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INVESTIGATION OF KEY ASPECTS FOR THE SUCCESSFUL MARKETING OF COWPEAS IN SENEGAL

by

MBENE DIEYE FAYE

Submitted in partial fulfillment of the
requirements for the degree

PhD

in the
Department of Agricultural Economics
Faculty of Natural and Agricultural Sciences
University of the Free State
Bloemfontein
South Africa

April 2005

DEDICATION

I would like to dedicate this thesis to my adorable husband Aliou, to my daughter Ndèye Fatou and to my sons Matar and Oumar for their love, support and patience when it was most required.

ACKNOWLEDGEMENTS

The undertaking of a thesis of this nature would not have been possible without the assistance, guidance and support by a number of people. Many individuals provided inputs in various aspects of this study. I give my thanks to all who have been involved, several of whom I must mention by name.

First, my foremost appreciation goes to my promoter, Associate Professor André Jooste, for the unfailing scientific rigour he showed during the different steps of elaboration of this thesis. His sincere interest in this work and his constant availability to discuss research issues will always be remembered. To him my deepest gratitude for making this thesis become a reality.

I would also like to thank my co-promoter, Dr Joan Fulton, Department of Agricultural Economics at Purdue University, for her constant availability and the wonderful ideas she provided for the success of this thesis. Thanks for reviewing and commenting on several drafts of this thesis.

I have also benefited greatly from the guidance and support from Professor Jess Lowenberg-Deboer Department of Agricultural Economics at Purdue University. His initial input, advice and instruction provided the basis for the completion of this study, without which this study wouldn't have been possible.

I also am thankful to Professor André Pelser, Department of Sociology at the University of Free State, for his specific and valuable help when setting up survey approaches.

I am also greatly indebted to my colleagues at Senegalese Agricultural Research Institute (ISRA) for sharing and discussing ideas and information on agriculture, and cowpea in particular. I would like to specially acknowledge Mr Ibrahima Ndiaye for collecting most of data used in this thesis.

I wish to extend my gratitude to Mrs Katy Ibrahim and Jody Geller at Purdue University's International Program on Agriculture for their assistance throughout my graduate studies.

I also wish to thank Dr Dogo Seck and his wife for their care and attention.

Thanks to my parents, my sisters, brothers and to my family in law for their support throughout this work.

Finally, the financial assistance of the United States Agency for International Development (USAID) through the Bean Cowpea Collaborative Research Support Program (CRSP) towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at, are those of the author and are not necessarily to be attributed to the USAID.

Mbène Dièye FAYE
Bloemfontein
August 2004

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MBENE DIEYE FAYE

Degree: PhD
Department: Agricultural Economics
Promoter: Associate Professor A. Jooste
Co-promoter: Doctor J. Fulton

ABSTRACT

Due to the lack of information on the factors that affect the marketing of cowpeas in Senegal, this study investigates key aspects for the successful marketing of cowpeas in Senegal. The contribution this study makes lies in the information it generates to empower role-players in the cowpea value chain to better understand (i) the demand relations of cowpeas in Senegal, (ii) the information needs of role-players and the extent to which markets are integrated, and (iii) for which characteristics of cowpea consumers are willing to pay premiums.

An Almost Ideal Demand System (AIDS) model is applied to one period cross sectional data to estimate demand relations of cowpea's in Senegal. The own price elasticity of cowpea is -1.23 while its expenditure elasticity is 0.97 showing that cowpea is a normal necessity.

A sample of 443 respondents was taken to determine the information needs of different role-players in the cowpea supply chain. Availability of price information on local and export markets are deemed vitally important by all role

players. Information pertaining to quantities supplied and demanded, and buyers' preferences are not regarded by all role-players as equally important. The most appropriate mode to dissemination cowpea related information should depend on the accessibility of a particular mode by role-players.

Bivariate correlation coefficients, co-integration tests, Granger Causality tests and Ravallion's model are used to investigate level of market integration. The results show that cowpea markets as a whole are not integrated. This is not a surprising result since it can be linked to the general lack of market information.

The influence of cowpea characteristics on cowpea prices is analyzed with a hedonic pricing model. The results show that large grain size and sugar contents are characteristics for which consumers are willing to pay premiums in all markets.

The implication of the results of this study has several dimensions, i.e. (i) role-players in the cowpea supply chain now has information to guide pricing strategies, (ii) changes in expenditures on cowpeas can be properly discounted in marketing strategies, (iii) interventions can be designed to address the needs of information users and to address the non-integrated nature of cowpeas markets, and (iv) research programs and role-players should focus their research and marketing activities on those characteristics for which consumers are willing to pay premiums.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
AIDS	Almost Ideal Demand System
ANCAR	Agence Nationale de Conseil et d'Appui aux Ruraux
CRSP	Collaborative Research Support Program
CSA	Commissariat à la Sécurité Alimentaire
DAPS	Direction de l'Analyse de la Prévision et des Statistiques
DPS	Direction de la Prévision et de la Statistique
DRDR	Direction Régionale du Développement Rural
FAO	Food and Agriculture Organization of the United Nations
FCFA	Franc Communauté Financière d'Afrique
FIARA	Foire Internationale pour l'Agriculture et les Ressources Animales
GCS	Gambian Customs Services
GDP	Gross Domestic Product
HS	Harmonized System
IMR	Inverse Mill Ratio
ISNAR	International Service for National Agricultural Research
ISRA	Institut Sénégalais de Recherches Agricoles
KG	Kilogram
LES	Linear Expenditure System

MIS	Marketing Information System
Mt	Metric ton
NGO	Non Gouvernemental Organisation
PPCL	Projet de Promotion des Céréales Locales
SIM	System d'Information sur les marches
SUR	Seemingly Unrelated Regression
TPS	Trade Point Senegal
USAID	United States Agency for International Development
USDA	United States Department of Agriculture

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Cowpea is one of the most ancient crops known to man, with its center of origin and subsequent domestication being closely associated with pearl millet and sorghum. In the modern world it is a broadly adapted and highly variable crop, cultivated around the world primarily as a pulse, but also as a vegetable (for both the grains and the green peas), a cover crop and for fodder.

Cowpea is a source of high quality protein at relatively low cost and is consumed all year round. Cowpea has a number of common names, including Crowder pea, Black eye pea, Southern pea, and internationally as Lubia, Niebe, Coupe or Frijole. All these names are scientifically known as *Vigna unguiculata* (L.) *Walp*, which in older references may be identified as *Vigna sinensis* (L.).

1.2 THE STUDY ZONE

Located in the western part of Africa, Senegal is surrounded by Mali (east), Mauritania (north), Guinea Bissau and Guinea Conakry (south) and by the Atlantic Ocean (west) (see Figure 1.1). Senegal is the most westerly country in West Africa.

Figure 1.1: Map of Senegal in West Africa
Source: mw.com, 2001.

Senegal has a total area of 196,190 sq km of which 12 per cent is arable. In July 2004 the Senegalese population was estimated at 10,128 million inhabitants (DPS, 2004).

Agriculture is dominant in determining the level of household welfare in Senegal since it employs about 60 per cent of the labor force. Agriculture also plays an essential role in both the national food supply and in the national economy by contributing 19 per cent to the GDP (World Bank, 2002). Senegalese agriculture is characterized by rainfed cultivation where the vegetative cycle coincides with

the short wet season from July to October. The distribution and kinds of crops are closely tied to the amount, distribution and timing of rainfall. Rainfed cultivation consists of cash crops dominated by groundnuts (peanuts), and subsistence crops traditionally dominated by millet and cowpea.

Groundnuts are the main cash crop grown in Senegal. Although its share of total export value has fallen in recent years, it is still a major source of rural income. Groundnuts are also crucial to one of Senegal's major industries, which are the groundnut oil factories that produce groundnut oil for the domestic market and for export. The world price for groundnuts is a major factor determining Senegal's balance of trade. In 2002, export sales of Senegalese groundnut products were estimated at $147 million (World Bank, 2002).

In addition to rainfed cultivation, two other types of traditional agriculture are practiced. One is associated with paddy rice cultivation and depends on flooding of low-lying areas from runoff in the humid south. The second is the flood recessional agriculture associated mainly with the Senegal River. A non-traditional form of cultivation is irrigated agriculture, which is located along the Senegal River where water is available year-round.

After millet and groundnuts, with 10 per cent of the area cultivated, cowpea is the third most important crop in Senegal. Traditionally grown for food by

women, cowpeas have become progressively viewed as an alternative cash crop since 1985, following several years of poor groundnut harvests. This is particularly true in the northern part of the “peanut basin” where crops are mostly affected by the effects of erratic rainfall.

Given the growing importance of cowpeas as a means to improve the livelihoods of people in Senegal, coupled with the little information available on the marketing of cowpeas and associated problems, the focus of the current study is to investigate the market for cowpeas in Senegal.

1.3 PROBLEM STATEMENT

In realizing the potential of cowpeas as an alternative cash crop in the northern parts of Senegal, the Senegalese Agricultural Research Institute (ISRA) since 1987 has been engaged in a research program focusing on the breeding and dissemination of early maturing (less than 45 days) and high yielding varieties of cowpea to improve production and promote cowpea marketing.

As part of the research program surveys were conducted to assess the impact of the new varieties on production and cowpea marketing. The surveys revealed that cowpea production had not expanded as expected. Reasons for this can be attributed to the following:

- Producers cited low demand as one of the most important reason why production has not expanded as predicted (Faye, 1996). As a consequence, prices during harvest season, i.e. from October to January, can be as low as 45 FCFA[1] per kg. Apart from seasonal effects very little is known about cowpea price and demand.

- Cowpea marketing, i.e. buying from producers and selling on markets in Senegal, is mainly undertaken by middlemen or Bana-Bana. Very little is known about the way this marketing is conducted, i.e. how prices are set, what problems are experienced, the level of coordination, etc.

- Marketing research has focused to a large extent on export crops, such as cotton and groundnuts, and to a limited extent on cowpea and cereals. While the cowpea-breeding program started in 1921 in Senegal, an effective research program on its socio-economic aspects only started in 1993 (Faye, 1996), and studies on cowpea marketing aspects commenced in 1998. These studies have not yet provided consistent information.

The result of the above is that there is currently a gap in terms of information related to how buyers value the different characteristics (color, grain size, taste, etc.) of cowpea varieties. In addition, information on cowpea demand and

[1] Senegal belongs to the African Financial Community which uses FCFA as currency. The FCFA has a fixed parity with the Euro (1 Euro = about 656 FCFA).

market information are still lacking in Senegal. Clearly, by addressing these issues a significant contribution can be made to overcome the problems in cowpea marketing, and probably more important, the full potential of cowpea production in Senegal could be realized.

1.4 OBJECTIVES

The main objective of this study is to investigate the cowpea marketing system in Senegal in order to generate sufficient information that could assist all the players involved in cowpea production and marketing to realize fair incomes and to sustain their livelihoods while taking advantage of the potential that cowpea production holds. In order to reach the primary objective, several secondary objectives have to be met, namely:

- Estimate and characterize cowpea's potential demand;
- Describe and evaluate the cowpea market information system;
- Investigate the influence of different cowpea attributes on market prices; and
- Suggest policy measures in order to enhance cowpea marketing.

1.5 RESEARCH METHODOLOGY AND DATA USED

To estimate and characterize cowpea's potential demand an AIDS model is applied to one period cross sectional data from the Senegalese National Statistic Service.

To describe and evaluate the cowpea market information system, a questionnaire was developed that is specifically applicable to producers and other market actors. Aspects such as what type of information should be a priority were addressed. This should provide guidelines to public and private institutions that supply data on cowpea products. Econometrical tests are also conducted to investigate the degree of cowpea market integration.

To investigate the influence of different cowpea attributes on market prices, data were collected each month from six markets from January 1998 to December 2003. Data collected include physical attributes, such as grain size, skin texture and eye color, and biochemical characteristics, such as sucrose level and cooking time. This data is then analyzed by means of a hedonic pricing model to test the probable impact of different cowpea attributes on cowpea prices.

The main sources of data were field surveys, the FAO database and the National Statistical Services database.

1.6 OUTLINE OF THE STUDY

Chapter 2 provides an overview of the cowpea sector in Senegal. It describes amongst others, issues related to cowpea production, the different market actors and their relationships, transaction costs and cowpea price formation. **Chapter 3** investigates cowpea demand in Senegal and aims to provide information on cowpea consumption patterns, as well as on how changes in income and prices could affect cowpea consumption. **Chapter 4** describes and evaluates the cowpea market information system in Senegal. In this chapter the degree of cowpea market integration is also analyzed. In **Chapter 5** the influence of cowpea characteristics on prices are investigated. In **Chapter 6** conclusions are formulated and appropriate recommendations are made.

CHAPTER 2

OVERVIEW OF THE COWPEA SECTOR IN SENEGAL

2.1 INTRODUCTION

Producers require information on where and when to sell their cowpeas (*Vigna unguiculata* (L)) at a profitable price while, consumers want to buy cowpeas at the lowest cost without compromising specific desired grain characteristics. Production and marketing are therefore inseparably linked together. In order to understand this linkage better one needs to have information about the value chain of cowpeas.

Information regarding cowpea production and marketing can be regarded as vitally important to producers, marketers, consumers and policy makers. Not only will such information assist producers to produce what consumers want, but it will also assist intermediaries to lower transaction costs through more efficient marketing. Further this will guide policy makers to create a conducive environment through which role-players can interact in a sustainable and profitable manner. Unfortunately, information on cowpea in Africa in general, and in Senegal, in particular is limited. Not only is there little information available, but the sources reporting desired existing information are often conflicting and are spread over many sources. This chapter attempts to bring together available information related to the Senegalese cowpea industry since

it provides the background to the research problem being addressed in this study.

2.2 COWPEA PRODUCTION IN SENEGAL

2.2.1 General production attributes

Cowpea is a warm season crop that is relatively easy to grow. It is sometimes cultivated under extreme agricultural conditions around the world. It can grow in various types of soil, ranging from acid to alkaline and it is tolerant to low soil fertility. Because of these production attributes it can be produced across a wide range of agro-ecological zones. The main agronomic constraints when growing cowpeas are the major pests that attack plants, such as flower thrips *(Megalurothrips sjostedti),* pod borer *(Maruca vitrata)* and pod sucking bugs. Fungal diseases including Charcoal rot or ashy stem blight disease *(Macrophomina phaseolina),* as well as bacterial blight *(Xanthomonas campestris pv vignicola)* and cowpea aphid-borne mosaic virus can also reduce cowpea yields. The parasitic weed *Striga gesneroides* can also severely damage cowpea plants.

Cowpea varieties, given their agronomic characteristics, can also be grown as a dual-purpose crop, for both grain and fodder, as vegetable and as green manure. Erected cowpea varieties are usually grown mixed with groundnuts or

cereals, while spreading types are grown as monocrop. Contrary to many African countries, cowpea is mainly grown as a monocrop in Senegal.

Promoting cowpea production has been a priority for Senegalese Authorities. The National Agricultural Research Program aims to create new cowpea varieties, to improve traditional varieties and to find appropriate cropping techniques and efficient storage technologies. As a result, several varieties were developed and made available to farmers. These varieties are shown in Table 2.1. It is clear that the yield's per variety differs quite substantially and that there are also differences in terms of resistance to bacterial infections.

New storage methods were also developed, such as the use of metallic drums. Since 1980, the Bean Cowpea Collaborative Research Support Program (CRSP), a project funded by USAID, in collaboration with some American Universities provided funds to support cowpea research at research stations, as well as at farm level. The most important achievement from this collaboration was the development of two cowpea varieties, namely Mouride and Melakh. These two varieties are short cycled and high yielding, adapted to the Northern parts of the country, and are more resistant to cowpea diseases.

