmers of the underlying incentives that they would gain by producing and supplying quality and differentiated products with desirable market traits. They also inhibit farmers' ability to penetrate niche markets (Jones et al. 2002). Thus, widely dispersed and unorganized smallholder farmers are often unable to exploit market opportunities (Poulton et al. 2006), as their smallness prevents them from taking advantage of economies of scale and limits their bargaining power in negotiating prices. These limitations reduce their ability to compete with well-established large-scale producers or farmers in more favored areas and to take advantage of emerging market opportunities (Johnson and Berdegue 2004). In order to overcome the limitations imposed on smallholder farmers by the nature of markets under which they operate, researchers and policymakers need to clearly understand the structure and functioning of individual crop markets. The section below provides some facts about the structure and functioning of pigeonpea markets and marketing channels.

4.2 Structure of pigeonpea supply chains

Pigeonpea production in Kenya is dominated by smallholder farmers. Most farmers grow pigeonpea both for self-consumption and for cash to meet food security and other requirements. Trade in pigeonpea is limited to one season with very minimal inter-seasonal trade. Interseasonal trade is constrained by the high costs of pigeonpea storage because the grains are susceptible to storage pests like bruchids. Consequently, a significant portion of pigeonpea is offered for sale immediately after harvest. Our survey results indicate that about 43% of pigeonpea farmers in Mbeere district and 84% in Makueni district offered some of the produce for sale (Figure 2). Although the proportion marketed is likely to vary depending on the growing conditions, the results demonstrate that pigeonpea is an important cash crop for smallholders in drought-prone areas. In general, the pigeonpea farmers in the semi-arid districts market about 62% of their dry grain pigeonpea harvests. On the contrary, only less than 10% of the total fresh peas harvested are marketed (Figure 8). This is mainly because: (1) most farmers prefer to consume pigeonpea as fresh peas because it is sweeter and cheaper than the alternatives (especially beans) and, (2) harvesting of vegetable pigeonpea coincides with hunger periods characterized by acute shortage of household food staples.

Grain and vegetable pigeonpea are traded both in rural and urban markets. Intermediaries in the rural markets include farmers and a network of assemblers, retail shopkeepers, open-air retailers, and wholesalers who are linked to urban markets through transporters. On the other hand, urban markets consist of wholesalers, processors/exporters, supermarkets, retail shopkeepers and open-air retailers. The large numbers of intermediaries translates into high marketing costs that drive up consumer prices. The risk of high consumer prices is that it often results in consumers shifting to alternative sources of protein due to high price elasticity of pigeonpea (Joshi et al. 2001). High consumer prices cause welfare losses for poor consumers who cannot afford other sources of protein.

Figures 3, 4 and 5 present the marketing system and supply chains for the dry grain pigeonpea, *dhal*, and vegetable pigeonpea in Kenya. The important channels in terms of the volume of product traded are described using bold arrows. In all cases, marketing starts with farmers selling their grains to rural assemblers. These intermediaries typically bulk the grains (by collecting small quantities from individual farmers) and then sell to rural wholesalers. The assemblers may also store the dry grain in sacks for limited periods (usually 2-3 days) before moving it. They rarely treat the grains with pesticides as this is costly; nor do they store the product for longer periods due to lack of storage facilities. While the rural wholesalers are the main outlets, assemblers also sell to rural open-air retailers and rural retail shopkeepers. Some rural assemblers sell to urban wholesalers and/or processors and exporters.

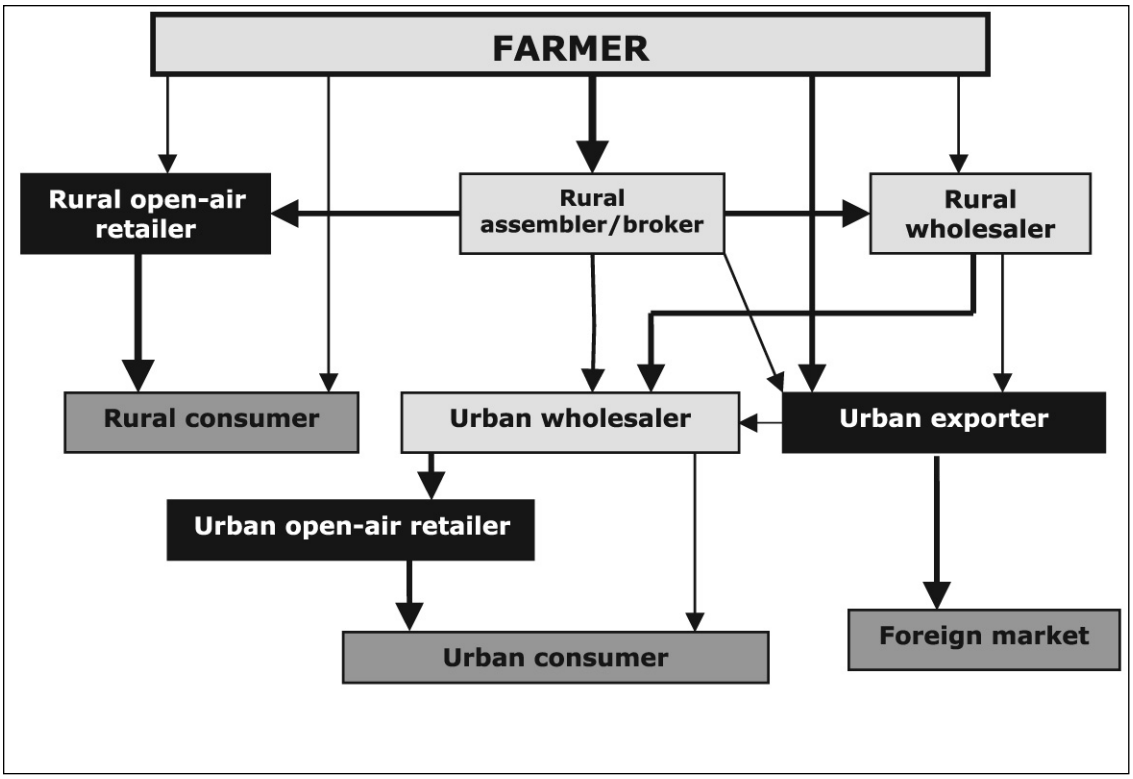


Source: Market survey, 2006.

Figure 3. Dry grain pigeonpea marketing channels in Kenya.

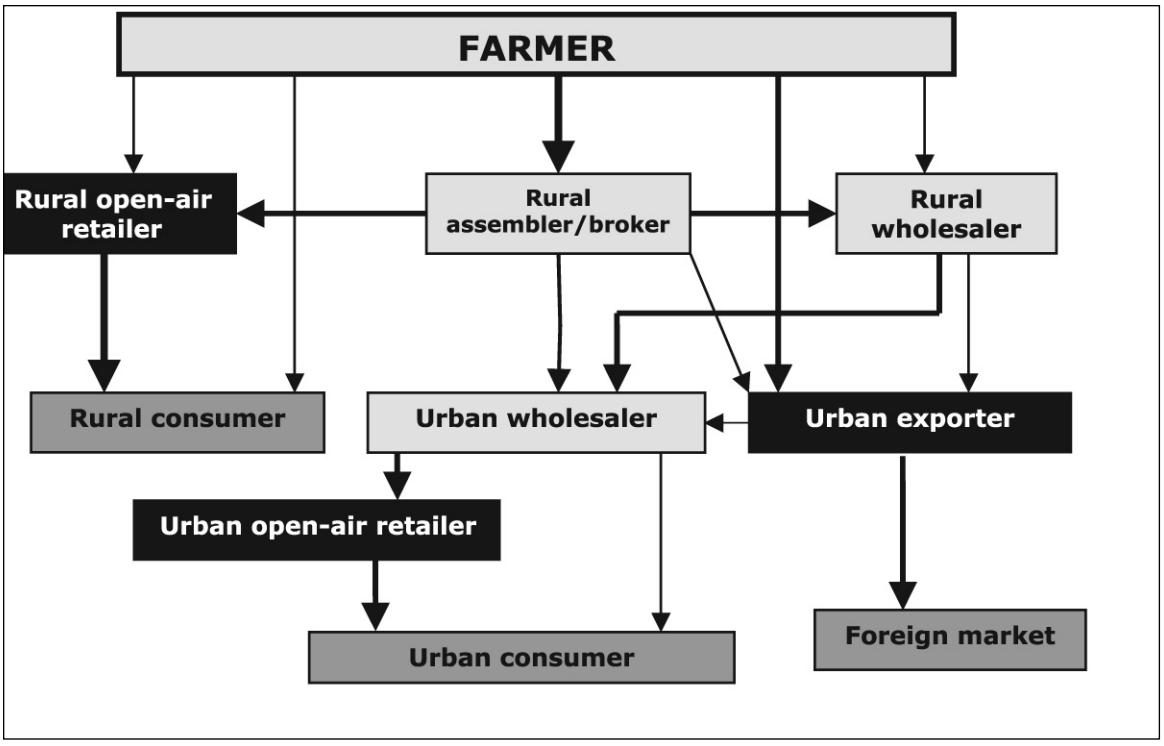
Rural wholesalers have better storage facilities and usually combine wholesale grain with retail of other commodities. They are located in larger rural trading centres that are easily accessible to other market participants at the upper end of the supply chain. Apart from buying the grain from rural assemblers, they may also source some volumes directly from farmers, depending on the proximity of farmers to such outlets. As part of value addition, rural wholesalers may sometimes clean the grains by removing foreign objects and spoiled grains[5]. They then weigh and bulk the grain before transporting it to their buyers. The main purchasers of the grain from rural wholesalers are the urban wholesalers and processors/exporters, and in some cases, rural open-air retailers and rural retail shopkeepers (Figure 3). Urban wholesalers deal in pigeonpea and a wide range of other grains. They own warehouses from where they trade, mainly with urban retailers (including supermarkets) and, to some extent, urban processors/exporters. Urban wholesalers often get the grain delivered to their warehouses by sellers and sell in bulk from the same premises without incurring any transport costs. However, they clean the grain to some extent when the buyer demands higher quality and is willing to pay a premium for it. Their most important marketing function is the breaking down of large volumes of grain supplied to them into units affordable by the urban retailers.

[5] While smallholders do not get any premium from assemblers for cleaning, grading or sorting, traders at the upper end of the chain seem to capture quality effects as product differentiation becomes more important for the end user.



Source: Market survey, 2006.

Figure 4. Marketing channels for dhal in Kenya.



Source: Market survey, 2006.

Figure 5. Marketing channels for vegetable pigeonpea in Kenya.

Urban retailers of pigeonpea can be categorized into three types: supermarkets, small-to-medium retail stores, and open-air retailers. Supermarkets get most of their supplies from the urban processors/exporters in pre-packed and well labeled 1-kg packets while small and medium retailers and urban open-air retailers source most of their grain supplies from urban wholesalers (Figure 3).

Urban processors/exporters add value to pigeonpea before exporting it either as whole grain or split dry grain (*dhal)*. Pigeonpea processing entails dehulling and splitting the pigeonpea grain to make *dhal*. This greatly reduces cooking time and improves the physical appearance, texture, and palatability of pigeonpea (Freeman et al. 1999). Most processors/exporters are located in the main urban centres (mainly in Nairobi and Mombasa). They export both *dhal* and dry whole grain pigeonpea (Freeman et al. 1999) but also sell some limited quantities of *dhal* to domestic supermarkets and urban retail shops. The supply chain for processed pigeonpea is therefore nested within the larger dry grain pigeonpea. The nested supply chains for *dhal* are presented in Figure 4. As the figure shows, once the grain is processed, the trading of *dhal* is exclusively in urban areas, while some of the *dhal* may also be exported depending on prevailing prices and competitiveness of local processors/exporters.