Table 2.1: Characteristics of different cowpea varieties released by ISRA

Varieties	50% flower DAS*	Grain yields (kg)	Fodder yields (kg)	Grain color	Other characteristics
58-57	44	2000	1800	White	Resistant to Bacterial Blight
Mougne	47	1100	1900	Black speckled	Resistant to Bacterial Blight
Ndiambour	44	1000	2000	White	Tolerant to Bacterial Blight
Bambey 21	41	950	1300	White	Resistant to CAbMV
IS275 (Mouride)	40	1300	1500	White	Resistant to Bacterial Blight, CAbMV and Striga
IS504 (Melakh)	40	1200		White	Resistant to CAbMV and thrips

Source: Ndiaye, 1986.
* DAS: Days After Sowing

2.2.2 Cowpea area cultivated and production

Worldwide, on average, 3.15 million Mt of cowpea are produced annually on about 8.75 million hectares. About 97 per cent of this area is in Africa and the rest in America, Europe and Asia (FAOSTAT, 2004). Approximately 99 per cent of the cowpea area in Africa is located in west and central Africa, which accounts for 94 per cent of total production.

Nigeria is the largest cowpea producer in the world with about 2 million Mt on 4.4 million hectares annually. Niger, the third largest producer in the world behind Nigeria and Brazil, is the second largest producer in Africa with an average of 364,785 Mt annually on 3.28 million hectares. Apart from Nigeria and Niger, other cowpea-producing countries in West Africa are, amongst

others Mali, Senegal, Burkina Faso, Ghana and Mauritania (see Appendix A). In general, cowpea yields vary from 0.11Mt/ha to 0.45Mt/ha depending on the variety planted, the use of fertilizer and pesticides, the cropping system, the soil type and agro-climatic conditions. In West Africa, the average cowpea yield is estimated at 0.34Mt/ha.

Figure 2.1 compares average cowpea areas and production between Senegal and its neighbouring countries. There was no data available for Gambia and Guinea Conakry and Guinea Bissau.

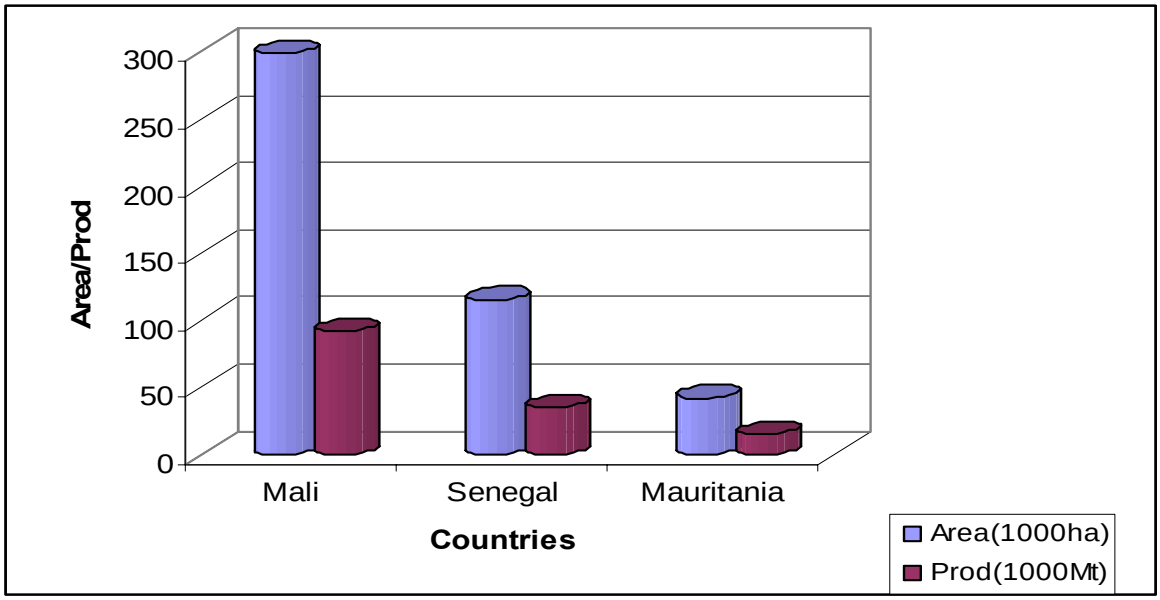

Figure 2.1: Average cowpea area and production (1993-2003)
Source: FAOSTAT, 2004.

On average, about 35,000 MT of cowpeas are produced annually in Senegal of which 85 per cent originates from the Northern parts of the country. The area planted with cowpea in Senegal only accounts for 1.3 per cent of the world total, whilst production accounts for 1.1 per cent of world production. In Senegal, the

average cowpea yield is approximately 0.30 Mt/ha, lower than the West African average.

In fact, 90 per cent of the approximately 115,000 ha planted to cowpea is found in the Northern regions of Senegal characterized by sandy soils, low water holding capacity, short rainy season and an annual rainfall not higher than 500mm as shown on Figure 2.2. These regions are known as Louga, Diourbel and Thiès.

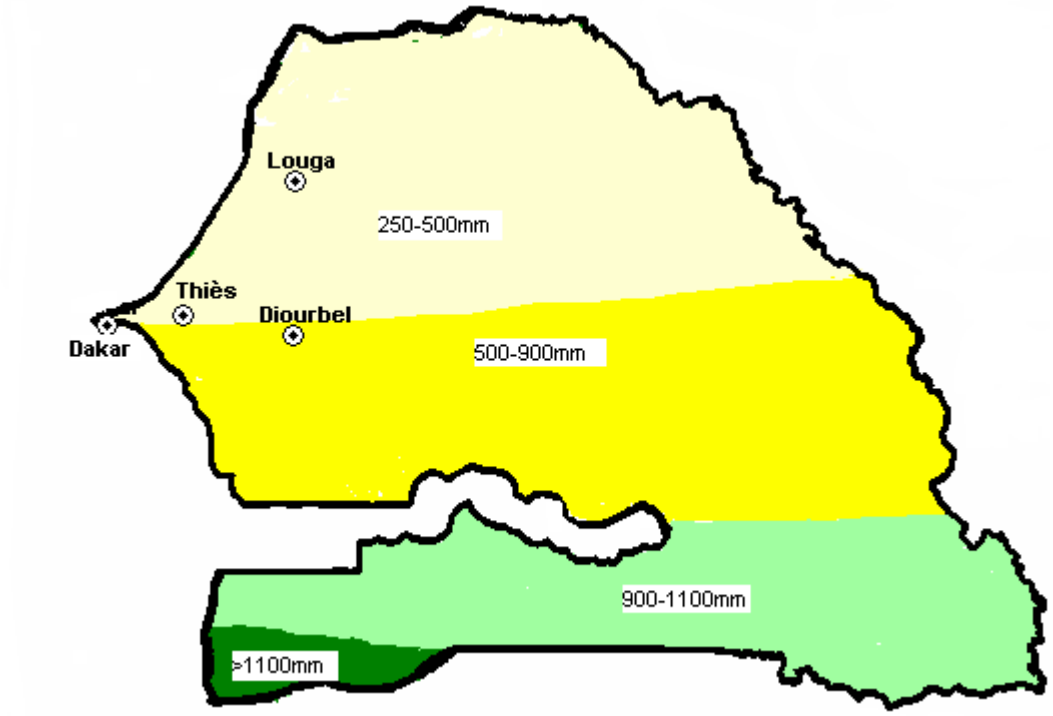

Figure 2.2: Louga, Diourbel and Thiès regions
Source: FAO, 2004.

The area planted to cowpea varies significantly over time with a standard deviation of 27,030 hectares. As illustrated on Figure 2.3, cowpea area increased to over 160,000 hectares in 1999 and then dropped back to levels consistent with those found prior to 1999. Many factors, among which, market price and lack of seeds, contributed to these variations. Moreover, producers seem to adjust their cowpea production based on the prices they received the previous year, and also their expectations of having seeds. The area planted with cowpea is also highly positively correlated (r=92.43) with grain production.

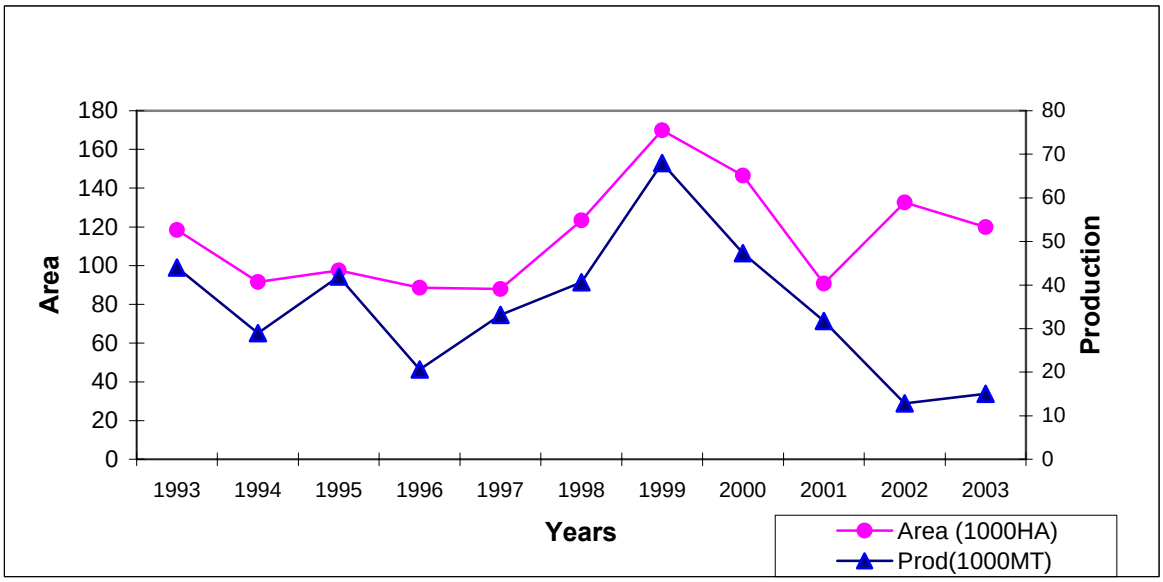

Figure 2.3: Cowpea area and production (1993-2003)
Source: FAOSTAT, 2004.

The low level of production recorded in 1994, 1996 and 2002 can be explained by periods of severe drought. In addition to this, the drop in production and area observed from 2000 to 2003 is influenced by the fact that during that time farmers were supplied with groundnut seeds by the government.

In general, problems related to accessibility of improved cowpea varieties and pesticides, as well as the high costs of these inputs inhibit expansion of cowpea production in Senegal to its full potential. The cost of production per hectare could vary from 9,000 FCFA to 88,250 FCFA (see Table 2.2). Option 1, which constitutes the higher cost option associated with the use of the improved technology package for cowpea production, provides yields three times higher compared to option 2 the traditional low cost option. However, it is the latter option that dominates cowpea production in Senegal due to the reasons mentioned earlier.

Table 2.2: Cost of production per ha (2003)

Activities	Option (1)	Option (2)
Seeds	13600	4000
Fertilization	30000	
Spraying	39250	
Threshing and storage	15000	5000
Total Cost (Fcfa)	88250	9000
Production (kg/ha)	600	167

Source: Data gathered during research.

In Senegal, cowpea is mainly produced by small scale farmers for family consumption and sale. Several intermediaries get involved in the cowpea market channel at different levels. The following section will focus on a description of market channels for cowpea and the role of the various actors.

2.3 MARKET ACTORS AND RELATIONSHIPS

Compared to groundnuts for which the market was regulated by the government until 2001, the cowpea market is without any government intervention. Transactions in the market are based on informal agreements and ethical considerations such as sincerity and trust. Figure 2.4 shows the different cowpea market actors and their relationships. Each of these is discussed shortly in terms of the role and activities they perform.

- Producers represent the largest group as far as numbers are concerned. They sell their produce directly or indirectly to exporters, collectors, wholesalers, processors, retailers and to consumers. Producers can receive a cash advance from wholesalers or collectors prior to the harvest period. In such cases, there is no negotiation on price, since the buyers set it. The practice of providing cash advances is common between relatives or close friends.

  Producers also bring their cowpeas to the market where collectors sell the product for them. Collectors and producers agreed on a selling price and producers get their money and unsold cowpea at the end of the market day. Producers use horse carts, taxi *brousse* (bush taxi) and small trucks to transport cowpea from villages to the rural markets.

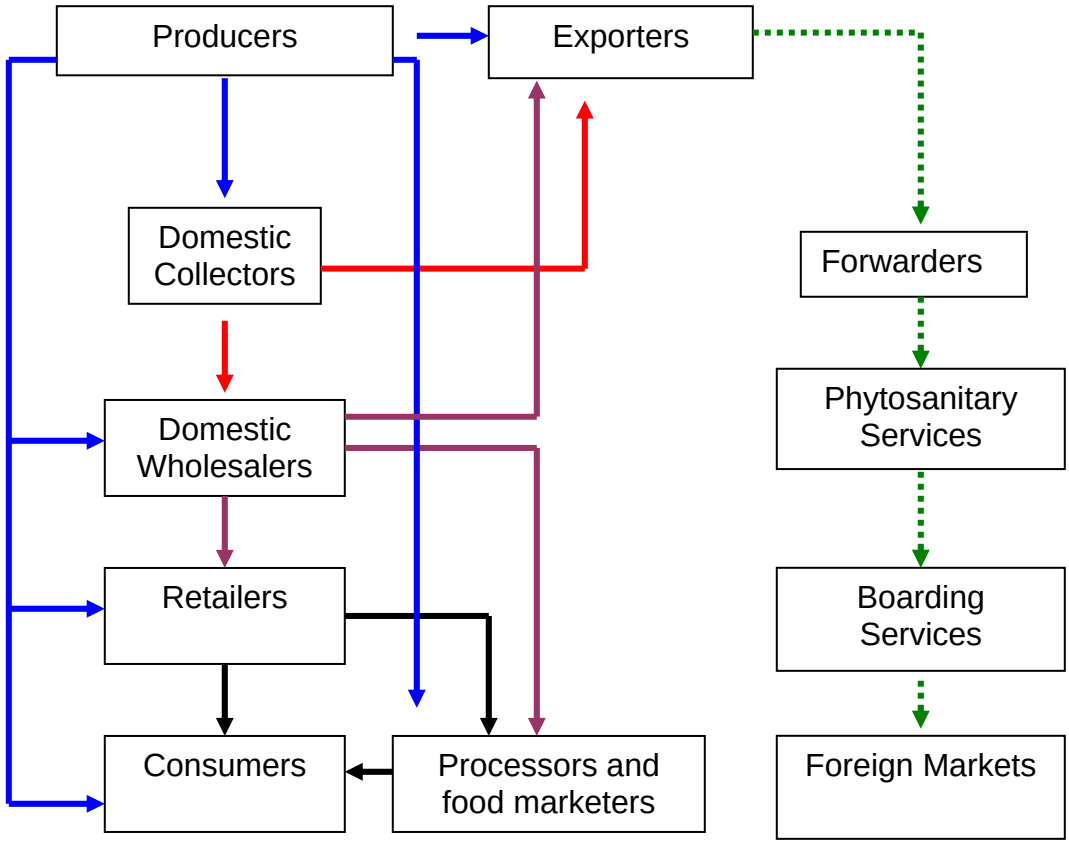

Figure 2.4: Cowpea market channels in Senegal

Stands for domestic transactions (no matter the color of the line)

Stands for export transactions

❖ Collectors are individual entrepreneurs. Apart acting as an intermediary at the market place, they also buy cowpeas from markets located in production areas and supply wholesalers in urban areas and exporters. To avoid competition with retailers they don't sell directly to consumers. Most of the time collectors use their own money to finance transactions. They can also get advances from wholesalers who play an important role in informal finance in both rural and urban areas (the nature of these advances will depend on specific relationships, such as being a relative or close friend). It is important to mention that, informal credit plays a

significant role in cowpea exchange since there is no formal credit line for cowpea traders, such as in the groundnut sector. In terms of storage facilities, collectors don't usually have specific storage space except in their home village or town. In most cases rooms are used as storage area and cowpea seeds are kept in metallic drums or in plastic bags. The risk of insect infestation is in general limited by the extensive use of metallic drums.

- Although wholesalers and retailers are both considered to be shopkeepers, the former are specialized in one or two agricultural products and handle larger quantities of cowpeas compared to retailers. Wholesalers are usually based in urban areas and buy the product with cash or in exchange for food products (tea, rice or sugar). They often store cowpea for six to eight months in order to get higher prices. They usually sell their cowpea to retailers, processors and exporters.

- Retailers are found in stalls in market places and sell cowpeas per kg or *pot.* The retail trade is characterized by a large number of actors due to the small amount of money required to enter the market and the lack of alternative employment opportunities. Since retailers do not store large quantities of cowpea, their risks are fairly low.

- Processors and other food marketers are people who own small units where they process cowpea into flour or other cowpea-based products. Depending on their location, they buy their supply from wholesalers, retailers or sometimes directly from producers.

- Exporters are traders who sell their cowpeas outside Senegal. They usually operate in Louga, Touba, Kaolack and Dakar. The reason for this is the accessibility to transportation and storage facilities. Most of the time exporters don't travel, but send their product through forwarders to their representatives who stay in neighbouring countries, such as Mauritania and Gambia. Any grain targeted for export must be inspected by certified government plant health officers that will issue a phytosanitary certificate if the product complies with regulations.

  An export tax of 20 FCFA per kg is levied on exports. This is seen as a barrier to potential smaller exporters who do not have enough capital to finance large-scale cowpea exports. In other words, the export tax restricts the number of traders, and as a consequence, financially strong exporters face little competition.

  To export cowpeas to Gambia and Mauritania, traders mainly use trucks. The cost is fixed per load and varies between 75,000 FCFA and 150,000

FCFA depending on the volume of cowpea transported, the price of gas and the cross border taxes.

Cognizance should also be taken of the fact that role-players also extend their functions into their non-traditional areas of operation. Some successful farmers for example may become farmer traders or even wholesalers. However, the number of traders tends to decrease as you move from the farm to the urban centers.

2.4 MARKETING MARGINS

This section provides insight into the gross profit and marketing margins at different levels of the supply chain. The marketing margin estimates are for cowpeas produced in the MPal production area and sold in Dakar, the main consumption area. The calculated margins are based on average prices prevailing in 2003, the period for which data were collected. Since some role-players may perform overlapping functions, in particular producers and collectors, it is difficult to distinguish between the margins of these role-players. Therefore the targeted categories are the producers, the wholesalers and the retailers. Cognizance should also be taken that this type of information is not readily available, and for this reason the margins between other combinations of production areas and markets are not discussed; the data reported here was specifically gathered within the scope of this study. The results of the

calculations are shown on Table 2.3. The considered farmer is cultivating cowpeas under option 2 described in Table 2.2 since it is most common. The producer's gross profit is 72 FCFA, which translates into a profit margin of 55 per cent. For wholesalers and retailers the gross profit and profit margin are 198 FCFA (59%) and 83 FCFA (20%), respectively.

Table 2.3: Cowpea profit margin

Items	Profit margin
Cost of production	**54**
Bags	2
Producer transportation cost	**2**
Producer total cost	**58**
Producer Price	130
Producer gross profit	**72**
Producer gross profit margin	**55%**
Cowpea price from producer	**130**
Bags	2
Insecticide	0.5
Bag filling	0.2
Storage	0.5
Loading	0.2
Transportation to Dakar	4
Local Wholesaler Cost	137
Selling Price	**335**
Wholesalers gross profit	**198**
Wholesaler gross profit margin	**59%**
Cowpea price from wholesaler	**335**
Cowpea handling	1
Transportation to markets	0.2
Retailers costs	1.2
Cowpea cost	337
Consumer price	**420**
Retailer gross profit	**83**
Retailer gross profit margin	**20%**

* Profit margin = gross profit divided by selling price

2.5 COWPEA PRICE TRENDS

The National Statistic Services do not record data on cowpea prices, but the set of prices collected by ISRA through the Bean Cowpea CRSP project from 1998 to 2003 is used to provide insight into price movements of cowpeas.

The mean and median prices over the reported period were 321 FCFA per kg and 324 FCFA per kg, respectively, and the maximum and minimum prices are 700 FCFA per kg and 45 FCFA per kg. Cowpea prices show a relatively high level of deviation from the mean with a standard deviation of 185 FCFA. As shown on Figure 2.5, it is clear that there exists a significant negative correlation between production and prices (r = - 90%).

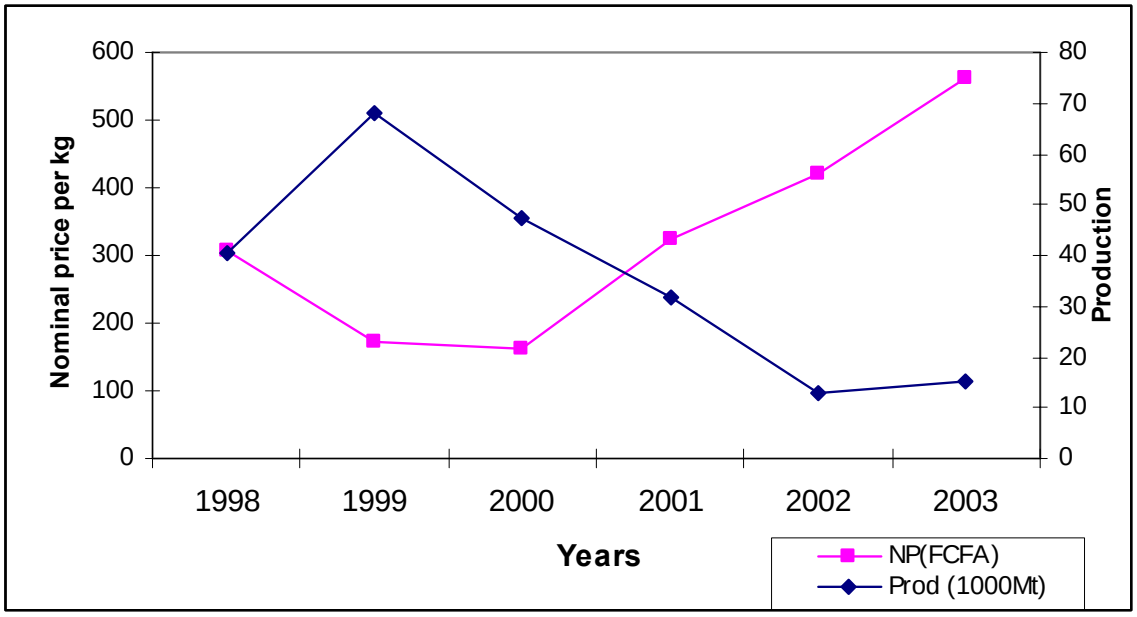

Figure 2.5: Cowpea price and production variation

Figure 2.6 shows the nominal and real prices of cowpea. It is obvious that since 2001 real prices started to decrease. This is largely attributable to increases in

the inflation rate. The increase in the inflation rate was partly caused by government's decision not set or control food prices anymore. The result was rent seeking by role-players in the food chain that led to increased food prices which in return put upward pressure on inflation.

A drop in real prices can influence farmers' decisions to plant. In fact, in some rural areas, farmers try to adjust by switching to other more profitable crops such as watermelon.

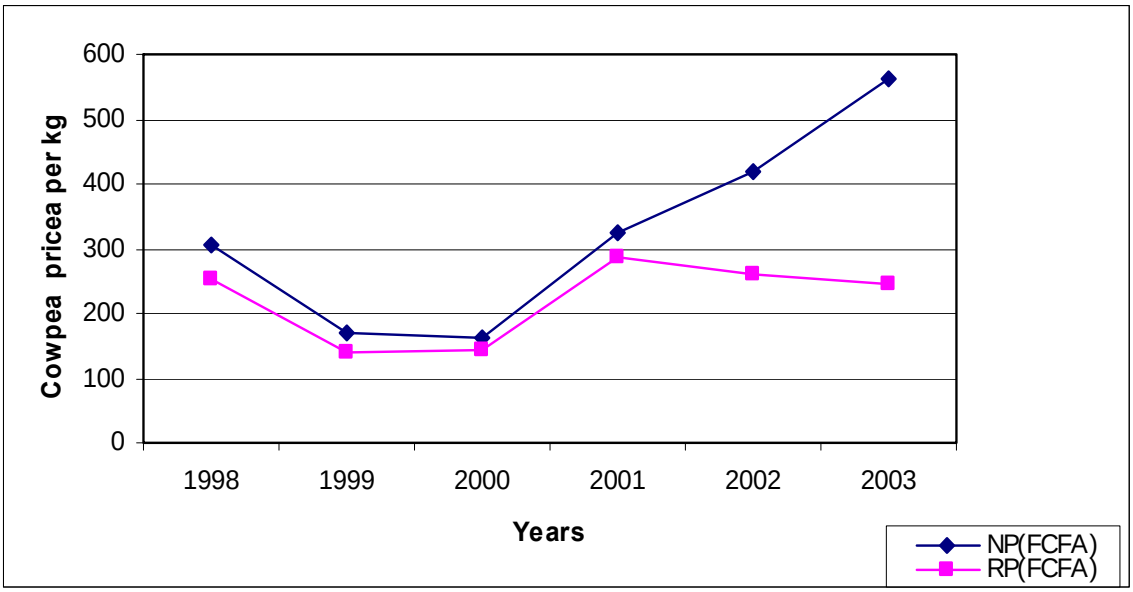

Figure 2.6: Average cowpea nominal vs real prices

2.6 CONCLUSION

This chapter brought together available information related to the Senegalese cowpea industry. Cowpea is mainly produced by small-scale farmers for family consumption and sale. The area planted with cowpea accounts for 1.3 per cent

of the world total and is subject to wide variations with a standard deviation of 27030 hectares. Many factors, among which, market price and lack of access to inputs, contributed to these variations.

Average cowpea production is 35,000Mt and represents for 1.1 per cent of world production. Yields are 0.30 Mt/ha lower than the West African average. In general, problems related to accessibility of improved cowpea varieties and pesticides, as well as the high costs of inputs inhibit expansion of cowpea production in Senegal to its full potential. This is notwithstanding the fact that various programs have been launched to increase the production of cowpea.

It also appears as if the lack of access to credit facilities limits the ability of certain role-players to fully participate in the market. This is an issue that needs further investigation, but falls outside the scope of this study.

CHAPTER 3

COWPEA DEMAND RELATIONS

3.1 INTRODUCTION

In Senegal, very little information is available on cowpea demand. Hence, the main objective of this chapter is to analyze the current cowpea demand situation and to estimate demand behavioural parameters that can be used by decision makers in the value chain. Moreover, this chapter aims to supply information on local demand and export patterns, as well as price and expenditure elasticities that could assist stakeholders in the cowpea sector to better understand the factors that affects the demand for cowpeas. This in turn will assist stakeholders in making informed decisions regarding production and marketing to improve the efficiency in the value chain for cowpeas. In addition, it will assist policy makers to better measure the impact of policies they implement in the cowpea sector or that could be implemented to improve the efficiency in the cowpeas value chain.

3.2 COWPEA ATTRIBUTES AND USES

Epidemiological studies in over 40 countries of the world show a direct link between consumption of dry beans and reduced incidences of chronic diseases, including cancer. Cowpeas can also be used to enhance child

survival (USAID, 2003). Cowpea seed is a nutritious component in the human diet, as well as a nutritious livestock feed. It is considered among the most nutritionally complete staple foods (see Table 3.1) and represents the second most important source of dietary protein in most countries in Africa.

Table 3.1: Nutrient contents in 100gram of cowpea seed

Mineral nutrients	Quantities
Calcium (mg)	110
Iron (mg)	8,27
Magnesium (mg)	184
Phosphorus (mg)	424
Zinc (mg)	1112
Sodium (mg)	16
Vitamines	
Vitamin B_6 (mg)	0,357
Vitamin A (UI)	50
Lipides	
Fat acids (g)	0,33

Source: Omueti and Singh, 1987.

The dry matter is the most important part of the cowpea, but the leaves, green pods and fodder are also used in different ways from one region to another. In West Africa, cowpea is primarily grown for its grain and fodder, while in eastern and southern Africa it is cultivated primarily for its leaves. Cowpea grain is consumed directly following boiling as an ingredient of meals. Immature snapped pods are used in the same way as snap beans, often being mixed with other foods. Green cowpea seeds are boiled as a fresh vegetable, or may be canned or frozen. Dry mature seeds are also suitable for boiling and canning.

In Senegal, cowpea is used in several dishes, except in the southern part of the country where it is not part of the diet.

3.3 COWPEA CONSUMPTION IN SENEGAL

In contrast to cowpea data pertaining to production, data on cowpea consumption in Senegal is nearly non-existent. The method most often used to estimate local consumption is to subtract exports from production and allow a given percentage for retained seed and losses. However, due to a paucity of official export data, this method is inaccurate. An alternative is then to rely on household survey data and to extrapolate it over the population. Using the Household Income Expenditure data in Dakar, an annual average per capita cowpea consumption was estimated at 1.5 kg in 1997 (DPS, 1997) against 1.2 kg in 1989 (FAO, 2004). Despite the fact that cowpeas are a highly nutritious food, and is also becoming a more valued commodity in urban areas, the overall demand remains low simply because of consumption habits. Moreover, even though the per capita cowpea consumption has increased from 1989 to 1997, the level is still low compared to cereals. For example in 1997, the annual per capita consumption was estimated at 44 kg and 65 kg, respectively, for millet and rice (DPS, 2001b).

In Senegal, cowpea dry seeds, as well as the green pods are consumed in two main forms: (i)*Thiebou Niebe* which is made of rice, dried fish and cowpea as vegetable and (ii) *Ndambe* made of boiled cowpea cooked with oil, tomatoes and spices and served as dinner or breakfast. *Ndambe* is also sold with bread as a sandwich in many places in the cities. These dishes are very popular in

Senegal, particularly in large cities following the devaluation of the CFA FRANC in January 1994 when all imported pea prices doubled.

Ground cowpea is also used to make snack foods, such as *Accara*, which is a traditional beignet. *Accara* is made from cowpea paste seasoned with peppers, onions and salt and deep fat fried. This product is relatively popular in West Africa. In Senegal, *Accara* is sold as snack food in the morning or late afternoon.

Cowpea was also used to make flour and as ingredient in infant food on a small scale. Table 3.2 shows the processors of cowpea and the products they manufacture. A survey conducted by ISRA and Purdue University in May 2004 revealed that only one of the processors mentioned on Table 3.2 currently produces cowpea flour, whilst none uses cowpea in infant food anymore.

Table 3.2: Cowpea processors, products and location (1999)

Processors	Products	Location
AGC	Ruy Xalel /infant food	Dakar
La Vivrière	Cowpea flour	Dakar
SENCERLOC	Nene lack (baby food)	Dakar
Frères Unis	Cowpea flour	Thiès
Moulins du Cayor	Cowpea flour	Thiès

Processors and shop owners indicated that cowpea flour did not sell well since it is mostly bought by women from other West African countries (not Senegalese women). In addition to the low demand, deterioration of cowpea

flour during storage represents another constraint. These constraints are the main reasons for processors moving away from cowpea flour production.

In summary, cowpea consumption remains low compared to cereals even though per capita consumption has increased. The low level of consumption can probably be attributed to (i) eating habits, (ii) lack of information about the factors that influence consumption and that restrains the ability of marketers to promote higher consumption, and (iii) lack of technologies to protect the quality of processed cowpea products.

3.4 COWPEA EXPORTS

Although it is known that Senegal export cowpea to its neighbouring countries, information on the exact quantities is basically non existent since the Harmonized System (HS) codes which are used internationally, do not distinguish cowpeas from other types of peas and beans.

Hence, information on cowpea exports was mainly sourced from those countries that import cowpeas from Senegal or through oral declarations. The only official statistics that were available for cowpeas that originated from Senegal during the time of this study was provided by the Gambian Customs Services (GCS). Based on the GCS records, the quantities imported from Senegal by Gambian traders were 2,000 kg and 2,800 kg for April and May

2000, respectively. Based on oral declarations by traders in Banjul (Gambia) the estimated quantity of cowpea imported each year from Senegal is approximately 100 tons. According to Gambian merchants all the cowpea they sell come from Senegal. They mainly buy cowpeas in Touba because of its proximity and the availability of cowpea in this city throughout the year. Wholesalers in Sagatta and MPal markets indicate that they export about 10 tons of cowpea per week to Mauritania. In many markets visited in Nouakchott (Mauritania) during this study, most of the cowpea sold was imported from Senegal.