Fresh or vegetable pigeonpea is also marketed both in rural and urban areas. In rural areas, peas are sold through assemblers, open-air retailers, and wholesalers (Figure 5). Farmers typically sell the unshelled fresh peas to rural assemblers who then sell it to rural open-air retailers, rural wholesalers, and, in some cases, to urban wholesalers. Rural wholesalers usually transport fresh peas in pods and sell it to urban wholesalers.

Though the rural wholesalers serve as the main source of vegetable pigeonpea for urban wholesalers, the latter also get some of their supplies from urban exporters. This occurs when exporters have fresh peas that do not meet export quality standards. Hence, most of the vegetable pigeonpea sold by exporters to urban wholesalers constitutes rejects mainly sourced from non-contracted farmers and rural wholesalers. The urban wholesalers mainly sell to urban open-air retailers, though in some cases they also sell to final consumers (Figure 5).

The exporters of fresh peas consist mostly of Nairobi-based horticultural companies, who sell fresh peas in pods mainly to Europe (UK, France, and Denmark). However, the export volumes traded are quite low and seem to be largely constrained by foreign demand and ability to produce and supply good quality vegetable peas. These exporters supply packaging materials (corrugated 6-kg cartons) to their suppliers (farmers, rural assemblers, and rural wholesalers) and hence receive the crop from farmers in well labeled and traceable cartons. Most of the contracted farmers are located in Yatta division of Machakos district and Kibwezi division of Makueni district. Most exporters also formally contract pigeonpea farmers to produce other export crops, especially Asian vegetables such as *okra, karela, and ravaya*.

4.3 Pigeonpea marketing channels, marketing costs and quality requirements

In this section, we identify and describe the major channels through which pigeonpea is marketed and the associated margins, marketing costs and quality requirements. Products typically pass through a number of players/agents along the different marketing channels linking producers with consumers, hence producing a marketing chain (also called value chain). The strength of the value chain depends on the degree of trust and relationship that exists among the different participants. In situations where sharing of market information is poor and players behave in ways that undermine the activities of the

others, the value chain is highly underdeveloped and largely inefficient and inequitable. Transaction costs are incurred at each node for cleaning, packaging, transport, and other marketing functions required in buying and selling the product. This tends to increase the marketing costs and lower the share of the consumer price received by the smallholder farmers, especially when the value chain is overextended, involving a large number of nodes and players.

Mbatia and Kimani (1992) identified three pigeonpea marketing channels in rural areas of Kenya. These channels link pigeonpea farmers to neighbors, nearby shops, and local markets in rural areas. Freeman et al. (1999) and Muricho (2002) identify four main marketing channels; farm-gate to urban supermarkets, farm-gate to open-air retailers, farm-gate to processed pigeonpea (*dhal*) urban retailers, and farm-gate to export of dry grain pigeonpea. Freeman et al. (1999) note that processing of pigeonpea has continued to perform poorly partly because of higher raw material prices offered for dry whole grain in the domestic market and high procurement and processing costs. This has reduced the competitiveness of *dhal*, particularly for export, limiting processing only to small quantities serving the Asian population settled in major urban centres in Kenya. Based on the evidence gathered during this study, we present in the next sections a more comprehensive view of the various marketing channels for pigeonpea in Kenya. Unlike the previous studies (Mbatia and Kimani 1992, Freeman et al. 1999, and Muricho 2002) which focused only on few pigeonpea channels, we present a more comprehensive assessment of all relevant channels that link farmers to both rural and urban markets.

4.3.1 Marketing channels for dry pigeonpea grain

This study has identified six marketing channels for dry pigeonpea. These channels link pigeonpea farmers to both domestic and export markets. In the domestic market, the channels link farmers with rural and urban traders. Hence, the six marketing channels (Table 6) for dry grain pigeonpea identified in this study link smallholder suppliers to:

i) Rural open-air retail markets
ii) Rural retail shops
iii) Urban open-air retail markets
iv) Urban retail shops
v) Urban supermarkets
vi) Export markets

Among the six marketing channels, overall profits are highest for the supermarket channel followed by urban retail shops, with the lowest for rural retailers. Total marketing costs also follow a similar pattern; marketing costs for the urban supermarket channel is Ksh 797/bag as compared to Ksh 435/bag for the rural open-air channel. The share of marketing costs in the final price seems to be highest for the export channel, but this was not ascertained as none of the surveyed traders exported pigeonpea during 2006. The producer's price as a share of the final consumer price is highest for the rural retail channels and lowest for the supermarket channel (32%), which shows the level of transaction costs involved and also the value-adding activities as the product flows from the producer to the different end users. This also shows that producers would earn better prices if institutional innovations that link them more directly with the high-value channels can be developed (Table 6).

Table 6. Dry pigeonpea selling prices in different marketing channels (Ksh/90 kg bag).

Actor	**Channel 1:** Rural open-air retailer	**Channel 2:** Rural retail shopkeeper	**Channel 3:** Urban open-air retailer	**Channel 4:** Urban retail shopkeeper	**Channel 5:** Urban supermarket	**Channel 6:** Urban exporter
Farmer	2250	2070	1710	1710	1710	1710
Rural assembler	2610	2610	2070	2070	2070	2070
Rural wholesaler	3510	3060	2520	2520	2340	2340
Rural open-air retailer	3690	-	-	-	-	-
Rural retail shopkeeper	-	3240	-	-	-	-
Urban wholesaler	-	-	3150	2970	-	-
Urban open-air retailer	-	-	4050	-	-	-
Urban retail shopkeeper	-	-	-	4140	-	-
Urban exporter/processor	-	-	-	-	5040	2289
Urban supermarket	-	-	-	-	5400	-
Farmers' share in final price (%)	61	64	42	41	32	75
Total marketing costs	435	462	692	764	797	676
Marketing costs as share of final price (%)	12	15	17	18	15	30
Total profits (Net marketing margins)	1005	678	1648	1666	2893	-97[a]

Source: Market survey, 2006.

a/ These are not actual profits in this channel because there were no exports in 2006 due to very low prices in the international market compared to the domestic markets. This indicative value was computed using the CIF import price in India (Figure 11) while exporters' marketing costs were based on Muricho (2002).

The channels that link producers to retailers in rural and urban open-air markets and also those that link producers to rural and urban-retail shops involve purchase and sale of grain of average quality with very limited cleaning, sorting, and repackaging[6]. These marketing channels are characterized by low technology, low volumes and low costs. They typically involve many small traders with limited market assets and exchanging small amounts of produce with no or very limited value addition. Quality is verified by visual inspection during the exchange process, which requires the physical presence of the buyer. This is consistent with similar findings in other countries of Africa (Fafchamps and Gabre-Madhin 2006). In a majority of the cases, produce is measured using a weighing scale. Even the rural assemblers carry hooked weighing scales to measure the grain and most farmers understand the kg measure for pricing their grain. This is unlike the common practice in western Kenya where a nonconventional scale (a nonstandardized tin called *goro goro*) is popularly used. Using the *goro goro*, grains are measured into larger containers, usually gunny bags.

The channel linking producers to urban supermarkets involves the movement of dry grain pigeonpea from rural areas to major urban markets (especially supermarkets) by urban processors/exporters. Typically, the grain passing through this channel is well cleaned, sorted, and pre-packed (mainly in well-labeled 1-kg or 2-kg packets) by processors before delivery to the supermarkets. The major supermarkets included in the survey are shown in Appendix 6. This channel is characterized by large volumes, high consumer prices, high marketing costs, and use of improved technology, specialized marketing services, and higher net margins/profits (Table 6). Traders in the channel use fair and average

[6] Quality in this study was classified as "above average", "average/medium" and "below average" based on the amount of impurities (foreign matter, insect damage, and rotten/broken grains).

quality specification that is also verified by physical inspection.[7] Although the grains are packaged in 1-2 kg packets, they are usually shipped to the supermarkets wrapped in bigger bundles.

Lastly, the channel linking pigeonpea farmers to grain export companies involves grains of average to above-average quality sourced by exporters from a network of rural assemblers, rural wholesalers/ transporters, and urban wholesalers. The grain is typically cleaned, sorted, and packed in 50- or 90-kg bags by the exporters. Measurement of grain in this channel is also done using the conventional weighing scale.

The major export markets for dry grains are India and Europe. There is no data on volumes exported into these markets, although it is estimated that India absorbs up to 90% of Kenya's dry grain pigeonpea exports. The European market also absorbs some of the exports. However, it is more sensitive to grain quality and hence more extensive cleaning has to be done to meet its quality standards. Pigeonpea exported to the European market must have no impurities, especially foreign matter, and should be of uniform size and color (i.e., large cream-colored grains). Consequently, pigeonpea exports to European markets often require high quality grains and fetch a price premium of up to US$ 30 per ton above the average price (Lo Monaco 2003). The dry grain export channel is also characterized by use of modern technology and typically has large volumes of pigeonpea moving through it. It however tends to have higher marketing costs than the earlier channels.

4.3.2 Marketing channels for dhal

This study identified three marketing channels for *dhal* in Kenya. They link farmers to: (1) urban retail shops; (2) urban supermarkets, and (3) export markets. The structure of marketing costs and margins in these channels are presented in Table 7.

Table 7. *Dhal* selling prices in different marketing channels (Ksh/90 kg bag).

Actor	**Channel 1:** Urban retail shopkeeper	**Channel 2:** Urban supermarket	**Channel 3:** Urban exporter
Farmer	1710	1710	1710
Rural assembler	2070	2070	2070
Rural wholesaler	2340	2340	2340
Urban exporter/processor	6660	6660	5850
Urban retail shopkeeper	7200	-	-
Urban supermarket	-	7650	-
Farmers' share in final price (%)	24	22	29
Total marketing costs	1502	1502	2153
Marketing costs as share of final price (%)	21	20	37
Total profits (Net marketing margins)	3988	4438	1987

Source: Market survey, 2006.

Dhal is manufactured by urban processors/exporters. The manufacturing process involves de-hulling and splitting dry pigeonpea grains to form *dhal* using vertical decorticators. The average yield of *dhal* is about 71% (range 65%–75%) of the original dry grain pigeonpea weight. Approximately 80% of the dry grain bought by processors/exporters is processed into *dhal* while the remaining 20% is sold

[7] Although the produce is usually packed in plastic bags when it arrives in the supermarket, the bags are clear (i.e., not colored) hence allowing the supermarket procurement staff to inspect quality.

as whole grain. Because of the nature of its market, the *dhal* produced is usually of high quality and is sold both in the domestic and export markets. Both markets are characterized by medium to high income consumers hence are sensitive to quality.

Over 70% of the processed *dhal* is exported, mainly to the UK and USA. The rest is sold through large domestic urban supermarkets and a few urban retail shops. The Asian community in Kenya accounts for the bulk of the domestic market for *dhal*.