Data recorded from mid-October 2000 to mid-January 2001 at the borders between Senegal and Mauritania showed that 61 tons were exported by the Senegalese Bana-Banas[2] to Rosso in Mauritania. Table 3.3 shows that these consignments were made up of several varieties. Mixed consignments made up the largest proportion of the recorded exports (62% of the total).

Table 3.3: Varieties traded and quantities

Variety	Proportion (%)	Quantity (kg)	Quality
Mixed	62%	37427	Good
Matam	29%	17460	Good
58-57	5%	3105	Good
Wolete	4%	2248	Good
Mélakh	1%	310	Good
Mame Fama	0.1%	85	Good

Source: Faye, 2001.

[2] *Bana-Banas* = Most common name given to collectors or low scale traders

Traders in Senegal usually export their cowpea to Mauritania in 50 kg bags that are loaded in big trucks mixed with vegetables in order to avoid paying taxes at the borders since vegetables are exempted. Their representatives in Mauritania sell the cowpeas on a commission basis agreed upon prior to selling the cowpeas.

Using available data, it appears that the exports of cowpea to neighbouring countries represent approximately 1 per cent of the total production in Senegal.

3.5 ESTIMATION OF COWPEA DEMAND RELATIONS

Demand system estimation was and is being used widely to enable analysts and decision makers to get a better understanding of consumer behaviour. Information from such estimations allows marketers and policy makers to base decisions on quantified consumer behaviour parameters. In this section different methods to estimate demand systems are reviewed briefly in an effort to determine the most appropriate method to estimate cowpea demand relations.

3.5.1 Functional forms in demand

Consumers are assumed to choose consumption bundles to maximize utility, subject to a budget constraint. There are several theoretical models that could

be used when estimating consumer demand functions. However, based on the pure theory of demand, for all the models some restrictions should hold. These restrictions are (1) demand functions must add up, i.e. total expenditure on goods and services must equal total income, (2) equal change in income and price should not have an effect of the quantity of goods purchased, (3) less of a good should be demanded if its price increases and (4) the matrix of substitution should be symmetric.

The Cobb Douglas, the Linear Expenditure System (LES), the Translog and the Almost Ideal Demand Systems (AIDS) are all common functional forms that can be used to estimate consumer demand systems. These demand systems are briefly discussed below following Berck, Golan and Smith (1996).

- If the utility function is **U(c),** where **c** is the consumption bundle, the consumer is supposed to choose **c** in order to maximize utility. The solution to the constrained utility maximization problem is then a set of demand equations. If **U(c)** takes the form of a Cobb-Douglas function, the demand equations are denoted as follows:

  $\mathbf{q_i = \lambda_i I/p_i}$

  Where:

  $\mathbf{q_i}$ = demand for good *i*;

  I = total income;

$\mathbf{p_i}$ = price of good *i*; and

$\boldsymbol{\lambda_i}$ = parameter to be estimated.

A major constraint in using this method is that own-price elasticities remain constant across all levels of consumption. The same applies to the share of household expenditure on each good.

❖ The Linear Expenditure System (LES) approach, introduced by Klein and Rubin (1947), is a theoretical consistent demand system that can be used in applied work. Klein and Rubin started from a linear demand equation for which they imposed the restrictions implied by demand theory. Later, Samuelson (1948) pointed out that their demand can be derived from a Stone-Geary utility function.

The Stone-Geary (1954) utility function is of the form $\mathbf{U = \Sigma\beta_k ln(q_k - \gamma_k)}$

Where:

$\mathbf{q_k}$ = quantity of good k and $\mathbf{\Sigma\beta_k = 1}$.

γ_k = subsistence level for good k

Maximizing U subject to a budget constraint: $\mathbf{X = \Sigma p_k q_k}$

Where:

$\mathbf{p_k}$ = price of good k; and

X = total expenditure.

From the first order conditions of the utility maximization problem are derived the share form of the LES denoted as:

$$W_i = \gamma_i p_i/X + \beta_i (1 - \Sigma \gamma_k p_k/X)$$

Where:

W_i = expenditure share for good *i*;

p_i = price of good *i*; and

γ_i, β_i and γ_k are the expenditure share parameters to be estimated.

In this case, price elasticities are defined as:

$$e_{ij} = (\gamma_j p_j (\delta_{ij} - \beta_i)/ x_i) - \delta_{ij}$$

Where:

δ_{ij} is the Kronecker delta; δ_{ij} = 1 if i=j and 0 otherwise.

The expenditure elasticity is defines as:

$$e_{ij} = \beta_i/W_i$$

The LES has been recently used by Creedy (2004) to capture household consumption patterns. However, the key problem with using LES is that it restricts price and income elasticities to unity what might be sometimes plausible but not always.

❖ The ordinary translog functional form also leads to a system of expenditure shares defined as:

$$\mathbf{W_i = (\alpha_i + \beta_{ij} \log (p_j/X)) / (1+\Sigma\Sigma\beta_{kj} \log (p_k/X))}$$

Where:

$\mathbf{W_i}$ = expenditure share for good *i*;

$\mathbf{p_i}$ = price of good *i*;

X = total expenditure; and

α and $\boldsymbol{\beta}$ are the expenditure share parameters to be estimated.

The price elasticities are defined as:

$$\mathbf{e_{ij} = (\beta_{ij} - W_i \Sigma\beta_{kj}) / W_i(1+\Sigma\Sigma\beta_{kj} \log (p_k/X)) - \delta_{ij}}$$

Where:

δ_{ij} is the Kronecker delta; δ_{ij} = 1 if i=j and 0 otherwise.

The expenditure elasticities are defined as:

$$\mathbf{e_j = ((-\Sigma\beta_{ij}) / W_i(1+\Sigma\Sigma\beta_{kj} \log (p_k/X)) +1}$$

A major criticism against the translog demand system is that it leads to a difficult nonlinear estimation, and allows unrestricted estimates of the substitution elasticities (Urga and Walters, 2003). For these reasons, it has been largely passed over in favor of the Almost Ideal Demand System (AIDS) discussed next.

❖ Deaton and Muellbauer (1980a) developed the AIDS model using a general algorithm for demand system generation. Starting from an expenditure function, defined as:

$$\mathbf{Logc(p,u) = \alpha_0 + \Sigma\, \alpha_i\, logp_j + \tfrac{1}{2}\, \Sigma\Sigma\gamma_{kj}\, logp_k\, logp_j + u\beta_0\, \Pi p_k^{\beta k}} \qquad (1)$$

Where:

c(p,u) = expenditure function;

p = price of the commodities in question;

u = utility level; and

α, β and γ = expenditure parameters.

A Hecksian demand system can then be obtained by taking the derivative with respect to price, i.e.

$$\mathbf{\delta(c(p,u))/\delta p_i = q_i(p,u)}$$

By multiplying both side by p_i /c(p,u) produces the demand equation in share forms, denoted as follows:

$$\mathbf{\delta logc(p,u)/\, \delta logp_i = q_i\, p_i / c(p,u) = w_i\, (p,u)}$$

Since consumers are maximizing utility, at the optimum, minimum cost **c(p,u)** will be equal to expenditure **x**; therefore **c(p,u)** which is not observable can be replaced by **x** which is observable. Also, **u** can be expressed in terms of variables and other parameters in expenditure

function (1)**.** After substitution and rearrangements, the uncompensated budget share which is now a function of **p** and **x** is denoted as:

$$\mathbf{W_i = \alpha_i + \Sigma\, \gamma_{ij}\, log p_j + \beta_i\, log\, (X/P)}$$

Where:

$\mathbf{W_i}$ = expenditure share associated with the *i*th good;

γ_{ij} = slope coefficient associated with the *j*th good in the *i*th expenditure share equation;

$\mathbf{p_j}$ = price of the *j*th good;

X = total expenditure on the system of goods; and

P = Stone price index = $\ln (P^*) = \Sigma w_i \log p_i$

The expenditure elasticity is defined as:

$$\varepsilon_i = 1 + (\beta_i / W_i)$$

The own price elasticity is defined as:

$$\varepsilon_{ii} = \gamma_{ii} / W_i - (1 + \beta_{ii})$$

The cross price elasticities are defined as:

$$\varepsilon_{ij} = (\gamma_{ij} - \beta_i W_j) / W_i$$

The AIDS model is restricted by the following conditions:

- Adding up

  $\Sigma\alpha_I = 1$; $\Sigma\gamma_{ij} = 0$; $\Sigma\beta_i = 0$

- Symmetry

  $\gamma_{ij} = \gamma_{ji}$

- Homogeneity

  $\Sigma\gamma_{ij} = 0$

- Negativity

  This requires the matrix of substitution to be negative semi-definite. One subset of the negativity restriction implies that all the compensated own price elasticities must be negative (Li, Song and Will, 2003).

The AIDS model has enjoyed great popularity in applied demand analysis. For recent uses in various domains, see Deaton and Muellbauer (1980a), Mclennan and Rambaldi, (1999); Abdullah, Rahman and Baharumshah (1999); Li *et al*. (2003) and Agbola (2003).

Deaton and Muellbauer (1980b) show that the AIDS model satisfies the axioms of choice, aggregates over consumers and has a functional form consistent with known household budget data. The model also allows the restrictions from

economic theory to be taken into account during estimation and the cross commodity impact to be captured. In addition, it is simple to estimate.

For these reasons, the AIDS model will be applied to estimate demand relations of cowpeas in Senegal. The demand parameters of interest are the own price, the cross price and the expenditure elasticities. These parameters show the extent to which households adjust their purchase in response to changes in prices or income.

3.5.2 Data used

The data used to estimate the AIDS model were obtained from a survey on household expenditures conducted in 2001 by the National Statistic Services. The survey consisted of a random sample of 1087 households in Dakar. The purpose of the survey was to collect data on all types of household expenditure.

Based on the data available, the AIDS model is applied to beans that include cowpea, white bean, green beans and small peas. It is assumed the group of beans is weakly separable from the other groups of goods.

The descriptive statistics of the data in question are reported in Table 3.4.

Table 3.4: Descriptive statistics of per year expenditure data (FCFA)

NAME	N	MEAN	ST. DEV	MIN	MAX
Cowpea	1087	1376	2328	0	19588
White bean	1087	329	1976	0	32242
Green bean	1087	554	2559	0	40150
Small peas	1087	230	1720	0	26767
Total expenditure	1087	2488	4405	200	47450

Source: DPS, 2001a.

It is clear from Table 3.4 that the sample included household that do not purchase any of the different bean categories. Also, the data reflect a high standard deviation that indicates the wide differences amongst households in terms of expenditure patterns. From a modeling point of view, the occurrence of observations with zero expenditure is problematic. The reason for this is that when developing the AIDS model, Deaton and Muellbauer (1980a) assume that consumers will spend at least some proportion of their income on the product included in the modeling framework (Nevo, 1999). This is a real challenge when using household survey data since it is not unrealistic to expect that not all consumers surveyed will purchase all products. Households can for different reasons decide to not report consumption of a particular good. For example, in the case of Senegal, the presence of zero expenditures can be explained by the fact many families in cities can receive agricultural products, like cowpea, as a gift from their relatives living in rural areas. Since they don't pay money for the product, they don't report it.

The econometric treatment of zero expenditure observations in household surveys has received considerable attention in household demand analyses.

Park, Holcomb and Raper (1996) state that an option would be to run the AIDS model without the zero expenditure observations. They, however, argue that such estimation fails to take into account the censoring impacts and will lead to biased parameter estimates.

An alternative would entail the use of the Heckman-type sample selection correction factor as described by Heien and Wessell (1990). When using this option, the zero values are omitted at the second step of the budgeting procedure and as a consequence all effects are not captured (Akbay and Boz, 2001).

Akbay and Boz (2001) describe another method to deal with zero expenditure observations that also uses a two step estimation procedure for the system of equations. According to them, the method involves two stages:

At the first stage, the Inverse Mill's Ratio (IMR) is estimated by using a probit regression. The computed IMRs, which represent the unobservable influences on the participation decision, are then as a second step, included into the AIDS model to estimate household food demand elasticities. The advantage of this model over traditional demand studies is to accommodate the zero expenditure in order to steer away from biased results, and was hence used in this study. More formally, the probit model is defined as the probability of a given household to buy or not to buy a given good and is denoted by:

$Q_{ih} = f(\beta X)$ **or**

$Q_{ih} = f(P_{1h}, \ldots P_{ih}, Y_h, D_{1h} \ldots D_h)$

Where:

Q_{ih} = 1 if the household buys the good and 0 otherwise;

F = standard normal density function;

β = parameters to estimate;

X = explanatory variables;

P_{ih} = price of the goods;

Y_h = household income; and

D_h = Demographic and other socioeconomic variables.

It is necessary to point out that the probit is applicable only to the observations with zero expenditure.

3.6 RESULTS OF THE AIDS MODEL

In general, the model fits quiet well with a system R^2 of 0.96. Estimated coefficients from the demand model are significant at 10 per cent level or better. The only exception is with cross effects between small peas and both cowpea and white beans; therefore the related cross elasticities are not reported. Table 3.5 shows the coefficients of the related goods and their expenditure shares.

Table 3.5: Output of AIDS model

Goods	Coefficient	t-ratio	Expenditure shares
Cowpea	-0.1433	-2.5671**	**0.58**
White bean	-0.1557	-1.6178*	**0.11**
Green bean	-0.9778	-7.2258***	**0.23**
Small peas	-0.6448	-6.6748***	**0.08**
System $R^2 = 0.9644$			

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

The results show a high expenditure share for cowpeas (0.58). This can be explained in part by the fact that after the FCFA devaluation, some household switched from imported beans to cowpea. However, its demand still remains low as stated previously. The expenditure elasticities are all positive (Table 3.6), hence one can expect demand for cowpea, white bean, green bean and small peas to increase as expenditure increases. The expenditure elasticity of cowpea and white bean are less than one and therefore are considered as normal necessities. That is, when expenditure increases by 1 per cent, demand for cowpea and white bean will increase by 0.97 per cent and 0.63 per cent respectively. Expenditure elasticities for green beans and small peas are greater than one, and are hence considered as luxury products. That is, if expenditure increases by 1 per cent, demand for green bean and small peas will increase by 1.19 per cent and 1.14 per cent, respectively.

Table 3.6: Expenditure and own price elasticities

Goods	Expenditure elasticities	Own price elasticities
Cowpea	0.97	-1.23
White bean	0.63	-2.40
Green bean	1.19	-5.29
Small peas	1.14	-8.94

Own price elasticities are negative as expected (Table 3.6). Cowpea, white beans, green beans and small peas are all price elastic, i.e. if the price increases, the associated change in quantity demanded will be greater, *ceteris paribus*. Hence, if the price of cowpeas increases by 1 per cent, the quantity demanded will decrease by 1.23 per cent, *ceteris paribus*.

The estimated cross price elasticities between cowpea, white bean (-0.121) and green bean (0.368) suggest that cowpea and white bean are substitutes, while cowpea and green bean are complements.

3.7 CONCLUSION

Although the per capita consumption of cowpea has increased, total demand remains low compared to other agricultural products. This is notwithstanding the fact that cowpeas have multiple uses and are considered as a very nutritious product. This sate of affairs could partly be explained by the fact very little information is available on consumer reaction to changes in price of cowpeas, its substitutes and complements, and expenditure. Such information could assist decision makers in the cowpea value chain to make more informed decisions since it provides benchmarks on how consumers react. It is for this reason that cowpea demand relations were estimated.

The parameters estimated for cowpea complements information on cowpea demand patterns. Even though price variation was limited in a single cross-section data set, the results demonstrate that it is possible to estimate expenditure and price elasticities.

The results show that cowpea is considered as a normal product. In addition, demand for cowpea is more likely to respond to price changes than expenditure changes. Demographic (household size, ethnic group, etc) and location (districts, urban rural) effects would provide additional information on cowpea demand patterns.

CHAPTER 4

COWPEA MARKET INFORMATION AND INTEGRATION IN SENEGAL

4.1 INTRODUCTION

In recent years there has been growing concern about the accuracy and quality of publicly supported market information. Producers, on one hand, have to make decisions' on what to produce, what inputs to use, what marketing channels to use, etc. to maximize their return on capital. On the other hand, players in the rest of the value chain need information to plan distribution and other marketing activities in an efficient manner. Such decisions can only be meaningful when decision makers have access to proper information. Market information is also crucial for policy makers in order to create the basic conditions that promote investment for sustainable agricultural production, marketing and trade. Good information improves the competitiveness and efficiency of markets (Salin, Thurow and Elmer, 1996).

In Senegal, there is a definite gap in terms of market information for cowpeas. The reason for this is that the National Market Information System mainly collects information on cereals and groundnuts. In order to suggest improvements in the publicly supported statistical services provide it is

necessary to describe and evaluate existing market information systems as it relate to cowpeas.

This is done by determining actual information needs of different players in the cowpea supply chain. In addition, this chapter will also add to the existing market information base by investigating the relation between cowpea prices in different Senegalese markets, i.e. the level of market integration.

4.2 MARKET INFORMATION NEEDS OF ROLE-PAYERS IN THE COWPEA SUPPLY CHAIN IN SENEGAL

4.2.1 Defining the scope of market information

The FAO (2000) defines an information system as a collection of objects and processes, called components, which interact to perform a given function or functions. The relations between the components take place through the system of materials, energy and information flow among the components. Therefore, an information system can be defined as a coherent relationship of significant information pertinent to a decision. Bonnen (1975) and Gardner (1975) describe an information system as the well-known processes by which data are collected from primary and secondary sources and transformed into information, which is then communicated to the decision maker to produce

knowledge. Consequently a simple information system consists of three basic elements, namely inputs, processing and output (Figure 4.1).

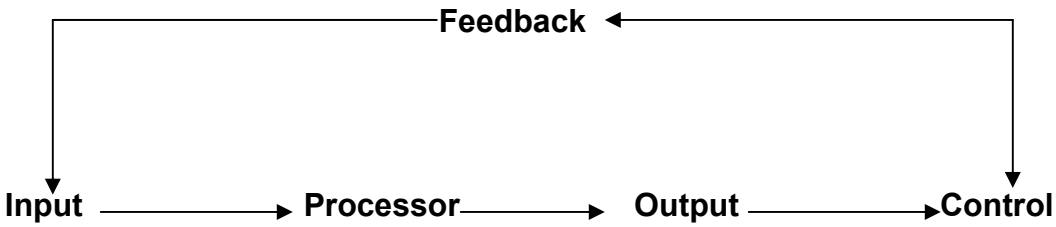

Figure 4.1: A simple information system
Source: Frick and Groenewald, 1998.

A Marketing Information System (MIS) is a structured approach to collecting, analyzing and communicating information about markets and marketing. It should increase market transparency for users and enable them to make more informed production and marketing decisions (FAO, 2000). Users who set up a MIS should find that their skills are improved in terms of making informed marketing decisions, negotiating with other actors in the marketing chain and organizing production and sales.

However, as mentioned by Louw, Jooste, Van Schalkwyk and Frick (2000), market information can take various forms. It varies from market analysis and forecasts for different commodities to the social and economic impact of trade agreements and the effect of climate on the production of certain commodities in various geographical regions.

Furthermore, one should consider the formal or informal nature of information. Wu, Just, Zilberman and Wolf (1999) define informal information as information

that one cannot buy with money, but for which one must find time through conversation.

4.2.2 The importance of market information

If you are in business and your objective is to make a profit - and no business is sustainable without it - one of the first things to do is to identify the potential market, find out what the market wants and what is it willing to pay (Louw *et al*. 2000). Which kind of information is the most important will depend upon local needs, priorities and the user's position in the marketing chain. The very nature of agriculture sector linkages, as well as the differences that exist amongst specific interest groups, suggest that information are likely to differ. Differences in activities amongst groups of market actors lead to differences in their information needs. In most cases, each person requires information about the sector in which he or she is involved. Certainly, in order to market goods or services effectively, the seller needs reliable information about buyers' preferences. Similarly, to ensure that the most effective production and distribution methods are being used, producers need to know what their options are. Wu *et al.* (1999) state that since different groups makes different kinds of decisions, one would expect to also see different information seeking behaviour on the part of each group. There is, however, a common aim, direct or indirect, among all the users of agricultural information, namely to maximize the returns on investment in the short, medium and long run (see Frick and Groenewald,

1999; Christy, 1984; Russell, 1983; Craig, 1979). Marketing information is therefore critical to the success of any business.

Based on this, marketing information makes the market more transparent so that market actors can make proper choices about production and sales. Many types of marketing information are useful in business decision-making since they enable users to:

- Compare prices in different markets;
- Compare transport alternatives and cost;
- Assess opportunities to improve production;
- Determine the break-even point for production;
- Locate and assess new product opportunities;
- Identify problems like the availability of cheap substitutes; and
- Determine factors affecting prices.

Notwithstanding the aforementioned, market information may not always be available in a symmetric way. Asymmetric information usually gives rise to different bargaining positions in the market. This may cause market failure, which in turn might result in more policies to regulate trade. However, if information is available in a symmetric basis, this could serve as a countervailing power to market failure. Hence, instead of policies designed to counter market failure, government should create an environment where

information can be accessed by all the market participants (Jooste and Groenewald, 2001).

Aina (1995) regards repackaging and dissemination of information as crucial to the provision of relevant and timely information to agriculture information users. In his view, this is the crux of the matter as it is the main source of the problem of providing agriculture information in Africa. ISNAR (1993) reinforced this view by mentioning that the linkage between information staff and their clients is the weakest part of the information management chain.

4.2.3 Existing market information systems in Senegal

Several market information systems were identified in Senegal. However, few are related to agricultural products. Those applicable to agricultural markets are discussed briefly below.

- The Governmental Market Information System (SIM) is based at the Food Security Service (CSA). It collects, on a weekly basis, data on producer prices, retailer prices and quantity of millet, sorghum, maize and groundnuts. SIM covers 47 markets in Senegal since 1987. Information collected is disseminated through a report to potential users. The same information is also broadcasted in local languages and published in newspapers.

- Manobi is a private market information system and uses teams to gather information about prices of foods, such as groundnuts, fruits and vegetables, being sold in and around Dakar since 2000. Through the Manobi project farmers and market actors can receive, in real time, market information using their mobile (cell) telephones. Users need to register with a username and password in order to have access to the information.

- Oryza Corporation is an internet based market information system which focuses on rice information pertaining to production, trade and Government policies. Oryza has an alliance of key industry participants from the leading rice markets worldwide. It provides worldwide rice market information in order to guide rice market actors. The information provided is free of charge, but is limited to its network members.

- The *Direction de l'Analyse et des Previsions Statistiques* (DAPS), which operates under the control of the Ministry of Agriculture and Livestock, collects and disseminate some agricultural data. It provides aggregated data on areas planted, production and inputs used, but to particular users such as researchers or input suppliers.

- Trade Point, created in 1998, operates under the supervision of the Trade Ministry. The mission of Trade Point Senegal (TPS) is to facilitate

data collection and processing. Trade Point aims to: (1) allow diffusion and access to strategic commercial information, (2) facilitate commercial transactions and (3) provide information on local and foreign markets without any restriction. TPS gathers information on about fifty countries that trade with Senegal.

Except for the DAPS, none of the systems described collects data on cowpeas. Farmers currently have no way of finding out what prices are before they actually travel to the market, even if their crop is in short supply at a particular market place. Often collectors take advantage of this ignorance and offer to buy the cowpea at prices far lower than what farmers could get if they traveled to the appropriate market themselves.

The survey described below could hence provide valuable insights into what is required in terms of cowpea information, which in turn could be used to advise information providers on the specific needs that exist.

4.2.4 Data collection

The US Department of Agriculture (USDA), a world leader in collection and distribution of agricultural data, prescribes the following methodologies to gather agricultural data:

- Informal methods that imply the use of indications received from data users verbally or in written form;
- Data user conferences or meetings, or
- Survey techniques.

In this study the informal methods and a survey was used to determine the information needs of stakeholders in the cowpea supply chain. A questionnaire (see Appendix B) was developed to gather data from producers, wholesalers, collectors and retailers. Aspects such as what type of information should be a priority and the way of communicating information is addressed.

The survey was conducted in the Louga, Thiès and Diourbel regions since they supply about 85 per cent of the cowpea produced in Senegal. In addition, all types of market actors as described in Chapter 2 can be found in these regions. Informal methods were applied in Kaolack, Touba and Dakar to collect information from institutions and key persons who have experience in cowpea production and marketing.

4.2.5 Sampling strategy and sample size

On the producers' side, ISRA and the Non-Governmental Organization (NGO), World Vision International, have set up a network called the Pilot Cowpea Producers Network. All the leading members of this network were interviewed.

In terms of small-scale producers a list of all the villages and households published by the Ministry of Agriculture and the World Bank in 1999 was used to identify respondents.

A sample of 400 producer households was randomly chosen using the Table of Random Numbers. The sample size was drawn in accordance to Leedy (1997) who argues that if a population size is larger than five thousand, the sample size becomes almost irrelevant and a sample size of 400 is adequate. In each household the questionnaire was directed to an individual who is involved in cowpea production and/or marketing. Collectors, wholesalers and retailers were surveyed in rural and urban markets located in the area where the survey was conducted.

Data collected from different players were supplemented by information provided by traders based in Touba, Kaolack and Dakar who also handle significant quantities of cowpea each year.

Table 4.1 shows the spectrum of the role-players interviewed. In total 443 market actors were interviewed from which 54 per cent were producers, 17 per cent retailers, 15 per cent wholesalers, 14 per cent collectors and 2 per cent exporters.

Table 4.1: Different role-players interviewed

Actors	Interviewed	Percentage
Producers	238	54
Retailers	75	17
Wholesalers	66	15
Collectors	64	14
Exporters	7	2
TOTAL	**443**	**100**

On average, 60 per cent of the interviewees were male while 40 per cent were female. In the case of retailers and collectors 60 per cent were female while only 10 per cent of the exporters were female. In the case of producers, 48 per cent were male while 52 per cent were female. 60 per cent of the sample can read and write in French, in the local language or in Arabic.

4.2.6 Results

4.2.6.1 Importance of price, quantity and preferences

Table 4.2 shows the extent to which different role-players in the market require information on prices, availability of cowpeas and preferences of consumers.

Table 4.2: Information requirements of different role players

Actors	Price		Quantities		Buyers preferences	
	Percentage					
	Yes	No	Yes	No	Yes	No
Producers	100	0	48	52	98	2
Wholesalers	100	0	65	35	100	0
Collectors	100	0	22	78	59	41
Retailers	100	0	55	45	35	65
Exporters	100	0	100	0	100	0

All respondents interviewed indicated that they require the price per kg of cowpea. Price information should be available for local and export markets. Respondents have indicated a particular need for price information for the Mauritania and Gambia markets to where they often export their cowpea.

About one half of the producers interviewed did not see information on quantities as important. This could probably be explained by a combination of several factors; (i) they are focused mainly on providing enough for own consumption with relatively small surpluses sold to collectors, (ii) it is their main source of additional income and for this reason sell at any prices offered to them, (iii) the lack of understanding of the impact of over-supply in the market and (iv) that such information is in any case not available. Collectors, surprisingly, do not attach much importance to the availability of supply either. This is attributable to the fact that they mainly act on the directives of wholesalers. One would also expect the importance attached to supply to have been rated higher by retailers. This is probably explained by the fact that retailers buy what is available from wholesalers, and that low supplies can easily be substituted with other products. The importance exporters attach to availability of supplies is indicative of a more organized marketing chain where exporters stand to lose market share and clients should they not be able to honor export contracts.

In the case of buyers' preferences, the results are also mixed. For producers, such information assists them in their decision to plant the appropriate varieties and affects their ability to sell in appropriate markets. For wholesalers and exporters, this information is important since they need to make the correct purchasing decision for further distribution and to ensure that they buy from the appropriate production region or producer. The probable reason why collectors and retailers attached lesser importance to buyers' preferences is because they act on signals they receive from the wholesalers and exporters, i.e. collectors buy what wholesalers ask them to and retailers sell what is being supplied by wholesalers.

4.2.6.2 Information needs of researchers

For researchers, the only information needed is related to producer variety preferences and the cost of production, as well as the constraints farmers' face in production**.** Cowpea breeders, agronomists and food scientists are interested in such information because it could enable them to appropriately adapt their research programs. In addition, it could provide guidelines on what are the most appropriate issues to research.

4.2.6.3 Information needs of institutions

Institutions dealing with market information systems, such as SIM, need to know what information is needed by market actors' and also what is the most

appropriate form of disseminating such information. In addition, they need information related to donors who can support the market information systems to disseminate available information.

4.2.6.4 Method of communicating the needed information

With respect to the method of communicating cowpea related market information, the results show that different modes are preferred depending on the players access to different communication methods. Options include the use of radio broadcasting, telephone calls, television documentaries, e-mail exchanges, web pages specializing in cowpea or other agricultural products, reports and the daily newspapers. Table 4.3 shows the preferences of respondents with respect to different information dissemination methods.

Table 4.3: Methods of communicating information on cowpea market

Actor	Percentage of respondents favoring:						
	Radio	Telephone and Cell-phone	TV	e-mail	Internet	Reports	News-paper
Producers	100	60	42	45	26	3	1
Wholesalers	100	95	37	40	9	7	3
Collectors	100	75	24	7	3	5	2
Retailers	100	19	41	1	2	4	1
Exporters	100	96	80	57	41	3	2

Radio was mentioned by all the respondents as being the best way of communicating market information to its users. This is because radio is popular and every market participant can have access to a radio wherever he or she is.

In addition, there are many radio stations in Senegal broadcasting in local languages and in French at different times everyday. Respondents did, however, indicate that the broadcasting time is an important issue to consider. Between 8pm and 9pm or early in the morning from 6am to 7am were regarded as being good times to provide information, particularly on prices. Another issue to consider is that farmers, in some cases, could perceive prices disseminated through such media as prices being set by government since this was the practice in the past. Therefore, it is imperative that when the information is disseminated an explanation is provided about how the data is being collected in the market and that the government has no role in setting such prices.

Telephone and cell-phones also appear to be a popular way of receiving information. This can be attributed to wide spread use of the cellular phones in Senegal. The only major constraint would be the billing system, but the pre-paid phone card is well established and phone cards are available in all cities and in some of the larger villages.

Television appears to be the 3rd most favored way to receive information. The use of this mode is, however, limited due to time constraints in, and scheduling of, time slots compared to the radio. In addition, access to television could be limiting.

The other modes of information dissemination appear to be less favored. This can be attributed to lack of access to, for example, computer technology, the time it takes for reports and newspapers to reach interested parties, the time and ability to do own evaluation of information and the language in which reports and newspapers are published. As for the latter, 58 per cent of the respondents indicated that such documents should be written in French, 33 per cent would like materials prepared in Wolof, which is the main national language, and 12 per cent preferred Arabic.

4.3 COWPEA MARKET INTEGRATION

This section is based on the hypothesis that there is a general lack of market information in the cowpea sector, and for this reason cowpea markets are not well integrated.

According to economic theory, two markets are intergraded when their price levels are closely related (Stigler, 1969). Economic literature distinguishes three forms of market integration (Bopape and Christy 2002). These forms are (1) integration across time, (2) integration across product and (3) integration across space. Markets are said to be integrated across time (inter-temporally integrated) when the expected price differential does not exceed the cost of storage. When integrated across product form, markets are vertically integrated and the price differential between two related commodities should not exceed

transportation and processing costs. Markets are integrated across space if, when trade takes between them, price in the importing market equals price in the exporting market plus transportation and other costs of moving the product between the two markets. The relationship between prices in different markets has been the topic of investigation by many researchers; these include amongst others Delgado (1986), Huff and Rust (1984), Dublin (1988), Monke and Petzel (1984), Ravallion (1986), Uri and Rifkin (1985) and Dahlgran and Blank (1992).

This section shows how different cowpea markets in Senegal are interrelated across space. The following discussion is important since data on storage and processing cost were not collected and was not available at the National Statistic Services. Monthly retail prices for cowpeas collected from 1996 to 2003 by the former food security project (PPCL) and ISRA are used. Data were collected from Dakar, a major consumption area in Senegal, Louga a major cowpea producing area and Bambey and Nioro that are transition zones from producing to consumption areas. The descriptive statistics of the data used are summarized in Table 3.4.