Dhal marketing channels are characterized by use of modern technology, high volumes, and high net margins, especially in channels serving the domestic markets (Table 7). Among the three channels, marketing costs are highest for the export channel, but total profits for the channel were highest for supermarkets, followed by the other urban retailers. This indicates that to the extent that the demand in the local markets can be expanded, the domestic channels offer greater incentives in terms of lower total costs and higher net margins. The quality of *dhal* traded in both domestic and export channels is usually above average, due to quality-conscious export and domestic markets. As in the dry grain market, the quality of *dhal* sold in the domestic markets is verified using physical inspection. Measurement in the urban retail markets (including supermarkets) is done using conventional weighing scales, usually in kilograms.

4.3.3 Marketing channels for vegetable pigeonpea

Vegetable pigeonpea is traded both in the local and export markets mainly through three channels. These channels link producers to: (1) rural open-air retailers (2) urban open-air retailers, and (3) exporters. There is no channel directly linking farmers to urban supermarket retailers, probably due to the erratic and seasonal nature of vegetable pigeonpea supply and small volumes, which reduce incentives for supermarkets to directly source from farmers. Table 8 shows the structure of marketing costs and profits through the different channels. The total costs are highest for the export channel as it is sent under refrigeration—the costs therefore account for almost 80% of the final price. This compares to just 4% for rural retailers and 12% for urban retail shops. However, profits are not high in this channel although captured only by the exporters who directly procure from contracted farmers. The urban retail channels seem to offer highest net margins although the farmers receive only 14% of the final price.

Table 8 presents data on farmers' share in the final price paid by the consumers. The farmers' share is highest in the rural open-air retail channel (27%) and lowest in the urban export channel (12%). Overall, the share of consumers' price earned by farmers is much lower in all the vegetable pigeonpea market channels than in the dry grain market channels. This may be due to, among other factors, the nature of the product and the sensitivity of the market to quality. Indeed, the share of final price earned by farmers decreases as one moves from primary to tertiary markets and then to export markets. Vegetable pigeonpea is perishable, hence subject to greater losses than dry grain pigeonpea. The urban open-air retail channel earns the highest total profits from vegetable pigeonpea trade while the urban export channel earns the lowest. Once again, the relatively low total profit earned in the export channel is likely to be due to the high marketing costs, especially the costs of monitoring and enforcing quality standards and high freight costs.

Table 8. Vegetable pigeonpea selling prices in different marketing channels (Ksh/90 kg bag).

Player	Channel 1: Rural open-air retailer	Channel 2: Urban open-air retailer	Channel 3: Urban exporter
Farmer	900	900	2880
Rural assembler	1620	1620	-
Rural open-air retailer	3330	-	-
Rural wholesaler	-	2250	-
Urban wholesaler	-	3330	-
Urban open-air retailer	-	6210	-
Urban exporter	-	-	23288
Farmers' share in final price (%)	27	14	12
Total marketing costs	137	722	18346
Marketing costs as share of final price (%)	4	12	79
Total profits (Net marketing margins)	2293	3958	2062

Source: Market survey, 2006.

Typically, rural assemblers (also known as brokers) purchase the fresh peas (in pods) from farmers and bulk them before selling them on to the next intermediary. This could be the rural open-air retailer, rural wholesaler, urban wholesaler, or urban exporter. Rural wholesalers typically sell the peas to either to urban wholesalers or urban exporters. Urban wholesalers, on the other hand, sell the peas to either to urban open-air retailers or directly to consumers. Some urban exporters (especially the horticultural export companies) buy their supplies directly from farmers. Vegetable pigeonpea for export is subject to stricter physical quality and pesticide residue standards, and are subjected to pesticide residue testing as required by the destination markets. In terms of physical attributes, the pods are required to be straight, of uniform size (usually about 5cm in size), and spotless. In addition, the peas must be of the right stage of maturity. These physical quality attributes are verified by physical inspection and some export market buyers subject the peas to pesticide residue testing as part of the due diligence requirements of these markets.

Vegetable pigeonpea destined for export is usually collected by the exporters at various designated collection points on particular days of the week depending on flight logistics. Since the peas are perishable, picking, collection, processing, and export must be carefully synchronized. Production of fresh peas for export is therefore characterized by temporal asset specificity. This means that farmers growing pigeonpea for export market must work closely with exporters' agents to plan their harvesting, transportation (to the collection points), and sale of peas. Poor scheduling of these activities can result in losses to producers because of its perishability.

Vegetable peas are sold in the domestic market to consumers through rural and urban open-air retail channels. Rural open-air retailers buy vegetable peas mainly from rural assemblers or directly from farmers. Urban open-air retailers buy their supplies mainly from urban wholesalers and, to a limited extent, rural wholesalers. Vegetable pigeonpea sold in the domestic market is either shelled manually before selling to consumers in small volumes or sold in-shell depending on the target retail market. Quality requirements in the domestic vegetable pigeonpea markets are limited to physical attributes only and are less stringent than the export market requirements. As in the exported vegetable peas, quality is assessed through physical inspection in the domestic vegetable pigeonpea market channels.

4.4 Marketing margins, costs and profits by market participant

In this section, we present the distribution of net marketing margins and costs across different players within each of the major value chains for the different pigeonpea products mentioned above.

4.4.1 Dry grain pigeonpea

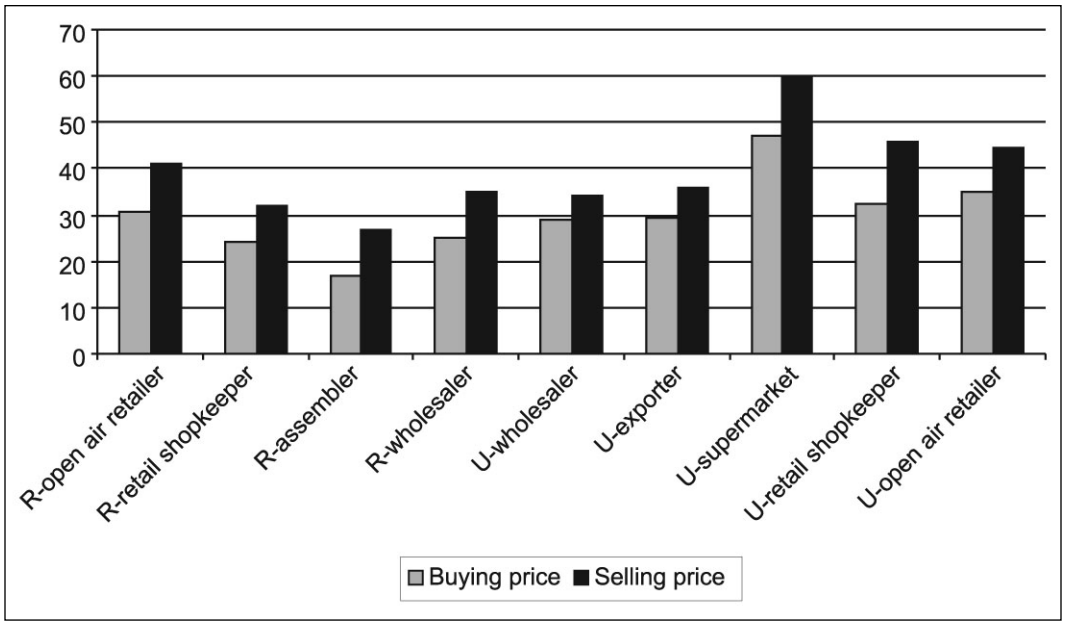
Market participants in all the six marketing channels buy grain from more than one source and sell to more than one buyer. Therefore, selling prices used for deriving farmers' shares in the final price (Table 6) are averages. Prices typically differ for different buyers; hence farmers get different prices based on the channel used. The distribution of total costs and profits to different agents involved within a given channel for dry grain pigeonpea is presented in Table 9. The actual buying and selling prices are shown in Figure 6 while Figure 7 presents the marketing costs and net margins for the different agents. The average buying price for a given participant is, in most cases, different from the selling price of the preceding participant. This is partly because the traders surveyed within the supply chain are not always exactly those engaged in the transactions and the average prices given here were aggregated over different seasons and quality classes. Consequently, the buying price of rural wholesalers is sometimes slightly lower than the average selling price of rural assemblers (Figure 6). However, the prices generally increase as the commodity moves through the marketing chain from primary to secondary and tertiary markets.

The average buying prices for the different market participants ranged from Ksh 17/kg for rural assemblers to Ksh 47/kg for supermarkets. On the other hand, selling prices ranged from Ksh 27/kg for rural assemblers to Ksh 60/kg for supermarkets (Figure 6). On the other hand, urban retail shopkeepers had the largest marketing margin of Ksh 13.6/kg, whereas urban wholesalers had the least margin of Ksh 5/kg. The net margins (profits) were, however, highest for the supermarkets, followed by other urban retailers and were lowest for wholesalers and exporters (Figure 7).

Table 9. Distribution of dry grain pigeonpea total channel marketing cost and profits.

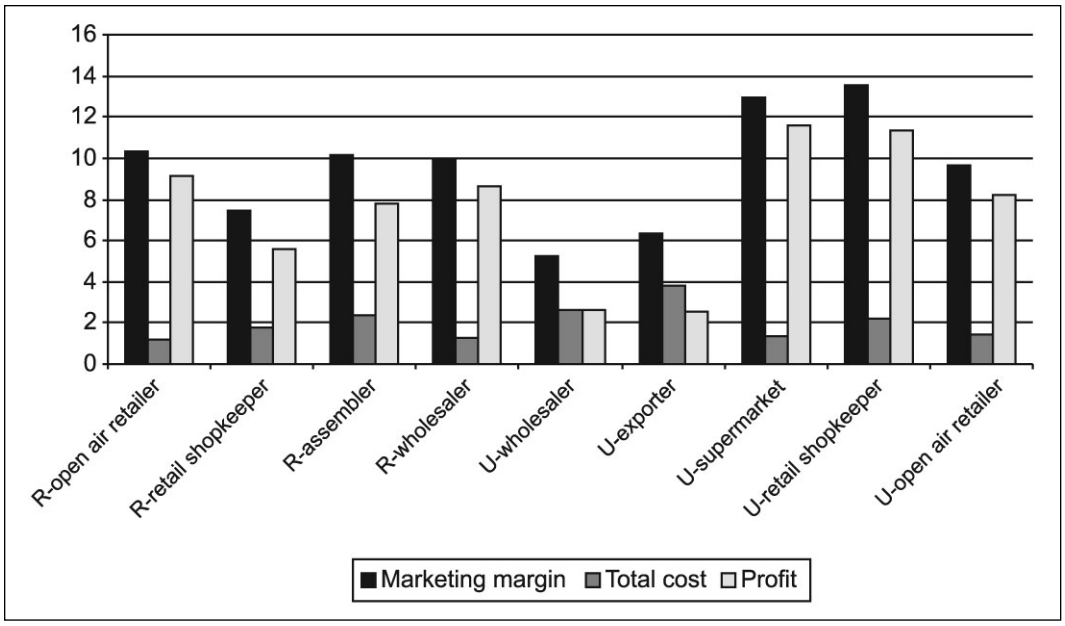
	Channel 1: Rural open-air retailer		**Channel 2:** Rural retail shopkeeper		**Channel 3:** Urban open-air retailer		**Channel 4:** Urban retail shopkeeper		**Channel 5:** Urban supermarket	
Actor	Cost	Profit	Cost	Profit	Cost	Profit	Cost	Profit	Cost	Profit
Channel total (Ksh/bag)	435	1005	462	678	692	1648	764	1666	797	2893
Rural assembler (%)	50	14	44	48	31	9	28	9	27	5
Rural wholesaler (%)	26	78	23	49	17	20	15	20	14	5
Rural open-air retailer (%)	24	7	-	-	-	-	-	-	-	-
Rural retail shopkeeper (%)	-	-	33	3	-	-	-	-	-	-
Urban wholesaler (%)	-	-	-	-	34	24	31	13	-	-
Urban open-air retailer (%)	-	-	-	-	18	47	-	-	-	-
Urban retail shopkeeper (%)	-	-	-	-	-	-	26	58	-	-
Urban exporter/processor (%)	-	-	-	-	-	-	-	-	43	81
Urban supermarket (%)	-	-	-	-	-	-	-	-	15	8
Total (%)	100	100	100	100	100	100	100	100	100	100

Source: Market survey, 2006.



Source: Market survey, 2006.

Figure 6. Dry grain pigeonpea buying and selling prices of different agents (Ksh kg^{-1}).



Source: Market survey, 2006.

Figure 7. Dry grain pigeonpea marketing margins, total costs and profits of different agents (Ksh kg^{-1}).

The detailed computations for the marketing costs and net margins are given in Appendix 2. The distribution of total costs and net margins by channel for different players summarized in Table 9 show that the cost shares for a given agent generally vary by channel. For example, the cost shares to assemblers vary from 27% in the supermarket channel to 50% in the rural retailer channel. Similarly the profit shares to assemblers vary from 5% to 48% for the rural shops retail channel. While the cost

shares generally seem to reflect the profit shares for each participant, this was not always the case, indicating inequitable distribution of benefits to different players. For example, the supermarkets, which account for 43% of the costs in channel 5, obtain more than 80% of the net margins. Similarly the profit shares for the rural retail shops are very low (3%) compared to their overall cost share of 33%. The low marketing margins in the dry grain pigeonpea export chain and the high domestic prices explains why exporters have resorted to supplying the domestic market.

The high marketing costs incurred by the exporters is likely to result from the costs of oversight needed to comply with quality standards of their destination markets. In addition, exporters incur higher costs related to packaging and labelling. These costs amount to 22% of their total marketing costs. The low profits earned by urban wholesalers, in turn, arise from the high storage costs (58% of total marketing costs). Appendix 2 shows that the highest transportation costs are incurred by rural assemblers (34% of total marketing costs) and urban exporters (20% of total marketing costs). In general, the marketing costs for all participants are less than Ksh 350/bag compared to farmers' production costs of Ksh. 1760/bag.

The large price spread (i.e., selling price less buying price) between producers and consumers and also the large net marketing margins for some post-farm level participants in different channels is probably due to inefficiencies in the pigeonpea marketing system. This implies that: (1) opportunities exist for transferring a proportion of the margins to benefit the producers/farmers, and (2) domestic prices can be lowered by reducing marketing costs.

4.4.2 Processed pigeonpea (dhal)

The total costs and net margins by channel and the distribution of the same to different market players are given in Table 10. The detailed computations are in Appendix 3. The results show that the *dhal* market is the most lucrative, especially for supermarkets and exporters. Despite heavy investments in fixed assets (machinery), urban exporters earn substantially high profits. The processors account for 78% of the costs and 71% of the profits in the supermarket channel. Similarly, they also account for about 85% of the costs and profits in the export channel. This shows that the processors and exporters are the major players in the *dhal* market both in the domestic and international markets.

Table 10. Distribution of *dhal* total channel marketing cost and profits.

	Channel 1: Urban retail shopkeeper		**Channel 2:** Urban supermarket		**Channel 3:** Urban exporter	
Player	Cost	Profit	Cost	Profit	Cost	Profit
Channel total (Ksh/bag)	1502	3988	1502	4438	2153	1987
Rural assembler (%)	14	4	14	3	10	7
Rural wholesaler (%)	8	4	8	4	5	8
Urban exporter/processor (%)	78	79	78	71	85	85
Urban retail shopkeeper (%)	0	14	-	-	-	-
Urban supermarket (%)	-	-	0	22	-	-
Total (%)	100	100	100	100	100	100

Source: Market survey, 2006.

The high procurement costs incurred by urban exporters arise from the relatively high costs of cleaning and storage of *dhal*. Rural assemblers' high procurement costs, on the other hand arise mainly from high

costs of assembling and storing the dry grains. The supermarkets and urban retail shopkeepers do not incur any expenses in procuring *dhal* because their supplies are delivered directly to their premises by processors/exporters, usually in predetermined packaging materials and sizes. For all domestic traders, *dhal* represents only a small proportion of the total stock of grains traded. We therefore did not compute the actual retailing costs (i.e., personnel, rental, and utility costs). Nevertheless, marketing costs are still higher in domestic channels than the corresponding dry grain pigeonpea channels. At the same time, farmers' share in the final consumer price in each channel is smaller (less than 30%) than that of dry grain channels as shown in Table 7. The processors and partly the supermarkets therefore capture most of the benefits of value addition. It is unlikely that the farmers can capture any of these benefits unless they go into value addition, in particular cleaning the produce before sale. For this to work however, farmers would need to be paid a premium for performing the cleaning function.

4.4.3 Vegetable pigeonpea

The net margins for different players in the fresh vegetable pigeonpea supply chains are presented in Table 11. The detailed net return and cost computations for different market players irrespective of the marketing channels are given in Appendix 4. As in the case of dry grain, overall marketing costs are high, indicating possibilities of inefficiencies. Consequently, strategies that reduce these costs can boost farm-gate prices and create incentives for growers to adopt improved technologies. Table 11 shows that as in the case of processed pigeonpea, the export channel for vegetable pigeonpea has the highest marketing costs while the rural open-air retail channel has the lowest. The export channel has the shortest chain as exporters directly contract smallholder producers and procure the produce by themselves. Hence, the exporter accounts for 100% of the marketing costs and also profits. However, the exporters pay high prices to producers (about three-fold) compared to other buyers. This shows that under contractual arrangements smallholder producers can also capture some of the benefits of supplying quality products that meet export standards. The distribution of costs and profits along the other channels is also quite skewed. The assemblers account for one-third of the marketing costs in the rural retail channel, but only capture less than a third of the total profits in that channel. The rural retailers seem to make up the balance and control over 70% of the benefits. The same can be said for the urban retailers who account for about 20% of the channel marketing costs but capture about 60% of the profits. This pattern of distribution of benefits shows the level of mistrust among the different players and asymmetric information that prevails in these channels which amplify the inefficiency of markets.

Table 11. Distribution of vegetable pigeonpea total channel costs and profits.

	Channel 1: Rural open-air retailer		**Channel 2:** Urban open-air retailer		**Channel 3:** Urban exporter	
Player	Cost	Profit	Cost	Profit	Cost	Profit
Channel total (Ksh/bag)	137	2293	722	3958	18346	2062
Rural assembler (%)	66	27	12	16	-	-
Rural open-air retailer (%)	34	73	-	-	-	-
Rural wholesaler (%)	-	-	40	9	-	-
Urban wholesaler (%)	-	-	26	18	-	-
Urban open-air retailer (%)	-	-	21	58	-	-
Urban exporter (%)	-	-	-	-	100	100
Total (%)	100	100	100	100	100	100

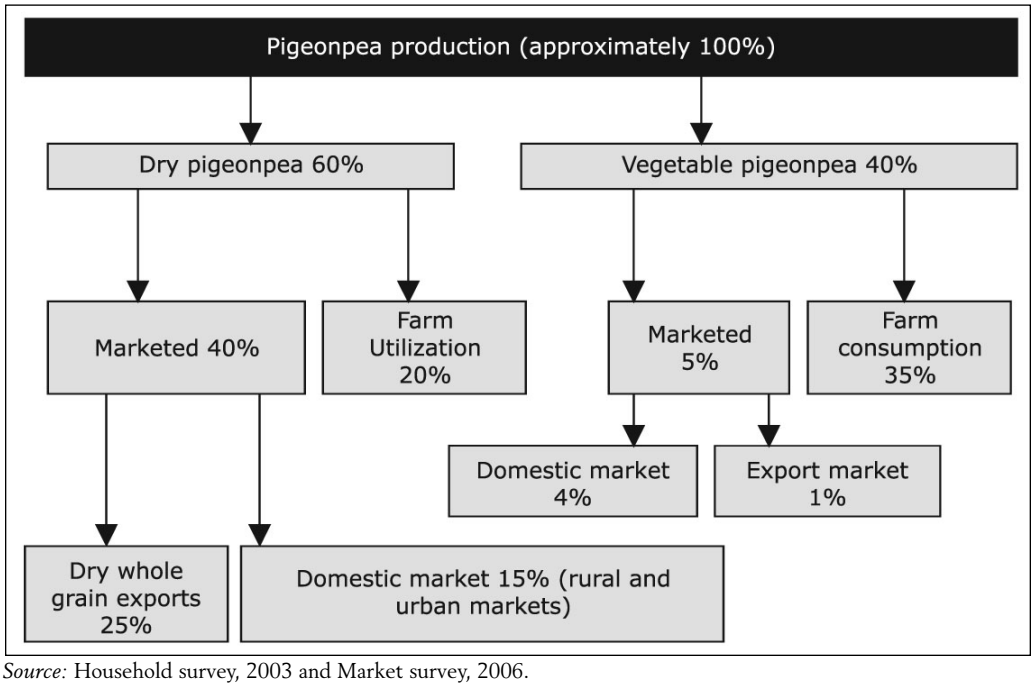
Source: Market survey, 2006.

The high marketing costs incurred by urban exporters arise from the high transport costs they incur in moving the produce to the buyer. It thus appears that marketing costs increase with stringency of quality requirements which may further explain why the producers' share of the final price is lowest in the export channel. Urban exporters also face logistical problems, namely (1) lack of cargo space and/or flights, and (2) unreliable supply during dry periods. At the same time, urban exporters incur high costs in monitoring their suppliers' compliance with the food safety requirements of their destination markets.

5. CONSUMPTION AND TRADE PATTERNS OF PIGEONPEA

5.1 Pigeonpea utilization

About 60% of the total pigeonpea produced in the country is dry grain, while the balance (40%) is harvested and consumed at the farm or marketed as vegetable pigeonpea. About two-thirds of the dry grain is marketed, while one-third is consumed at the farm. Under normal conditions, about 62% of the dry grain marketed is exported while the balance of about 38% is consumed within the country (Figure 8). A large proportion (87%) of the vegetable pigeonpea is retained at the farm for household consumption while the rest is marketed. Vegetable pigeonpea is mainly traded within the country, with exports amounting to less than 20% of the traded volume. Pigeonpea is consumed in many forms though mostly as a complement in cereal-based diets in many parts of Kenya particularly in the eastern, central, and coastal provinces. Most farm households consume pigeonpea as green peas because of its taste and ease of cooking (Ronno 2000, Mergeai et al. 2001). The green peas are boiled to make stew that is eaten along with rice or *chapati*. Pigeonpea are also widely consumed as boiled whole grains. Including amount consumed beyond the farm, about 70% of the total produce is consumed within the country (Figure 8). This implies that pigeonpea has a large domestic market, especially if pigeonpea prices can be more competitive in comparison with prices of other close



Source: Household survey, 2003 and Market survey, 2006.