Table 4.4: Descriptive statistics on retail prices used (FCFA/KG)

MARKET	N	MEAN	ST. DEV	MIN	MAX
Bambey	329	246	101	75	778
Dakar	329	309	99	138	550
Nioro	329	282	97	100	650
Louga	329	196	71	80	469

In total 329 observations on prices are used to test for cowpea market integration. The mean price ranges from 196 FCFA per kg in Louga to 309 FCFA per kg in Dakar. The highest and lowest prices were observed in Bambey.

4.3.1 Testing for market integration: model specification

One method to measure the significance of price relationships between markets in different geographic areas (across space) is to compute bivariate correlation coefficients (r) which are then used as a proxy for the level of market integration. A high (r) implies market integration and vice versa. The theory of price correlation was explicitly formulated by Stigler (1969). Stigler and Shervin (1985) linked the statistical test for price correlation to market integration when they proposed examining price correlation as a test for market integration. The use of correlation coefficients to ascertain the degree of market integration is quite common (see for example Bopape and Christy, 2002; Fafchamps and Gavian, 1995; Baulch, 1994; Stigler and Shervin, 1985).

However, the non-stationary nature of agricultural time series price data and some other common factors, such as occurrences of drought and inflationary pressures can influence prices in markets investigated in such a way that the (r) values suggest market integration even if markets are not really integrated.

Hence, testing for market integration by only using correlation coefficients could lead to biased results.

Another approach used to test for market integration is the co-integration method. The use of the co-integration test as a tool for analyzing market integration was proposed by deVany and Walls (1993), since it establishes whether or not there is a long-run equilibrium between two or more price series. The authors argue that the long-run equilibrium level that is present when price series are co-integrated serves as an indicator that the price series are integrated into a single market. Due to the non-stationary nature of most agricultural price time series data the co-integration approach usually involves two steps. The first step involves testing each time series for stationarity or for the degree of integration using the Augmented Dickey-Fuller unit root test.

To test for integration of degree 0 price integration, the following equation is estimated:

$$\Delta P_t = \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 \Delta P_{t-1} + \alpha_3 \Delta P_{t-2} + \varepsilon_t$$

Where:

P_t = log of cowpea price at time t; and

$\Delta P_t = P_t - P_{t-1}$

The t-values for α_1 are then compared to the critical values for the Augmented Dickey-Fuller test. If t-values for α_1 are smaller than the critical values then the hypothesis integration of degree 0 is accepted and the price series are said to be stationary. If integration of degree 0 is not accepted, then a second set of regressions is defined to test for integration of degree 1 and is denoted as:

$$\Delta^2 P_t = \beta_0 + \beta_1 \Delta P_{t-1} + \beta_2 \Delta^2 P_{t-1} + \beta_3 \Delta^2 P_{t-2} + \varepsilon_t$$

The t-values for β_1 are again compared to the critical values for the Augmented Dickey-Fuller test. Similarly, if t-values for β_1 are smaller than the critical values then the hypothesis integration of degree 1is accepted.

If integration is accepted, the second step involves testing for co-integration as defined by Engle and Granger (1987). First, residuals are obtained from regressing the price in market *i* on the price in market *j* as follows:

$$P_{it} = \alpha_0 + \alpha_1 P_{j,t} + e_t \qquad (1)$$

Where

P_{it} = Price in market *i* at time t;

$P_{j,t}$ = Price in market *j* at time t; and

e_t = Residuals

To test for price co-integration between market *i* and market *j*, the residuals from equation 1 are tested for integration of degree 0 using the following equation:

$$\Delta\hat{e}_t = k_0 + k_1 \hat{e}_{t-1} + k_2 \Delta \hat{e}_{t-1} + k_3 \Delta \hat{e}_{t-2}$$

The t-values for k_1 are then compared to the critical values for the Augmented Dickey-Fuller test. If t-values for k_1 are smaller than the critical values then the hypothesis of co-integration is accepted.

Toppinen and Toivonen (1998), L'Hegaret, Siliverstovs and Hirschhausen (2003) and Stevens and Brooks (2003) used the co-integration approach to investigate prices relationships in various domains such as energy, round wood and food markets.

However, Barret (1996) argues that co-integration is a linear approximation that assumes a linear relationship between prices. The assumption can be violated in the case where trade is severely affected. In such cases, the hypothesis of co-integration could be rejected while it should be actually accepted. In addition, co-integration itself cannot be used to make assumptions about the direction of price spread between markets.

Another method used to investigate the degree of market integration is the Granger Causality test. This approach is used to determine how price changes in one market explain price changes in another market. Granger Causality tests focus on the presence of at least unidirectional causality linkages as an indication of some extent of integration (Gupta and Mueller, 1982). Moreover, it assesses whether price movement follows a well defined path, i.e. if price movement starts around demand or production zones and spreads across other markets. This method has been used recently by Nath and Samanta, (2003), Wu (2001) and Piesse and Hearn (2002) to investigate market integration.

To conduct this test the following equation is estimated as suggested by Trotter (1992) and is denoted as:

$$\Delta P_{it} = \lambda_0 + \lambda_1 P_{it-1} + \lambda_2 P_{jt-1} + \lambda_3 \Delta P_{it-1} + \lambda_4 \Delta P_{jt-1}$$

To investigate for Granger Causality, the following hypothesis is tested:

$$H_0: \lambda_2 = \lambda_4 = 0$$

If the F-value is smaller than the critical value then price changes in market *j* have no effect on price changes in market *i*, i.e. λ_2 and λ_4 are not significantly different from zero.

A common problem with the Granger Causality test is also, like co-integration, it assumes a linear relationship between prices (Bopape and Christy, 2002).

Another approach to investigate market integration involves the dynamic dimension of market integration that applies the Ravallion model. As described by Dahlgran (2000), Ravallion's model of market integration is a basic methodology to investigate for spatial market integration. It accommodates prices that are determined in *n* related markets and is denoted as follows:

$$P_i = f_i (P_j, x_i)_i \qquad i = 1, 2\ldots,n \quad \text{and} \quad j = 1, 2\ldots,(n-1)$$

Where:

P_i = price of the product in market *i*;

P_j = price of the product in market *j*; and

X_i = the set of non-price exogenous variables such as, distance and transportation cost that influence the supply and demand for the product in market *i*.

Based on the above, the following pairs of equations are jointly defined to test for market integration:

$$\Delta P_{it} = \alpha_0 + \alpha_1 \Delta P_{jt} + \alpha_2 \Delta P_{it-1} + \alpha_3 \Delta P_{jt-1} + \varepsilon_{it} \quad (1)$$

$$\Delta P_{jt} = \beta_0 + \beta_1 \Delta P_{it} + \beta_2 \Delta P_{jt-1} + \beta_3 \Delta P_{it-1} + \varepsilon_{jt} \quad (2)$$

Where:

P_t = the log of price at time t ; and

$\Delta \mathbf{P_{it}} = P_t - P_{t-1}$

For each pair of markets, three sets of F-tests are conducted, i.e. three hypotheses are tested.

(1) To test if market *i* and market *j* are segmented, i.e. separated, the following hypothesis is tested:

$\mathbf{H_0: \alpha_1 = \beta_1 = \alpha_2 = \beta_2 = 0}$

If $\mathbf{H_0}$ is accepted then market are segmented, in other words markets are entirely unrelated.

(2) To test if market *i* and market *j* are integrated in the short run the following hypothesis is tested:

$\mathbf{H_0: \alpha_1 = \beta_1 = 1}$ and $\mathbf{\alpha_2 = \alpha_3 = \beta_2 = \beta_3 = 0}$

If $\mathbf{H_0}$ is accepted then markets are integrated in the short run.

(3) To test if market *i* and market *j* are integrated in the long run the following hypothesis is tested

$\mathbf{H_0: \alpha_1 + \alpha_2 + \alpha_3 = \beta_1 + \beta_2 + \beta_3 = 1}$

If $\mathbf{H_0}$ is accepted then markets are integrated in the long run

In this study, rather than relying on only one approach to investigate the degree of cowpea market integration in Senegal, all the approaches described above are used in order to account for the complex interactions of prices in different

markets. Cognizance should be taken that in the case of the Ravallion's model exogenous factors are excluded because the only exogenous factor identified as being able to affect supply is rainfall, and it is not significantly different within the production areas.

The idea of a central market was not maintained even though the production or the consumption zones could be considered as a focal point for cowpea price formation.

It should also be noted that analyzing market integration without accounting for transaction cost effects has been criticized since the primary mechanism ensuring market integration is spatial trade and arbitrage (Goodwin and Piggott, 2001). Nevertheless, even if the various measures of the degree of market integration have come under scrutiny there is still no unified approach to evaluate market integration (Meyer, 2003). By using different approaches to measure the degree of market integration, as in this study, it is believed that consistency in the results obtained will suffice whether market integration is present or not.

4.3.2 Results

4.3.2.1 The price correlation method

Table 4.5 shows the bivariate correlation coefficients, which range between 0.20 and 0.54. The coefficients are relatively low indicating a low degree of market integration. The highest correlation coefficient (0.54) is observed between Bambey and Louga. For Nioro, the relatively low coefficients (0.20 to 0.23) seem to be consistent with the hypothesis that long distances and poor transportation infrastructures make arbitrage unprofitable and isolate markets (Timmer, 1974). This hypothesis does not seem to be relevant when explaining the low correlation coefficient (0.21) between Bambey and Dakar. Transportation infrastructure is well developed between Dakar and Bambey and transportation cost is not a significant issue. The probable reason would be the lack of information and the low volume of cowpea traded compared to Louga.

Table 4.5: Price correlation matrix

Bambey	1			
Dakar	0.21	1		
Nioro	0.23	0.20	1	
Louga	0.54	0.48	0.21	1
	Bambey	**Dakar**	**Nioro**	**Louga**

4.3.2.2 The co-integration approach

Table 4.6 shows the results of step 1 as discussed earlier when using the co-integration test. At a 1 per cent level of confidence, the t-values for integration of degree zero are greater than the Augmented Dickey-Fuller critical values and therefore the hypothesis of integration of degree 0 is rejected while integration of degree 1 is accepted for all price series. Therefore, co-integration tests can be conducted for all pairs of prices series.

Table 4.6: t-values for degree integration

Locations	Integration of degree 0	Integration of degree 1	ADF critical value at 1% level
Bambey	-2.03	-9.03	-3.96
Dakar	-1.52	-8.52	-3.96
Louga	-3.54	-7.54	-3.96
Nioro	-3.48	-14.48	-3.96

The results of the co-integration test are shown in Table 4.7. Except for the pair Louga-Dakar, all the t-values are greater than the critical Augmented Dickey-Fuller (-3.96) therefore rejecting the presence of co-integration for the other pairs of markets. With a t-value of -4.65 which is smaller than the critical value for the Augmented Dickey-Fuller test, the hypothesis of co-integration is accepted for the pair Louga-Dakar.

Since co-integration serves as an indicator that the price series are integrated into a single market, one can expect that Louga and Dakar markets are integrated.

Table 4.7: t-values for price co-integration

Dakar	-2.53		
Louga	-3.21	-4.65	
Nioro	-3.35	-3.45	-2.61
Markets	**Bambey**	**Dakar**	**Louga**

4.3.2.3 The Granger Causality test

Based on the premise that the Granger Causality test assesses whether price movement follows a well defined path, i.e. if price movement starts around a demand or production zone and spreads across other markets, it was applied between Louga (production area) and the other markets. The results of the test (Table 4.8) show only a significant relation between Louga and Dakar with a F-stat of 8.25 and a P-value of 0.01. From this it could be derived that cowpea price variations in Louga affect, in some sense, cowpea price variations in Dakar. This is not a surprising outcome since most of the wholesalers in Dakar buy their cowpea from Louga, and hence any change in price in Louga may affect prices in Dakar.

Table 4.8: Results of Granger-Causality test

Pairs of markets	F-test	P-value
Louga-Bambey	1.69	0.13
Louga-Dakar	8.25	0.01
Louga-Nioro	1.42	0.23

Granger (1988) stated that co-integration between two variables implies the existence of causality between them. Furthermore, if two markets are integrated, the price in one market would commonly be found to have an impact on the price in the other market. Referring to the pair of markets Louga-Dakar, the results from the Granger Causality test are consistent with such a statement. Nevertheless, it is important to note that although co-integration between two price series implies Granger Causality, the opposite is not necessarily true (Rapsomanikis, Hallam and Conforti, 2003).

4.3.2.4 Results of Ravallion test

The results of the market integration test using Ravallion's model are summarized on Table 4.9.

Table 4.9: Output of Ravallion's test between pairs of markets

Test H_0: Markets are separated		
	F-stat	P-value
Louga-Bambey	1.82	0.12
Louga-Dakar	1.38	0.24
Louga- Nioro	0.66	0.62
Bambey-Dakar	2.15	0.07
Bambey-Nioro	11.52	0.00
Dakar-Nioro	0.59	0.66
Test H_0: Markets are jointly integrated in the SR		
	F-stat	P-value
Louga-Bambey	119.21	0.00
Louga-Dakar	137.21	0.00
Louga- Nioro	119.90	0.00
Bambey-Dakar	145.90	0.00
Bambey-Nioro	63.65	0.00
Dakar-Nioro	157.97	0.00
Test H_0: Markets are jointly integrated in the M or LR		
	F-stat	P-value
Louga-Bambey	99.62	0.00
Louga-Dakar	113.50	0.00
Louga- Nioro	88.53	0.00
Bambey-Dakar	122.35	0.00
Bambey-Nioro	53.51	0.00
Dakar-Nioro	133.74	0.00

The results show that out of the six pairs of markets, only the pair Dakar-Bambey and the pair Bambey-Nioro are not segmented, i.e. separated from each other. In other words, prices in Bambey seem to have similar trends than prices in Dakar and Nioro. If the result makes sense between Dakar and Bambey, it is not the same for Nioro since market actors don't even attend the Bambey weekly markets where producers from many areas bring different agricultural products for sale.

The hypothesis of integration in the short and long run are rejected throughout. Results from the Ravallion's test do not confirm the outcome regarding market co-integration between Dakar and Louga found from the co-integration and Granger Causality tests.

4.4 CONCLUSION

In order to suggest improvements in the publicly supported statistical services in terms of the information they provide for cowpeas the existing market information, as it relates to cowpeas, has been described and evaluated. None of the described systems, except the DAPS, collects data on cowpeas.

The survey conducted on market information needs shows that information on price and quantities (supply and demand) should be available for local and exports markets. Information on buyers' preferences is also very important. However, all information should be relevant to the users. According to the survey, information provided should also be understandable and accessible.

Radio, Telephone, Television, e-mail, Internet, reports and news-paper were all cited as ways of disseminating market information. Information dissemination by radio was noted by 100 per cent of the respondents as being the best way of communicating market information.

The degree of cowpea market integration was also assessed using different approaches, including bivariate correlation coefficient, the co integration test, the Ganger Causality test and Ravallion's market integration test. Results from these tests show that cowpea markets in Senegal as a whole are not integrated. This is not a surprising result since it can be linked to the general lack of market information.

CHAPTER 5

INFLUENCE OF COWPEA CHARACTERISTICS ON COWPEA PRICES

5.1 INTRODUCTION

Much attention is paid by economists, agro economists and other theorists to the price of a product and those factors, such as the price of substitutes and complements, which could have an influence on the price of the product under investigation. There is also good reason for the amount of energy spent on such investigations since information generated could greatly assist in the understanding of the relation that exists between different products and services. However, cognizance should also be taken of the fact that the price of a particular product reflects the utility that a consumer is willing to purchase at a given time and place. In other words, products possess certain characteristics that are attractive to consumers. In examining demand for a product it is useful to think of consumers not as purchasing the product, but as purchasing its characteristics that provide utility. Consequently, it is important to measure the specific characteristics that consumers perceive as providing them with utility.