Figure 8. Pigeonpea utilization in Kenya.

substitutes like beans, green gram and cowpea. Local consumption (especially of *dhal*) can be further increased if cheaper means of local processing can be identified and adopted

Dry pigeonpea grain is also boiled alone to make stew which is used as a side dish just as in the case of green peas. The grains can also be boiled together with maize grain and eaten as popular dishes locally known as *muthokoi* in eastern Kenya or *githeri* in central Kenya. There is very little processing of dried grain before it is cooked because many rural households are either unaware of or cannot afford improved processing methods and equipment. In general, pigeonpea consumption varies according to local preferences, income level, ethnicity, and between urban and rural populations. The low-income urban buyers consume it mainly as dry grain. The dry grain consumers comprise the largest market outlet for pigeonpea in urban areas. Vegetable pigeonpea is also becoming increasingly popular among medium- and high-income urban consumers. Only small quantities of pigeonpea are consumed in urban areas as *dhal*, mostly by the Asian communities (Lo Monaco 2003).

Kenya has a significant potential for developing the vegetable pigeonpea economy for both domestic consumption and for exports. Increasing availability of short- and medium-duration pigeonpea cultivars means that seasonality of vegetable pigeonpea production can be reduced substantially, making it possible for traders to have consistent supply of good quality products over an extended period of time. As indicated above, although approximately 40% of the total pigeonpea production is utilized as vegetable pigeonpea, only 5% is marketed. The rest is consumed in the farm. A small proportion of the total marketed vegetable pigeonpea is exported and the volume of trade highly variable.

5.2 Pigeonpea trade

As discussed in earlier sections, both dry grain and vegetable pigeonpea are marketed in both domestic and export markets. Previous studies (Freeman et al. 1999, Muricho 2002, Murage 2003) indicate that there exists a vibrant domestic, regional and export trade of dry grain and an emerging market for vegetable pigeonpea. Domestic trade arises from both the demand for *dhal* from the Asian community and for whole grain pigeonpea from the Kikuyu and Swahili communities, none of which are major growers of the crop. The main producers (Kamba, Mbeere, Embu) also consume substantial amounts locally. This domestic market accounts for over 30% of the dry grain pigeonpea marketed while the rest of the marketed volumes (70%) end up in the export markets. As indicated above, only a limited proportion of vegetable pigeonpea production is exported (Figure 8).

One of the major limitations to export trade is the high domestic prices, which reduce the competitiveness of Kenyan exports. Vegetable pigeonpea exports are also affected by expanding domestic demand and high farm-level consumption. This survey found that most traders are not able to get consistent volumes for export due to limited supplies and competition with local markets. The problem is exacerbated by bad weather (especially drought). In some cases, processors/exporters and wholesalers are forced to import dry pigeonpea from Babati district in Tanzania, to meet shortfalls in domestic production.

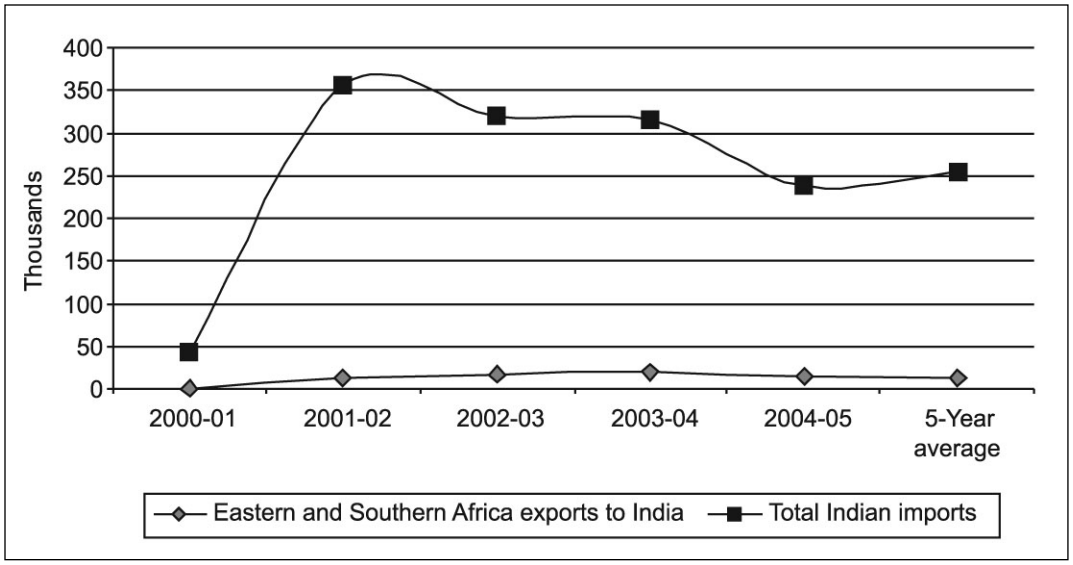
Data on the volume of regional pigeonpea trade is not available because most of this regional trade is in the form of undocumented informal cross-border trade. Regional trade in pigeonpea is largely driven by variability in local production. Although pigeonpea is drought tolerant, surplus production is dependent on receiving minimum sufficient rainfall for planting and during the critical stages of plant growth. Insufficient rainfall and local deficiencies often induce regional trade, with Kenyan traders travelling to northern Tanzania (e.g. Babati district) to purchase the grain. Therefore, Kenya has become an important regional market for dry grain pigeonpea, driven partly by lack of processing capacities in the neighboring countries, and higher prices in Kenya.

India is the major importer of Kenyan dry pigeonpea grain. It is estimated that annual demand for pigeonpea in India is about 2.6 million t (1996-98 average), whereas production is only about 2.45 million t. India therefore has to import whole grain pigeonpea to meet the annual shortfall of about 0.15 million t in domestic production. However, the size of this demand fluctuates from year to year, depending on domestic production in India (Jaeger 1998, FAOSTAT 2004) and has been fluctuating from 50,000 t to over 350,000 t in the last 5 years (Figure 9). Eastern and southern Africa has been supplying only 5% of the total Indian imports while Myanmar accounts for over 90% of the total Indian pigeonpea imports (Table 12). Though reliable data is not available, it is argued that 90% of Kenyan exports of dry grain pigeonpea go to India[8]. Unlike the dry grain, vegetable pigeonpea is mainly exported to European markets. Both availability and quality are major limitations in expanding this market.

Table 12. Dry grain pigeonpea (yellow pea) exports to India (t).

Country	2000-01	2001-02	2002-03	2003-04	2004-05	Average
Malawi	215	0	258	489	603	**313**
Mozambique	0	0	129	0	1,988	**423**
Tanzania	0	8,254	14,513	15,573	10,600	**9,788**
Kenya	0	2,541	1,369	1,720	0	**1,126**
Ethiopia (Yellow pea)	0	20	77	105	0	**40**
Mauritius	0	0	0	100	0	**20**
Eastern & Southern Africa	215	10,815	16,346	17,987	13,191	11,711
Total Indian imports	43,459	354,176	320,555	314,919	238,305	254,283

Source: Indian foreign trade journal (1999–2005).



Source: Indian foreign trade journal (1999–2005).

Figure 9. Dry grain pigeonpea exports and imports in India (t).

[8] The Kenya Revenue Authority (KRA) does not maintain data on pigeonpea import and exports. The closest entry available is for "peas" which is an aggregate category that includes several other pulses.

Dhal is exported to the UK and USA, but high raw material costs limit the competitiveness of pigeonpea processors in international markets. As discussed earlier, the future of *dhal* exports will depend on price differences in the domestic and export markets. Most commonly *dhal* sells at higher price in the domestic market (urban retail shops and supermarkets) than export market, although the latter accounts for a majority of *dhal* sales. The high domestic prices could create greater incentives for exporters to divert the commodity into domestic markets. However, the nature of the domestic market might not sustain such strategy long into the future for two reasons. First, although the actual size is unknown, the domestic market for *dhal* is thin and is unlikely to expand substantially to absorb future growth in *dhal*. Second, prices in the domestic market are quite volatile; hence an export-oriented strategy could help stabilize prices. The major limiting factors and determinants of pigeonpea export trade are discussed fully in the next section.

5.3 Determinants of export trade

The export of whole grain pigeonpea from Kenya has grown from about 500 t in the early 1990s to about 5400 t during the 2001–2003 period (Table 13). Several factors have contributed to the growing pigeonpea export trade between India and eastern Africa (Jones et al. 2002). These include (1) absence of export bans because the crop is not considered to be of strategic importance for national food security; (2) local harvests take place slightly before the Indian harvests, which gives traders a chance to take advantage of higher prices at the end of the Indian season; (3) pigeonpea productivity in India has not kept pace with domestic demand; (4) very low (5-10%), sometimes even zero, import duty on pigeonpea into India; and (5) lower freight charges to India. The East African region also has the potential to exploit the Indian market opportunities as the latter does not discriminate strongly on quality and thus the small producers are able to meet the fair average quality standard accepted in this market (Jaeger 1998). Owing to the growing population, the deficits in India are projected to grow in future, and these are expected to open further opportunities for African farmers to benefit from commercial production of this crop. Furthermore, positive market growth indicators of rising incomes and the continued dominance of vegetarian diets indicate better opportunities for pigeonpea export growth. These dietary considerations are likely to lead to increases in per capita consumption of legumes, which have higher income elasticity of demand than cereals.

Table 13. Exports of dry pigeonpea whole grain from Kenya.

Year	Dry grain export (t)
1992-94	526
1995-97	361
1998-00	4251
2001-03	5430

Source: FAOSTAT, 2004.

Many countries in eastern and southern Africa have, however, not been able to exploit the Indian market more fully because of inconsistency and variability of domestic production. For example, importers in India seek volumes of about 15,000–20,000 t per year from eastern Africa but this volume is often not readily available (Lo Monaco 2003, Table 12). Trade policies pursued by India also facilitated pigeonpea trade between African countries (including Kenya) and other importing countries. In the past, the

Indian government had prohibited export of *dhal*, while simultaneously levying import tariffs of up to 35% on imports of both pigeonpea grain and *dhal* in order to protect the domestic industry. This policy made the Indian market unattractive for pigeonpea grain and *dhal* exporters, thus providing the impetus for processors/exporters from the eastern African region to explore other global markets. The search for alternative markets in turn led to the development of processing industries in the region. The Indian pigeonpea import duty policy has also been changing over time depending on the local/domestic production levels. Since the early 1990s the import duty has been oscillating between 5% and 10%, and is sometimes completely scrapped when there are shortfalls in domestic production.

Kenya's trade in vegetable pigeonpea with UK has been possible because of the availability of short-duration pigeonpea varieties. There is also a potential for exporting fresh and frozen green peas to other European countries where demand is driven by: (1) dietary factors and health concerns, and (2) shift in consumer preferences from animal to plant-based protein and fresh vegetables. The shift towards consumption of fresh or frozen vegetable pigeonpea is expected to grow even further, providing more opportunities for export expansion.

5.4 Constraints in the export trade

A number of constraints continue to hinder Kenya's increased participation in the export market. These challenges include: (1) expansion of pigeonpea production by Myanmar, a major exporter of whole-grain pigeonpea to India. Myanmar, accounts for over 90% of India's imports and is a lower cost exporter than Kenya (Lo Monaco 2001). The unit costs of developing, monitoring, and enforcing contracts for Indian importers also seem to be lower with Myanmar than with African exporters; (2) several countries including USA, Canada, and France have identified the opportunity to export other pulses to India at much lower costs, and (3) high domestic prices and procurement costs in Kenya reduce the propensity to exploit the export markets, particularly with regard to *dhal* (Freeman et al. 1999).