Considering the above, very little is known about the willingness of consumers in Senegal to pay for certain characteristics of cowpea. This state of affairs puts producers, middlemen and other role players in the marketing chain at a disadvantage. Hence, if they have knowledge about characteristics of cowpeas

that consumers demand, they could alter their respective operational activities accordingly and thus improve their own state of welfare.

In this chapter, hedonic pricing as a tool to investigate the influence of different cowpea characteristics on cowpea prices will be discussed. This will be followed by specifying a hedonic pricing model for cowpeas in Senegal. The chapter will also discuss the results generated by the mentioned model.

5.2 LITERATURE REVIEW AND THEORETICAL MODEL

Demand theory has traditionally been based on the fundamental precept that a product or a service generates utility. Hence, utility theory has been used to analyze consumer choice of a good or a service based on price and a budget constraint. In the case of food products, the price a consumer is willing to pay may be a function of the marginal implicit prices that an individual is willing to pay for each nutrient (Brooker, Terry and Eastwood, 1986).

Based on the economic principle that product demand stems from the utility provided as a function of its quality characteristics (Berndt, 1991), a hedonic pricing model can be used to investigate the impact of different product characteristics on product prices. As defined by Lancaster (1971), a hedonic price function is a regression of observed prices of a commodity against its quality attributes.

The hedonic pricing method is most often used to value the individual characteristics of agricultural goods because it is relatively straightforward and uncontroversial to apply, since it is based on actual market prices and uses fairly easily measured data. Since its introduction, numerous economists have employed hedonic pricing models as a tool for estimating the price-quality relationships of commodities over time or through cross-sectional data analysis. One of the earliest examples of this methodology dates back to 1974, when Rosen, first used a model of product differentiation based on the hedonic hypothesis that goods are valued for their utility-bearing attributes. He used observed product prices and a specific number of attributes associated with each good to define a set of implicit or hedonic prices.

Brorsen, Grant and Rister (1984) further contributed to the acceptance of this analytical tool by studying market acceptance of rough rice. They evaluated the ability of Federal Grain inspectors to explain the factors that led to the grade classification and estimated the discount associated with each factor using a hedonic price model.

Espinosa and Goodwin (1991) with the same motivation as those authors cited earlier used a hedonic pricing model to assess the impact of wheat characteristics on market prices. Their results showed the importance of gain size and processing abilities on wheat prices.

In 1999, a Jefferson Institute study using a hedonic pricing model concluded that cowpea prices are responsive to discolored seeds, as well as foreign material. The result is that prices varied in concordance with variations in these variables and the product may even be rejected if there are too many discolored, broken or cracked seeds (Jefferson Institute, 1999).

Faye, Ndiaye and Lowenberg-Deboer (2000) used the same tool to analyze the impact of main cowpea physical characteristics on market prices in Senegal. Using a simple OLS model, their results showed that buyers are willing to pay a premium for larger cowpea size and white skin color, whilst prices were discounted for any other skin color and for a certain number of holes.

Balyamujura (2001) also used a hedonic pricing model to assess the impact of different characteristics of tea on tea prices in Uganda.

The general theory of hedonic pricing as used by Rosen (1974), Espinosa and Goodwin (1991) and Faye *et al.* (2000) closely relates to the current study in one important way. It follows the consumer demand approach, i.e. utility experienced by users of cowpeas is a function of its characteristics. From this, it can be assumed that cowpea consumers behave as utility maximizing agents.

The utility maximization problem can be set as follows:

$$Max(U(z))$$

$$S.t. \quad Z_j = \Sigma_i b_{ij} q_i$$

$$E = \Sigma_i p_i q_i$$

Where:

U = Utility;

z = good's characteristics;

b = components of the good;

q = quantity of the good consumed;

p = price of the good; and

E = total expenditure.

From the partial derivatives

(1) $\delta U / \delta z_i$ = marginal utility of the j^{th} product characteristic

(2) $\delta z_i / \delta q_i$ = marginal yield of the j^{th} product characteristic by the i^{th} product

(3) $\delta U / \delta E$ = marginal utility of income

The above utility maximizing problem is underlined by the following assumptions:

- Expenditure equals income, i.e.

$(\delta U/ \delta z_i)/ (\delta U/ \delta E)$

the marginal implicit price of the j^{th} characteristic denoted as

$P_i = \Sigma (\delta z_i/ \delta q_i)((\delta U/ \delta z_i)/ (\delta U/ \delta E))$

- Constant marginal implicit price, i.e.

  $(\delta U/ \delta z_i)/ (\delta U/ \delta E = ß_{ij}$ is constant

- Product characteristics are constant, i.e.

  $\delta z_j/ \delta q_i = z_{ij}$

After some rearrangements, the hedonic price model can be expressed as

$P_i = \alpha + \Sigma_{j=1} ß_{ij} Z_{ij}$

Where:

P_i = price of good *i*;

α is an intercept; and

$ß_{ij}$ = marginal value of characteristic *j* for good *i*.

5.3 DATA USED AND MODEL SPECIFICATION

5.3.1 Sampling method and data collection

To examine the influence of cowpea characteristics on cowpea market prices, data were collected from January 1998 until December 2003 at six Senegalese markets. Data were collected each month at each market and on the same market day where 5 samples were bought from 5 different vendors. The choice of the vendors at a given market was done randomly. The sample starts from a randomly chosen seller and every 5^{th} seller was then selected from whom a sample was purchased. For each sample, the following variables were recorded: market price, weight of 100 grains, average length and width, skin texture, skin color, eye color, number of bruchid holes per 100 grains, type of measurement, category of vendor and selling periods (months and years), sucrose level and cooking time (see Appendix C). For the latter two variables the data was only collected from January 2002 to December 2003. The markets were chosen according to their location and volume of cowpea sales. The six Senegalese markets shown in Figure 5.1 were:

- MPal and Sagatta in the main cowpea production area;
- Bambey and Nioro in the peanut basin where cowpea is a secondary crop; and

- Tilene and Castors in Dakar, which is a major urban consumption area where cowpea is not grown.

Figure 5.1: Targeted Markets in Senegal
Source: http://www.typesenegal.com 2002
Legend: 1 - MPal; 2 - Sagatta; 3 - Bambey; 4 - Nioro; 5 - Castors; 6 – Tilene.

The rest of this section will be used to describe the information that was gathered over the period mentioned. Table 5.1 shows descriptive statistics for different markets for cowpea prices, grain weight (w100) and insect damage (nh100). It is clear that prices show relatively large variations over time and between different markets, which makes analysis of this nature vitally important to understand these deviations better. For example, apart from the hypothesis that seasonality and the distance between markets could explain price changes and differences as attempted in Chapter 4, it is also important to know if there are other variables that affect cowpea prices.

The average grain weight varied between 17 and 19g/100 grains. The heaviest grains were observed in Bambey, Castors and Tilene, while the lightest was observed in Nioro and MPal. The low standard deviation is indicative that grain weight is largely uniform in different regions. It also appears that there only exist small differences across regions.

Insect damage was, on average, surprisingly low. The average number of bruchid holes per 100 grains is between 6 and 9. The low rate of insect damage can probably be attributed to the high rate of use of metallic drums to store cowpea. Faye and Lowenberg-DeBoer (1999) found that over 80 per cent of cowpeas in Senegal are stored in metallic drums.

Table 5.1: Descriptive statistics for prices, weight and insect damage in selected Senegalese markets

Item	N=203	Bambey	Castors	Nioro	MPal	Sagatta	Tilene
PRICE (FCFA)	Mean	188	316	278	156	169	269
	St. Dev	96	111	105	70	91	118
	Min	66	150	100	58	46	100
	Max	532	650	500	400	500	600
w100 (g)	Mean	19	19	18	17	18	18
	St. Dev	3.0	3.0	3.0	3.0	3.0	3.0
	Min	11	11	10	10	10	12
	Max	29	30	25	25	26	30
nh100	Mean	6	6	8	7	9	7
	St. Dev	11	11	10	8	12	8
	Min	0	0	0	0	0	0
	Max	98	100	46	48	102	47

Two types of skin texture are commonly found, namely smooth and rough. The former represents 24 per cent of the sample and the latter 76 per cent of the

sample. Figure 5.2 depicts that, except for MPal and Sagatta where the percentage of smooth skin cowpeas is about 50 per cent, the rough skin cowpea is dominant in most markets.

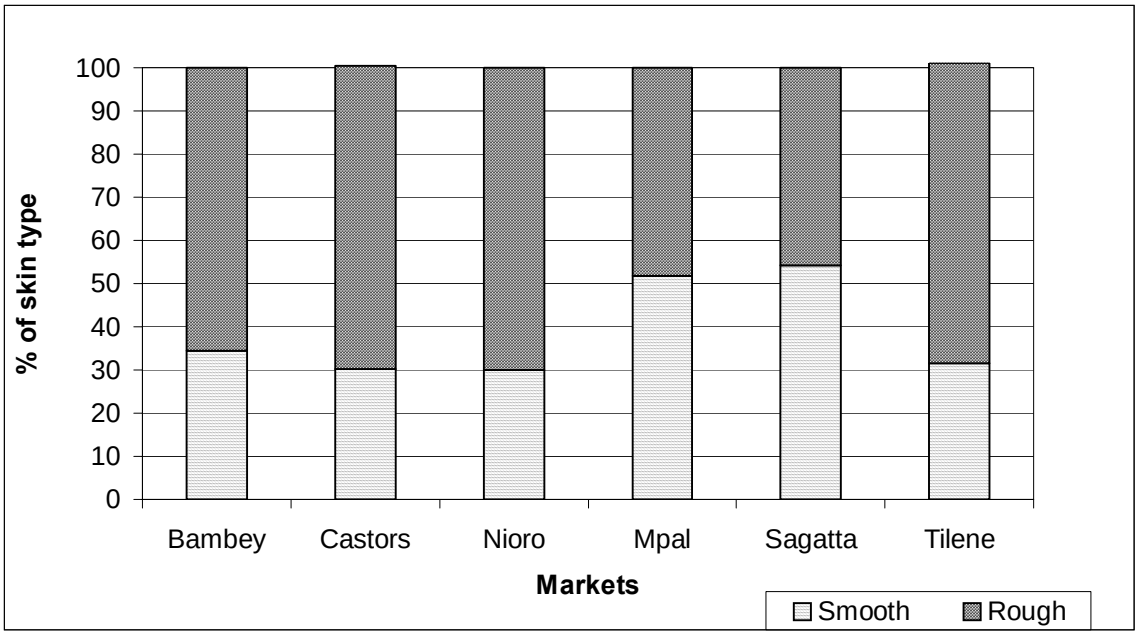

Figure 5.2: Distribution of skin texture

In terms of skin color, the survey has shown that 47 per cent of the cowpea sold is black speckled, 32 per cent is white and 21 per cent is red. Figure 5.3 shows the spread in terms of skin color for cowpeas sold in different markets. In MPal the proportion of white color is 53 per cent while in Bambey, Nioro, Castors and Tilene it is between 15 and 30 per cent. The reason for white cowpeas being the dominant color in MPal is derived from the fact that according to cowpea sellers Mauritanian buyers mainly buy from this market and prefer white cowpeas.

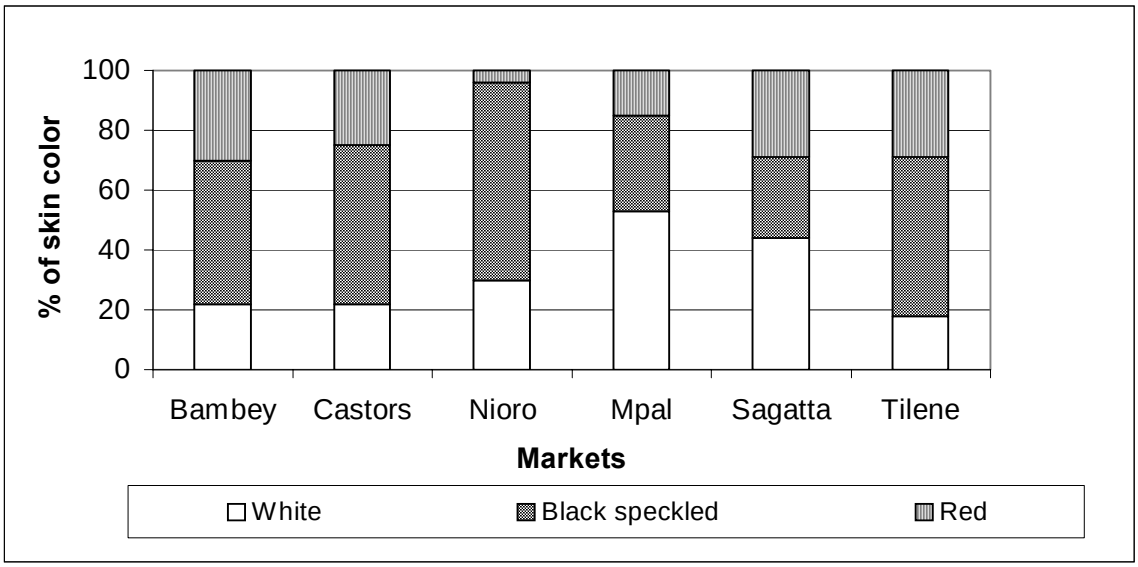

Figure 5.3: Distribution of skin color

Black and maroon eye colors are dominant in the markets surveyed. Black eye color represents 46 per cent of the sample, whilst 54 per cent have a maroon eye color. It is only in Bambey where the black eye color is dominant over maroon eye color. In the Sagatta, Nioro, Castors and Tilene markets the maroon eye color is the most common (Figure 5.4).

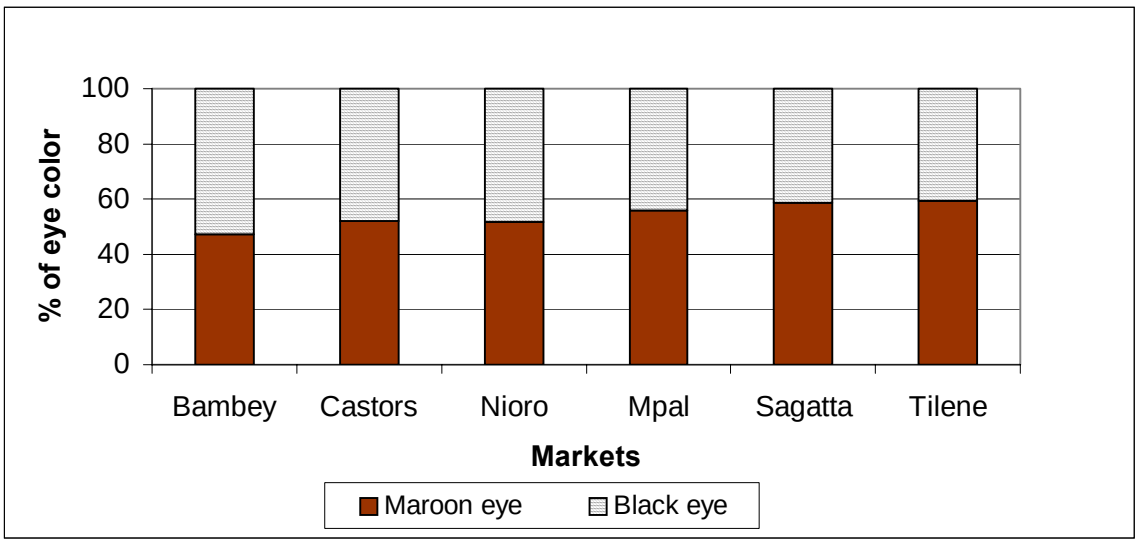

Figure 5.4: Distribution of eye color

The types of sellers from whom cowpea samples were bought are described in Table 5.2. Data show that at Castors and Nioro markets, all sellers are male. On the other hand, in Bambey and MPal, females represent the majority of the sellers, namely 76 per cent and 64 per cent respectively. It is only in Sagatta where the number of female and male sellers is equal. In Tilene and MPal wholesalers are also selling cowpeas.