The threat to Kenyan pigeonpea exports is not limited to the Indian market, but includes other emerging higher-value markets, particularly the USA, Canada, Europe, Middle East, and South Africa. It is difficult to ascertain the aggregate demand from these markets due to lack of reliable data on price elasticities and food consumption patterns. The most consistent estimate of the east African trade data with Europe is between 3000 and 5000 t per year comprising both whole grain and *dhal*. The demand from North America is estimated to be of the same magnitude (Jones et al. 2002). In these markets, import demand is driven by demand from immigrants from the Indian sub-continent.

Exports to these markets are driven by the higher and relatively more stable prices offered compared to the traditional Indian export market (Freeman et al. 1999). The problem of access to these markets is due to high quality standards and continuing pro-export reforms in the Indian pigeonpea subsector. These reforms include removal of the ban on export of *dhal*, and extension of tax incentives to exporters (Jaeger 1998). These incentives are not available to Kenyan processors and may continue to make it difficult to compete effectively in international markets.

The vegetable pigeonpea export potential in Kenya is limited by a number of demand-and-supply side factors including: (1) inconsistent and insufficient supply; (2) limited investments in postharvest handling and packaging to ensure quality; (3) lack of direct flights to destination markets and/or enough space on the flights; and (4) insufficient market research to understand consumer preferences and exploit existing and potential niche markets. The variability in supply is caused by unreliable rainfall patterns in the semi-arid areas where the crop is grown. In years of drought, most other food

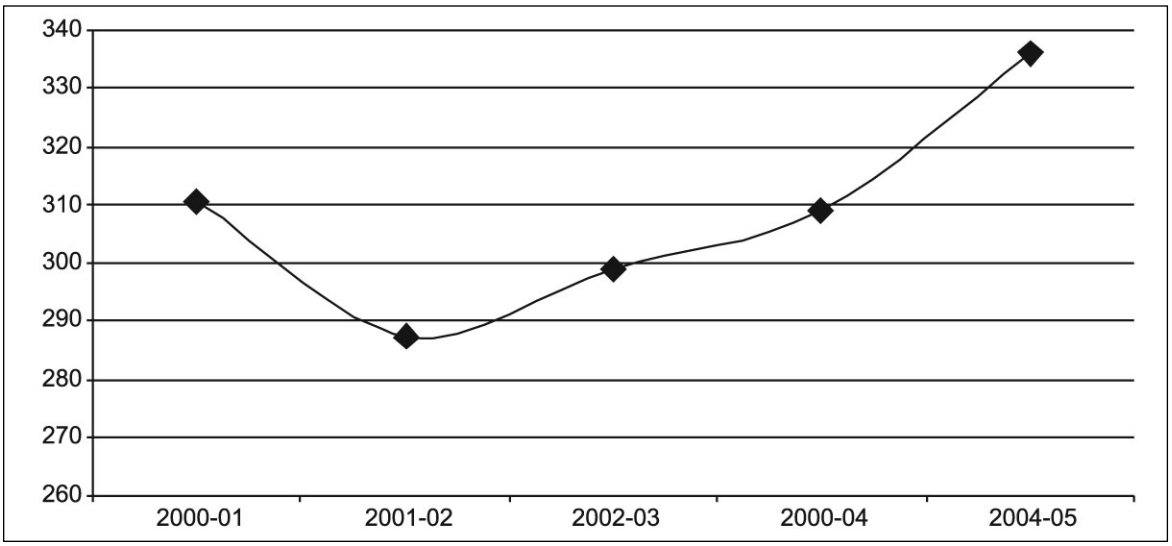
crops fail and households rely heavily on pigeonpea for their subsistence, seriously cutting back their supplies. The unreliability of supply reduces incentives for traders to enter into contracts with farmers growing the crop under rainfed conditions. Developing this subsector would require investments in supplementary irrigation to expand the volume, quality, and reliability of supplies in the production of vegetable pigeonpea.

5.5 Price trends in international markets

The reference prices for dry grain pigeonpea in international trade are the border prices in India, which are generally lower than the Indian domestic prices. These prices rose for two decades and stabilized during the 1990s at CIF prices Mumbai at US$350-400 t^{-1} (Mehta and Srivastava 2000). During years of drought and low domestic production, the prices rose to US$ 400 t^{-1} (wholesale import parity price, Delhi). The price hike is often driven by production shortfall in India's main pigeonpea-producing and consuming states of Maharashtra, Karnataka, and Gujarat.

In 2003/04, pigeonpea prices fell to less than US$ 290 t^{-1}, which was well below the long-term average of US$ 350-400. The fall was attributed to the surge in exports from Myanmar and the increase in India's import of yellow pea (*Pisum sativum*), which is a substitute for pigeonpea, thus considerably reducing pigeonpea demand in India. However, prices have steadily picked up since 2002 to over US$ 330 t^{-1} by the year 2005 (Figure 10). This could have been due to low production in India, which prompted the Indian government to extend the zero import duty on pulses until 2007 (Higgins 2006).

The seasonal variation in pigeonpea prices in India also affects world market prices. These seasonal price variations are a major factor in determining the competitiveness of Kenyan pigeonpea exports. In India, pigeonpea prices are lowest in March-April, begin to rise from July onward, and peak at around November-December. In Kenya, pigeonpea is harvested during August and September, and the marketing season thus coincides with a period of relative shortage and high prices in India. This means that Kenyan pigeonpea exports to India could enjoy a significant, though temporary, price advantage. The ability to exploit this export window opportunity will determine future competitiveness of Kenyan and other African exporters (Lo Monaco 2003).



Source: Indian foreign trade journal (1999–2005).

Figure 10. Pigeonpea CIF import price in India (US$ t^{-1}).

5.6 Export parity price of pigeonpea in Kenya

The export parity price provides an indication of the price at which a country has to trade at the border to maintain its competitive position in the global markets. The parity price for each exporting country is calculated by factoring in the costs of export operations into the price at the port of the importing country (cost, insurance, and freight – CIF price). In the case of pigeonpea trade between Kenya and India, the cost of freight and insurance is deducted from the Indian border price (CIF price) to arrive at the export parity price at the Kenyan port of export (Mombasa), i.e., free on board (FOB) price. Analogously, factoring in the relevant costs at any of the links of the marketing chain, the competitive threshold prices can be determined at each point along the pigeonpea supply chain. A systematic analysis of the cost structure is a prerequisite to implement this model. The major elements taken into account in computing export parity price are the costs of processing, transport, and other marketing costs at each point in the supply chain.

Appendix 5 presents the export parity price for pigeonpea exports to India. The parity prices were computed based on CIF price of Mumbai since India is the leading importer of pigeonpea and also imports almost 90% of Kenyan pigeonpea. Table 14 compares the export parity price and actual prices received by different intermediaries in the pigeonpea supply chain. It shows that all the market participants in Kenya receive prices that are higher than their equivalent export parity prices. All the intermediaries (including some rural retailers, supermarkets and other urban retailers) get a price greater than the export parity price. The price received by the smallholder farmers is however less than its equivalent export parity price. These findings corroborate the argument that high domestic prices have undermined the ability to harness export market opportunities. This implies that there exists an opportunity to profitably link the producers to the export markets and/or transfer part of the high margins that the post-farm traders earn to the benefit of small producers without necessarily increasing consumer prices. The high margins received by traders can also be lowered by shortening the supply chain, hence enabling farmers to capture some of these benefits. Given that pigeonpea has a high price elasticity of demand, lower consumer prices may translate into increased demand relative to its close substitutes like beans, green gram, and cowpea.

Table 14. Export parity price and actual price received by various dry grain pigeonpea participants in Kenya (Ksh t^{-1}).

Market participant	Export parity price	Actual local price received	Difference (%)
Exporter/processor	22,047	35,688	62
Urban supermarket	18,200	60,077	230
Urban wholesaler	19,436	34,067	75
Urban open-air retailer	18,024	44,525	147
Urban retail shopkeeper	17,224	45,833	166
Rural wholesaler	20,769	34,900	68
Rural open-air retailer	19,602	40,833	108
Rural retail shopkeeper	18,969	31,765	67
Rural assembler	18,380	27,000	47
Farmer	18,380	16,818	-8

Source: Computed from Appendix 2; Appendix 5.

5.7 Pigeonpea quality issues in domestic and international markets

There are no established quality grades and standards for pigeonpea in Kenya. Quality is therefore subjectively measured by physical inspection. This makes it difficult to describe and compare with precision the quality supplied by different traders/market participants. The market for pigeonpea is mainly characterized by fair, average quality (FAQ) grain with the major quality parameters considered being grain insect damage, foreign matter, moisture content, grain color, and size. However, as the grain moves through the different market participants in the supply chain, each agent tries to improve its quality on the basis of the above physical attributes. Due to lack of standardized quality grades, there is no visible price differentiation based on quality. Those with a superior quality product have only the advantage of being able to sell their product faster. For more commercialized agents like the processors/exporters who possess cleaning equipment, foreign matter is not a major consideration when procuring the grain because they routinely clean the purchased grain before processing. Therefore the most underlining factor, once FAQ standards are met, is the grain price. Indeed, a recent study (Shiferaw et al. 2006) found that farm-gate grain prices do not depend on quality aspects. Some buyers prefer particular seed sizes of pigeonpea. Most processors prefer large grains because they yield more (70% of the original weight) when milled into *dhal*. However, local processors do not pay a price premium for large grains.

The absence of price discrimination based on grain quality has reduced incentives for farmers to produce and market quality grain. This is a major challenge for targeting high-value markets (such as Europe and North America) that require differentiated and quality products. However, absence of quality grades is not limited to Kenyan markets. The only universal grade in India, the world's largest market for dry grain pigeonpea, is FAQ. Just like in Kenya, FAQ grade in India is not standardized since it is based on subjective visual observation and trading practices. It is argued that most of the price variation is attributed to market supply conditions rather than quality differences (Price et al. 2003). However, a few importers in India use foreign grading systems if they are importing from countries that utilize such standards e.g. US and Canada. The absence of harmonized quality standards is probably a reflection of the relatively low incomes and highly price sensitive Indian consumers. Another reason for preference given to FAQ grain imports is that the cost of cleaning the grain in India is much lower than in the exporting countries (Price et al. 2003).

Interestingly, the east African dry grain pigeonpea is sometimes traded at a premium price that goes above the average prices in the international markets. A price premium of of about US$ 50 t^{-1} over the average market price is given to the Tanzanian product while Kenyan pigeonpea receives a price premium of about US$ 30 t^{-1} (Lo Monaco 2003). This preference for east African pigeonpea is closely associated with its desirable attributes, namely its attractive cream color and large grain size. Part of this price premium reflects the lower processing costs associated with the eastern African grain compared to the Myanmar crop. The ICRISAT-improved long-duration variety, ICEAP 00040 recently released in Kenya and now widely grown in Babati district of Northern Tanzania embodies these important market-preferred quality traits. Why then don't local traders offer price premium for these traits? It is likely that this failure to reward quality is due to opportunistic behavior on the part of traders. However, as domestic and international consumers demand high quality standards, the importance of quality in determining prices and trade flows is projected to increase.

Nevertheless, the export market for vegetable pigeonpea is very strict on quality and only accepts one grade, i.e. above average, on all the parameters used. Uniformly green pods free from insect damage and foreign matter are considered for this particular market. The export market is also very strict on the size of the pods with preference being given to pods not more than 5cm long and not overgrown (still

tender). Because the export market is also strict on maximum residue levels (MRLs), the exporting companies have their staff in the field advising selected contracted and noncontracted farmers on how and when to spray and harvest their crop so that they can meet these stringent minimum quality standards for the market. There is only one grade in this market—only pods meeting the minimum standards are bought at one uniform price. Any of the produce below the set standards is rejected and returned to the producer or the trader who supplied it. Only pods that satisfy the minimum standards set by the buying agent are packed for export.

The local markets for vegetable pigeonpea do not, however, pay any price premium though they also prefer uniformly green pods with no insect damage. They are not very keen on MRLs probably as they do not have a mechanism to assess this. Traders buy the best quality pods first before subsequently buying the low quality at the prevailing market price depending on the quantities supplied in the market. No price premium is paid for a high-quality batch.

6. POLICY AND INSTITUTIONAL ASPECTS

A number of policy and institutional factors also affect the commercialization of pigeonpea production. In this section we discuss some of these factors and suggest the way forward.

6.1 Policy and institutional overview

For the pigeonpea subsector to remain competitive and to take advantage of the growing demand for pigeonpea in the domestic and international markets, productivity needs to increase, production be timed, marketing costs reduced, and quality, grades and standards established. These policy issues fall within the realms of different stakeholders (i.e., national government, private sector, researchers, extension workers, and traders), and suggests the need for greater collaboration. Currently, these stakeholders are acting largely independent of each other. Researchers and extension staff rarely interact with the private sector, leading to a situation where neither producers nor the private sector benefit from investments made in development of new pigeonpea technologies.

Researchers often solicit the participation of farmers in development of technology. However, the main constraint has been the lack of participation of traders, processors, and exporters in technology development. Such linkage can enhance farmers' ability to respond to market requirements, both in terms of quality, quantity, and timing of supply. Therefore, researchers working with farmers and extension agents can effect changes that will enable local supply to respond to both domestic and export market demand by developing strategic partnerships with market players and policymakers.

6.2 Production planning and market linkages

Pigeonpea production in Kenya is geographically localized. More than 90% of the farmers grow the crop in the producing areas and sell about 60% of their produce. The international pigeonpea market is dominated by India, the leading producer and consumer. In the short to medium term, expansion of pigeonpea production in Kenya will depend on exploitation of international markets, particularly India, where demand is growing, being driven by its growing population and increasing incomes. Kenya can greatly benefit from focusing on international markets because domestic consumption of dry pigeonpea is limited and volatile (Rusike and Dimes 2004). This will however entail increasing the crop productivity to improve the consistency, quality, timing, and volumes supplied.

The major determinants of competitiveness in the Indian pigeonpea market are timing and price. Price is considerably pegged to marketing costs. Kenya's competitive advantage therefore lies in taking advantage of the August-September window when demand in India is high due to low supply. In order to do so, Kenya needs to focus on early-maturing varieties of pigeonpea to enable the product to reach the Indian market in October/November.

Supplying at the right time is necessary but not sufficient to capture this market. The price should also be competitive as there are alternative legumes, particularly chickpea supplied from Canada and Australia and also yellow pea, which can be substituted for pigeonpea (Rusike and Dimes 2004). Therefore the long-term strategy for expansion of trade with India and other exporters will require that Kenya increases productivity and also adopts marketing strategies that lower marketing costs. In addition, pigeonpea marketing is based on a form of forward marketing whereby exporters seek confirmation of orders with specified prices beforehand. When domestic prices are high, exporters shun export markets because prices tend to be uncertain and volatile in India.

Poor and undeveloped physical and marketing infrastructure remain the major reasons for high marketing costs in Kenya. Reducing Kenya's high marketing costs and achieving long-term expansion in production can therefore greatly lower the transaction costs and spur commercialization. Transaction costs along the pigeonpea supply chain can be lowered by shortening the length of the marketing chain. Reduction in marketing costs can lower domestic prices and make Kenyan pigeonpea competitive in international markets. This can be achieved by lowering of production costs.

Another way of minimizing marketing costs and hence lowering domestic post-farm-gate prices may entail utilizing forward contracts instead of spot market purchases. Such contracts could help shorten the supply chain; reduce inspection costs, and hence increase farmers' margins. Contracts also permit development of quality grades, product differentiation and value addition. They also enable exporters to secure larger volumes of uniform products and therefore economies of scale during assembly, storage, processing and transportation. The use of contracts to promote commercialization of smallholder production has been successfully tried in Tanzania and Kenya through producer marketing groups. Farmers in such groups have been able sell their pigeonpea in niche markets at higher prices (Massawe 2001, Shiferaw et al. 2006).

Contracting is not a new concept in the Kenyan agricultural sector. Asian vegetable (and to some extent vegetable pigeonpea) growers for export and domestic markets have been organized into contracted production and marketing groups and linked to high-value markets. In the pigeonpea-producing districts, such arrangements have been facilitated by international NGOs such as Care-Kenya and Action-Aid Kenya. These organizations link farmers to exporters and even facilitate drawing up of formal contracts between farmers and buyers (Muricho 2002). Such arrangements facilitate more direct exchange between farmers and the buyers by eliminating some of the intermediaries (e.g., rural assembler), therefore helping reduce transaction costs and increasing farmers' margins.

While producer groups prefer contracting because it reduces transaction costs related to searching, screening, and negotiating contracts with smallholder farmers, the latter often face high transaction costs in organizing themselves into large associations for collective bargaining. In order to reduce market failures in many rural marginal areas, public investments are needed to help farmers form associations, strengthen their bargaining power, help control collusion and market power among exporting firms, and make seed and other inputs available at competitive prices (Shiferaw et al. 2006).

6.3 Seed access and productivity

Increasing pigeonpea productivity and grain quality will require formulation of strategies that ensure availability and farmers' access to and adoption of improved seed. Adoption of improved seed will significantly increase productivity. Evidence from the green revolution in Asia suggests that one of the key components to achieving a sustained and significant increase in food production is the availability and use of quality seed, particularly of improved varieties. Investments in seed development and distribution also call for output markets that are prepared to absorb surplus grain at competitive prices.

In formulating strategies to increase farmer access to improved seeds it is important to pay attention to demand side factors as well. The development of a commercial seed markets however requires, at a minimum, the presence of commercial grain markets (Tripp 2000). It is unreasonable to expect a commercial seed sector to emerge in areas where the grain market is poorly developed. In addition to working with farmers in testing/evaluation and selection of improved varieties, strategic partnerships with traders, processors, and consumers are needed to ensure that identified technologies are market friendly. Such partnerships can be forged by soliciting the participation of traders, processors, and consumers in technology development and by identifying and establishing quality standards. Introduction of simple and easily administered quality standards based on end-user needs would assist farmers, traders, and exporters benefit from niche markets that demand higher quality standards and offer better prices.

Demand for improved seed is stimulated by opportunities to sell these crops, and by markets that reward grain quality and type. Establishing a viable seed supply system in Kenya will require innovative institutional arrangements in the distribution of pigeonpea seed. Such arrangements include small packs, and contracting seed companies and farmer organization to bulk the seed.

Pilot marketing of small seed packs in several countries in the region has shown that farmers are willing to purchase profitable improved seeds at competitive prices. However, once they have the new germplasm, they tend to save their own seed rather than return to the market for the pure stock. This eventually leads to loss of varietal integrity and vigor and also discourages the private sector in seed distribution. Improving the distribution of improved seeds will therefore require providing incentives (.e.g., capital and loan guarantees) to the private sector, especially the rural-based small agrochemical dealers (agro vets). Promoting awareness among farmers about the loss of varietal vigor associated with recycling of saved seed for many generations can also increase demand for pure stocks.

Furthermore, development of large-scale public and private commercial seed enterprises and regulatory bodies need to be complemented by an increased understanding of the role of informal channels in areas where markets are underdeveloped. This calls for the government to deregulate specific segments of the seed industry and recognize the informal sector as an important low-cost source of quality seed. It can then use the informal seed sector as a vehicle for providing resource-poor farmers with quality seeds of modern varieties at affordable prices. Incorporating the informal sector in the seed supply system will require:

- Facilitating access to foundation seed by farmer groups and capable NGOs and others to multiply
- Providing extension advice on seed production, processing, treatment, and storage to selected farmer seed producers and agro-dealers
- Developing a legal framework that permits marketing of certified and uncertified seed of acceptable genetic purity and germination quality

7. CONCLUSIONS AND RECOMMENDATIONS

This study assessed the technological and market constraints and opportunities in the pigeonpea subsector in Kenya and defined key areas for priority intervention at different levels. The key issues and policy recommendations are summarized below.

7.1 Farm-level issues

The pigeonpea subsector in Kenya provides an opportunity for enhancing food security and increasing incomes for smallholder farmers. Since the domestic market is limited and volatile, long-term potential for growth of the sector lies in the exploitation of the international export markets. This will however require increased utilization of improved technologies to enhance production, productivity, and quality of the grain, and also restructuring of the current marketing system in order to lower post farm-level transaction costs so as to make pigeonpea production competitive in international markets.

Exploiting the export market opportunities will require collaboration between researchers, extension agents, processors/ traders, and consumers. Collaboration among various players is essential to promote continued testing selection of new promising lines that embody farmer and market preferred traits, and the adoption of such varieties. Past farmer-participatory research has ignored the role of demand-side factors by assuming that farmers will either adopt improved technologies purely for subsistence production, or farmers will automatically find attractive markets for their produce. Incorporating demand-side factors in technology generation requires soliciting the participation of traders/processors and consumers. Many of the existing improved pigeonpea varieties were selected for higher productivity and better grain quality for desired market traits to increase demand in domestic and international markets. Harnessing this opportunity calls for policy options and strategies that improve the seed supply systems and institutional arrangements that enhance market access for small producers.

7.2 Marketing issues

The pigeonpea marketing system in Kenya involves many intermediaries. These intermediaries convey the product, usually with minimal value addition (e.g. cleaning). While wholesale prices are generally high, farm-gate prices remain quite low and less competitive. Smallholder farmers produce only small surplus for markets, which is typically sold at the farm gate to rural grain assemblers often soon after harvest when prices are very low. Farmers face high transaction costs in marketing their small produce. Reorganizing this system by helping farmers develop viable marketing groups can reduce transaction costs and enable farmers to take advantage of economies of scale by consolidating buying and selling activities. Such farmer groups can also use forward marketing contracts to sell their products hence allowing access to reliable markets. This will require strengthening the capacity of the already existing farmer groups through training in group dynamics; management, analyses, and utilization of market information; and running the groups as viable business entities. Where farmer groups do not exist, farmers should be trained in group formation, collective marketing, and agribusiness skills.

Group marketing also benefits traders/processors since large volumes sold by groups reduce average procurement costs. Groups can also serve as entry points for building farmer capacity in introducing grades and standards. Group marketing therefore presents an avenue for increasing the productivity

and competitiveness of pigeonpea and an opportunity to exploit international markets for processed pigeonpea. The increased demand for export of processed grain to high-value markets could improve market prices for suppliers at the bottom of the supply chain and create incentives for smallholder farmers to adopt improved and high quality seeds.

7.3 Key policy issues

In order to revitalize the pigeonpea subsector and improve opportunities for tapping existing and emerging technological and market opportunities, Kenya needs to consider the following policy options:

- Review national policies guiding new variety testing and approval for release so as to reduce delays in accessing new germplasm in order to effectively respond to market demands. Avoidance of unnecessary delays and fast-tracking promising varieties tested in similar environments will enable farmer's access new cultivars more quickly.
- Develop policies and legal framework that promote and support contract farming and improve incentives for regular and consistent supply of quality grain. Future strategies should include promotion of forward market contracts between farmer groups, traders, and other market participants along a shortened commodity value chain.
- Enhance strategic linkages among researchers, farmers, extension agents, and traders/processors and also promote collective marketing of pigeonpea. Fostering of group marketing activities will require public and/or private sector investment in strengthening rural institutions for mobilizing farmers into groups/associations, enhancing their agribusiness skills, and developing forward (output) and backward (input) market linkages. Farmers will especially take advantage of collective action to improve their bargaining power. Government support is needed in establishing the institutional infrastructure and enabling policies to strengthen farmer organizations.
- Strengthen seed supply system by building the capacity of the formal seed system to multiply and distribute improved pigeonpea seeds while also enhancing the role of informal seed distribution system. This will entail de-regulating specific segments of the seed industry and recognizing the informal sector as an important low-cost source of quality seed to resource-poor farmers. Enhancing the capacity of informal seed distribution system is especially important for access to improved seed by small farmers and can potentially increase adoption, and hence, productivity of pigeonpea.
- Increase public investments in agricultural research to exploit emerging opportunities (e.g. hybrid pigeonpea) and address disease and pest problems that continue to undermine the productivity of the crop. Such investments are likely to facilitate the development of varieties that meet different end-user needs standards in domestic, regional, and international markets.

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APPENDIXES

Appendix 1. Rapid market survey sample size.

Marketing agent	Vegetable pigeonpea	Dry grain pigeonpea	Total
Rural assembler	2	4	6
Rural wholesaler	2	4	6
Rural open-air retailer	1	2	3
Rural retail shopkeeper	0	5	5
Urban wholesaler	1	4	5
Urban open-air retailer	2	4	6
Urban retail shopkeeper	0	4	4
Urban processor/exporter	2	3	5
Urban supermarkets	0	4	4
Total	10	34	44

Appendix 2. Cost and revenues for dry grain pigeonpea market participants.

Marketing costs/returns per (Ksh/90 kg bag)	Rural open- air retailer	Rural retail shopkeeper	Rural assembler	Rural wholesaler	Urban wholesaler	Urban exporter	Urban supermarket	Urban retail shopkeeper	Urban open-air retailer
Buying price	2745.00	2192.14	1513.64	2250.00	2596.80	2643.43	4245.00	2902.50	3140.25
Selling price	3675.00	2858.82	2430.00	3141.00	3066.00	3211.94	5406.92	4125.00	4007.25
Marketing margin	930.00	666.68	916.36	891.00	469.20	568.51	1161.92	1222.50	867.00
Transport from seller	0.00	5.00	29.09	11.11	31.33	0.00	0.00	64.00	80.00
Seller search cost	0.00	0.00	0.00	0.00	0.40	0.00	0.00	1.20	0.00
Payment to buying agents	0.00	22.50	73.64	27.78	0.00	0.00	0.00	0.00	0.00
Cleaning labor	0.00	11.50	3.27	8.89	8.00	42.86	1.33	40.00	0.00
Storage cost	0.00	26.43	39.91	11.78	136.00	42.29	0.00	8.30	2.25
Loading/offloading charges	0.00	3.21	2.18	4.44	14.80	10.29	0.00	0.00	0.00
Watchman costs	12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Council charges	75.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weight loss after cleaning	0.00	75.00	6.18	18.78	25.71	66.81	103.33	59.98	30.73
Total dry pigeonpea buying costs	87.50	143.64	154.27	82.78	216.24	162.24	104.66	173.48	112.93
Transport to buyer	0.00	1.76	44.44	20.00	0.00	67.06	0.00	0.00	0.00
Buyer search cost	0.00	0.00	0.00	0.00	0.00	36.24	0.00	0.00	0.00
Packaging and labeling	17.75	16.93	16.62	11.75	19.07	76.76	15.42	25.09	14.25
Customs clearance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Payment to agents	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bank charges	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total dry pigeonpea selling costs	17.75	18.69	61.06	31.75	19.07	180.06	15.42	25.09	14.25
Total cost	105.25	162.33	215.33	114.53	235.31	342.30	120.08[a]	198.56	127.23
Net marketing margins	824.75	504.35	701.03	776.47	233.89	226.21	1041.86[b]	1023.94	737.77

a) These costs were reported by two supermarkets out of the four supermarkets included in the sample. These two do not buy the grain from processors but instead buy from urban wholesalers and then clean, package and label the grain themselves. However, leading supermarkets like Nakumatt and Uchumi buy their pigeonpea directly from urban processors in well-packaged and labeled form.

b) These profits are just indicative because other costs like labor, rent etc were not accounted for as pigeonpea constitutes a very small proportion of total turnover in these supermarkets.

Appendix 3. Cost and revenues for *dhal* market participants.

Item (Ksh/90 kg bag)	Rural assembler	Rural wholesaler	Urban processor/ exporter	Urban supermarkets[a]	Urban retail shopkeeper[a]
Buying price	1513.64	2250.00	2534	6750	6750
Selling price	2430.00	3141.00	6557	7650	7200
Marketing margin	916.36	891.00	4024	900	450
Transport from seller	29.09	11.11	0	0	0
Seller search cost	0.00	0.00	0	0	0
Payment to buying agents	73.64	27.78	0	0	0
Cleaning labor	3.27	8.89	45	0	0
Storage cost	39.91	11.78	37	0	0
Loading/offloading charges	2.18	4.44	11	0	0
Watchman costs	0.00	0.00	0	0	0
Council charges	0.00	0.00	0	0	0
Weight loss after cleaning	6.18	18.78	94	0	0
Total dry pigeonpea buying costs	154.27	82.78	***186***	**0**	**0**
Transport to buyer	44.44	20.00	100	0	0
Buyer search cost	0.00	0.00	16	0	0
Processing costs	0.00	0.00	937	0	0
Packaging and labeling	16.62	11.75	206	0	0
Customs clearance	0.00	0.00	3	0	0
Payment to agents	0.00	0.00	0	0	0
Bank charges	0.00	0.00	2	0	0
Cost of fumigation before export	0	0.00	2	0	0
Total dry pigeonpea selling costs	***61.06***	***31.75***	***1265***	**0**	**0**
Total cost	215.33	114.53	1451	0	0
Net marketing margins	701.03	776.47	2573	900	450

a) In reality, the supermarkets and retail shops incur some costs in marketing dhal e.g. rent and staff costs. However, since dhal constitutes a very small proportion of their turnover, we have assumed zero marketing costs in this case.

Appendix 4. Cost and revenues for vegetable pigeonpea market participants.

Marketing costs/returns per (Ksh/90 kg bag)	Rural assembler	Rural open-air retailer	Rural wholesaler	Urban wholesaler	Urban open-air retailer	Urban exporter
Buying price	864.00	1620.00	1857.27	2400.00	3225.00	2902.50
Selling price	1602.00	2040.00	2770.00	2880.00	6210.00	23287.50
Marketing margin	738.00	420.00	912.73	480.00	2985.00	20385.00
Transport from seller	48.00	0.00	27.27	125.00	102.00	738.00
Seller search cost	0.00	0.00	0.00	0.00	0.00	0.00
Payment to buying agents	0.00	0.00	122.73	0.00	0.00	0.00
Shelling/sorting cost	0.00	0.00	0.00	0.00	0.00	0.00
Cleaning labor	4.00	0.00	0.00	0.00	0.00	208.25
Storage cost	0.00	0.00	0.00	0.00	0.00	0.00
Loading/offloading charges	0.00	0.00	0.09	25.00	0.00	0.00
City council charges	0.00	10.00	0.00	4.60	1.25	0.00
Watchman charges	0.00	25.00	0.00	0.00	0.00	0.00
Weight loss after cleaning	0.00	0.00	0.00	0.00	0.00	79.88
Total vegetable pigeonpea buying costs	52.00	35.00	150.09	154.60	103.25	1026.13
Transport to buyer	28.00	0.00	112.67	0.00	0.00	13350.00
Buyer search cost	0.00	0.00	0.00	0.00	0.00	0.00
Packaging and labeling	10.00	12.00	29.00	31.50	50.50	834.25
Customs clearance	0.00	0.00	0.00	0.00	0.00	2466.00
Payment to agents	0.00	0.00	0.00	0.00	0.00	657.00
Bank charges	0.00	0.00	0.00	0.00	0.00	12.25
Total vegetable pigeonpea selling costs	***38.00***	**12.00**	***141.67***	31.50	50.50	17319.50
Total cost	90.00	47.00	291.76	186.10	153.75	18345.63
Net marketing margins	648.00	373.00	620.97	293.90	2831.25	2039.38

Appendix 5. Export parity price for the dry grain pigeonpea in Kenya.

Item	Per t
CIF price at the port of import in India (US$) 2004-05	336
LESS:	
Freight and insurance from port of export to port of import (US$)	14
Kenya Ports Authority (KPA) handling charges (US$)	3
FOB at the port of export (Mombasa) in US$	319
Exchange rate of KSh per US $ (inter-bank annual averages in 2005)	77
FOB at the port of exit (Mombasa) in KSh	24,591
LESS:	
Packaging (KSh)	853
Cleaning, sorting, and grading (KSh)	476
Storage labor (KSh)	470
Transportation to port of exit (KSh)	745
Export parity price at Nairobi (KSh) - at exporter's warehouse	22,047
LESS:	
Processor's marketing costs to deliver to the supermarket (Ksh)	3,846
Urban supermarkets marketing costs	0
Export parity price at urban supermarket (KSh)	18,200
LESS:	
Urban wholesaler marketing costs (KSh)	2,611
Export parity price at urban wholesaler (KSh)	19,436
LESS:	
Urban open-air retailer marketing costs (KSh)	1,411
Export parity price at urban open-air retailer (KSh)	18,024
LESS:	
Urban retail shopkeepers marketing costs (KSh)	2,211
Export parity price at urban retail shopkeeper (KSh)	17,224
LESS:	
Rural wholesaler marketing costs (KSh)	1,278
Export parity price at rural wholesaler (KSh)	20,769
LESS:	
Rural open-air retailers marketing costs (Ksh)	1,167
Export parity price at rural open-air retailer (KSh)	19,602
LESS:	
Rural retail shopkeeper marketing costs (Ksh)	1,800
Export parity price at rural retail shopkeeper (KSh)	18,969
LESS:	
Rural assembler marketing costs (KSh)	2,389
Export parity price at farm-gate (KSh)	18,380

Source: Rapid market survey, 2006, and Indian foreign trade journal (1999–2005).

Appendix 6. Exporters and supermarkets contacted in the market survey.

Dry grain pigeonpea processors/exporters

1. Kenya Millers Limited
2. Spice World Limited
3. Pisu & Company Limited

Vegetable pigeonpea exporters

1. Superveg Limited
2. Makindu Growers & Packers Limited

Supermarkets

1. Seven Up Supermarkets
2. Tusker Mattress Supermarkets
3. Uchumi Supermarkets
4. Nakumatt Supermarkets

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