Table 5.2: Types of sellers (per cent)

Type of sellers	Castors	Tilene	Bambey	Nioro	Sagatta	MPal
Female producer	0	0	48	0	13.5	38
Female retailer	0	0	28	0	36.5	26
Female Wholesale	**0**	**0**	**0**	**0**	**0**	**0**
Total female sellers	**0**	**0**	**76**	**0**	**50**	**64**
Male producer	0	0	24	3	36.5	13
Male retailer	100	83	0	97	13.5	19
Male wholesaler	**0**	**17**	**0**	**0**	**0**	**4**
Total male sellers	**100**	**100**	**24**	**100**	**50**	**36**

To determine the sucrose level and cooking time, tests were conducted. The number of samples eventually used amounted to 72 per market because of a lack of vendors during the rainy season in certain markets, data recording errors and missing data. Table 5.3 shows the descriptive statistics. The average sucrose level ranges from 3.5 per cent to 4.1 per cent (Nioro). It is evident from the result that the sweetest cowpeas are found at Tilene followed by MPal and Sagatta. The lowest sugar content is observed at Castors. The average cooking time is almost homogenous throughout and is between 31 and 34 minutes for all samples.

Table 5.3: Descriptive statistics for sugar contents and cooking time

Item	N=72	Bambey	Castors	Nioro	MPal	Sagatta	Tilene
Sucrose content (%)	Mean	3.5	3.5	4.1	4.0	3.9	3.9
	St. Dev	0.7	0.9	1.0	1.1	1.0	1.2
	Min	2.0	0.6	2.1	2.0	2.0	1.3
	Max	5.2	6.4	6.1	6.7	6.6	6.8
Cooking time (mns)	Mean	32	32	34	31	30	33
	St. Dev	9	9	9	6	6	10
	Min	11	16	16	20	18	16
	Max	68	69	59	47	54	68

5.3.2 Model specification

As is common with statistical analysis of this nature it is necessary to conduct several statistical tests on the data in order to determine whether heteroskedasticity, autocorrelation and contemporaneous correlation are present.

According to Langyintuo, Lowenberg-DeBoer and Faye *et al*. (2003), who studied cowpea production and marketing in West and Central Africa, when using pooled cross-section and time series data where the cross-sectional units are distinct units, such as households and individuals, the disturbances of the cross-sectional time series units may be assumed mutually independent and not heteroskedastic. In this study, the cross-sectional units are randomized vendors and for this reason the presence of heteroskedasticity and autocorrelation are assumed ruled out.

However, a main estimation problem remains contemporaneous correlation, i.e. correlation between disturbances of different equations at a given period, which will influence the method of analysis. In other words, cowpeas are an agricultural commodity, and hence seasonal effects in a given year due to, for example variable weather conditions, are expected to have related effects on the disturbances for different demand equations in different markets. These disturbances are not always related to the characteristics of the cowpea, and hence the necessity to test for contemporaneous correlation by using the Breush and Pagan method (Judge, Griffiths, Hill, Lutkepoh and Lee; 1985) based on the following steps:

(1) Estimate separate least squares estimates of each equation.

(2) Calculate the error variance ($\sigma_{ii} = e_{ii}/T$) and covariance ($\sigma_{ij} = e_{ij}/T$), where T is the number of observations.

(3) The squared contemporaneous correlation between equations are computed as $r^2_{ij} = \sigma^2_{ij} / \sigma_{ii}\,\sigma_{jj}$

(4) The test statistics for contemporaneous correlation is set as

$\lambda = T*(\sum r^2_{ij})$

λ follows a CHI-square distribution with m(m-1) degrees of freedom where m is the number of equations in the model.

(5) **λ** is used to test if:
H_0: all $\sigma_{ij} = 0$

H_1: at least one covariance is not zero

In this study the null hypothesis of no contemporaneous correlation is rejected from the above conducted test. Consequently, demand models for the different markets are estimated using Seemingly Unrelated Regressions (SUR) to account for correlation between disturbances from different equations.

In order to measure the explanatory power associated with all the variables listed, two linear hedonic demand systems of respectively of five equations (SUR1) and (SUR2) are estimated using the Shazam econometrical software package. Data availability is the driving force behind the decision to estimate two different hedonic demand systems. In SUR1 a set of data collected from all markets from January 1998 to December 2002, excluding sucrose and cooking time, is used. In SUR2 a set of data collected from January 2002 to December 2003 that includes sucrose level and cooking time is used.

The hypothesis tested is whether the information conveyed jointly by dummy variables and the quantitative variables can explain the observed price variations at a given point in time. The linear model of hedonic pricing is used because of the easy interpretation of its coefficients, which are seen as discounts or premiums on price due to a given characteristic.

SUR1 is denoted by the following equations:

BPRICE = f (Bw100, Bnh100, Brsc, Bbsp, Bsmo, Bbey, Bmret, D1, D2)

CPRICE = f (Cw100, Cnh100, Crsc, Cbsp, Csmo, Cbey, D1, D2)

NPRICE = f (Nw100, Nnh100, Nrsc, Nbsp, Nsmo, Nbey, D1, D2)

PPRICE = f (Pw100, Pnh100, Prsc, Pbsp, Psmo, Pbey, Pmret, D1, D2)

TPRICE = f (Tw100, Tnh100, Trsc, Tbsp, Tsmo, Tbey, D1, D2)

Where:

- The first letter of the independent and dependant variables indicates the name of the markets, i.e. B stands for Bambey, C for Castors, N for Nioro, P for MPal and T is for Tilene;
- The dependent variable is price (*PRICE*) in FCFA per kg;
- *w100* = Grain weight or grain size (average weight of 100 grains);
- *nh100* = Number of bruchid holes per 100 grains;
- Skin color (*rsc* for red skin; *bsp* for black speckled skin and *wsc* for white skin);
- Skin texture (*smo* stands for smooth skin and *rou* for rough skin);
- Eye color (b*ey* for black eye and *mey* for maroon eye);
- D1 and D2 represent respectively month and year; and
- Other qualitative variables such as gender of sellers (*mret* for male retailer *fret* for female retailer) are also included in the model.

The qualitative variables are handled as dummy variables using the coefficient restriction $a_i = 0$ where *i* is a characteristic used in a point of reference. Table 5.4 shows the reference variables for the dummies used in the analysis.

Table 5.4: Reference variables

Variables	Base
Skin color	White
Skin texture	Rough
Eye color	Maroon eye
Market	Sagatta
Gender	Female
Month	November
Year	1998

SUR2 is denoted by the following equations:

BPRICE = f (Bw100, Bnh100, Brsc, Bbsp, Bsmo, Bbey, Bsuc, Bct)

CPRICE = f (Cw100, Cnh100, Crsc, Cbsp, Csmo, Cbey, Csuc, Cct)

NPRICE = f (Nw100, Nnh100, Nrsc, Nbsp, Nsmo, Nbey, Nsuc, Nct)

PPRICE = f (Pw100, Pnh100, Prsc, Pbsp, Psmo, Pbey, Psuc, Pct)

TPRICE = f(Tw100, Tnh100, Trsc, Tbsp, Tsmo, Tbey, Tsuc, Tct)

Where:

- Sucrose level (*suc*) and cooking time (*ct*)
- The other abbreviations are the same as for SUR 1.

The sucrose tests used the method developed by Murdock's group at Purdue University, while the cooking time test was done using a 25 grains Matteson

cooker. The minimum number of grains needed for the cooking time test has been determined to be 25 and was used to conduct the test. The cooking time tests were conducted under the most popular household conditions of cooking cowpea using tap water.

5.4 RESULTS AND DISCUSSION

For both models, SUR1 and SUR2, estimates are rounded up because the Senegalese currency doesn't have decimals.

5.4.1 Results from SUR1

The results for SUR1 are shown in Table 5.5 Results from this model show an overall R^2 of 90.6 per cent. This result suggests that the independent variables included in the model jointly explain 90.6 per cent of the variation observed in cowpea prices.

In terms of grain size (w100) consumers in all markets are willing to pay a premium. For example, in MPal market consumers are willing to pay up to 25 FCFA for each additional unit of grain weight. This can be explained by (i) consumers prefer large seeds for their sauce or rice and (ii) processors are willing to pay a premium for large seeds since it yields a larger amount of flour.

The impact of bruchid holes (nh100) on cowpea prices is only significant at Tilene market in Dakar where consumers discount price for just 1 FCFA for any additional bruchid hole. The negligible affect of bruchid hole on price can be attributed to the low level of infestation by insects as discussed previously.

The impact of skin color on price is significant in the MPal and Bambey markets. At MPal market consumers are willing to pay a premium of 15 FCFA for red skin color (rsc), but discount price with 25 FCFA for black skin (bsp) compare to the white skin color, which is the reference. In Bambey, on the other hand, consumers are willing to pay a premium for black speckled skin.

With regard to skin texture (*smo*), consumers discount prices for smooth skin cowpeas in Nioro, MPal and Tilene markets. This discount varies from 20 FCFA at Nioro to 30 FCFA at Tilene. The reason for this is that cowpea varieties with smooth skin are not easy to cook. Consumers in Bambey and Castors appear to be indifferent to the skin texture of the cowpea but discount price for black eye.

As far as gender is concerned consumers in Bambey and MPal prefer males (*mret*). In other markets all sellers are male and for this reason, the variable *mret* was not included in their respective equations since it was a constant.

For almost all the markets considered in this study, monthly dummies have a positive and significant impact on cowpea prices. More specifically, the monthly premiums reflect the storage premium relative to harvest time sales during the October to December period. None of the October variables are significant at the 5 per cent level, whilst only one of the December variables is significant. Almost all the other months are significant showing a very consistent seasonal price pattern.

Regarding the yearly dummies, compared to 1998, which is the base year, the model shows that prices were under considerable pressure in 1999, 2000 and most markets in 2001. This is largely due to the fact that production went from 41000 Mt in 1998 up to 68000Mt in 1999. Although production in 2000 dropped to 47 000Mt is was still higher than in 1998. Production decreased further in 2001 to 32000Mt, but it appears that prices only reacted positively in the production areas of Bambey and MPal.

Table 5.5: Output from SUR1

Variables	Bambey	Castors	Nioro	MPal	Tilene
W100	6*** (4.1)	4*** (2.61)	4*** (2.98)	25*** (4.75)	5*** (2.53)
H100	0.44 (1.31)	0.22 (0.64)	-0.32 (-0.87)	-0.15 (-0.15)	-1** (-2.15)
RSC	10 (0.96)	-8 (-0.72)	10 (0.49)	15** (2.22)	13 (1.21)
BSP	30* (1.70)	7 (0.43)	-25 (-1.48)	-25*** (-2.89)	20 (0.97)
SMO	1 (0.73)	-2 (-0.14)	-22** (-2.18)	-25*** (-3.22)	-30*** (-2.58)
BEY	-40** (-2.40)	-25*** (-2.50)	-5 (-0.18)	10 (1.40)	-20 (-1.05)
MRET	25*** (2.62)	-	-	25.66*** (4.75)	-
JAN	15 (0.84)	40*** (-2.4)	55*** (-2.93)	20** (-2.15)	60*** (-3.42)
FEB	25 (1.58)	50*** (2.99)	85*** (4.61)	15 (1.55)	70*** (3.99)
MAR	40*** (2.49)	60*** (3.25)	75*** (4.08)	30*** (3.34)	65*** (3.65)
APR	25 (1.59)	40** (2.39)	50*** (2.69)	25*** (2.81)	60*** (3.34)
MAY	60*** (3.74)	45*** (2.58)	70*** (3.86)	60*** (6.95)	60*** (3.37)
JUN	70*** (4.24)	65*** (3.79)	85*** (4.63)	45*** (5.13)	90*** (4.84)
JUL	75*** (4.50)	40* (1.94)	85*** (4.75)	70*** (8.53)	95*** (5.30)
AUG	80*** (5.14)	55*** (3.15)	55*** (2.97)	65*** (7.38)	95*** (4.79)
SEP	50*** (3.15)	100*** (4.67)	60*** (3.35)	55*** (5.45)	80*** (4.40)
OCT	-10 (-0.66)	0.02 (0.87)	-2 (-0.94)	15* (1.70)	25 (1.42)
DEC	-1 (-0.79)	-10 (-0.55)	10 (0.54)	35*** (3.48)	-25 (-1.21)
Y99	-55*** (-5.29)	-20*** (-6.16)	-20*** (-17.58)	-30*** (-6.15)	-20*** (-17.63)
Y00	-50*** (-4.93)	-20*** (-4.88)	-20*** (-21.33)	-40*** (-7.41)	-20*** (-17.78)
Y01	110*** (9.46)	-20* (-1.75)	-15 (-1.64)	100*** (17.13)	-25* (-1.76)
SYSTEM R^2 = 0.906					

The t-statistics are in parentheses

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

5.4.2 Results of SUR2

In addition to the information provided by SUR1, the results summarized in Table 5.6 shows that cooking time has a significant impact on price only at the Tilene market, while the sucrose level tends to provide a premium throughout. This premium is as high as 59 FCFA at Bambey and 38 FCFA at Castors in Dakar.

Table 5.6: Output from SUR2

Variables	Bambey	Castors	Nioro	MPal	Tilene
W100	24**	10*	14**	11***	10**
	(2.4)	(1.7)	(2.8)	(3.1)	(2.1)
NH100	-0.4	-0.3	-1.1	-0.3	-1.3
	(-0.3)	(-0.2)	(-1.1)	(-0.4)	(-1.2)
RSC	-24	43	-5.8	58*	16*
	(-1)	(1.1)	(-0.1)	(1.8)	‘(1.7)
BSP	25*	49	48	-54*	7*
	(1.7)	(1.5)	(1.1)	(-1.9)	‘(1.8)
SMO	-36	-77	-65**	-46	-76
	(-0.3)	(-1.2)	(-2.2)	(-1.4)	(-1.1)
BEY	-13	45	-39	-0.4	-8*
	(-1)	(1.55)	(-1.3)	(-0.1)	(-2.2)
SUC	59*	38*	21**	13*	18**
	(1.8)	(3.2)	(2.1)	(1.8)	(2.2)
CT	-1.9	-0.3	-0.5	-0.3	-3.3**
	(-0.7)	(-0.3)	(-0.4)	(-0.2)	(-2.7)
SYSTEM R^2 = 0.819					

The t-statistics are in parentheses

*** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

5.5 CONCLUSION

In this chapter the impact of different cowpea characteristics on cowpea prices in Senegal was investigated. The chapter provides valuable information for

researchers/research institutions, producers and traders. In the case of researchers/research institutions the analysis yields information that could guide plant breeding research. For example, cowpea plant breeders should focus on new breeding programs with the emphasis on large grain size and sugar contents as main characteristics since buyers are willing to pay premiums for this characteristic throughout.

The importance of proper post-harvest handling by farmers and traders are confirmed. Sorting and grading cowpeas according to certain characteristics could greatly enhance supply chain efficiency, e.g. the paper emphasizes differences between markets in terms of consumer preferences for testa color and texture. In other words, if producers sort and grade cowpeas according to these characteristics traders could plan their distribution activities better, which in turn should increase profits as there would be fewer discounts for undesired characteristics in markets where the analysis provided significant results. The importance of adequate storage is also emphasized to protect seeds against insect damage.

Finally, it appears that prices in different markets are not equally responsive to changes in the supply of cowpeas. Higher returns could hence be realized through more efficient sequencing of sales.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

By contributing 19 per cent to the GDP (World Bank, 2001), agriculture is dominant in determining the level of household welfare in Senegal. Agriculture employs about 60 per cent of the labor force and plays an essential role in both the national food supply and the national economy.

Senegalese agriculture is characterized by rainfed cultivation for which the distribution and kinds of crops are closely tied to the amount, distribution and timing of rainfall. The main crops consist of cash crops dominated by groundnuts and subsistence crops traditionally dominated by millet. After millet and groundnuts, with about 10 per cent of the area cultivated, cowpea is the third most important crop in Senegal. Given the growing importance of cowpeas as a means to improve the livelihoods of people in Senegal, coupled with the little information available on the marketing of cowpeas and associated problems, the focus of this study was to investigate the market for cowpeas in Senegal.

Consequently, issues related to cowpea demand, market information system and consumer preferences have been addressed. This chapter brings together the main results and makes recommendations in order to enhance cowpea marketing in Senegal.

6.2 MAJOR CONCLUSIONS DRAWN FROM THE STUDY

6.2.1 Overview of the cowpea sector in Senegal

6.2.1.1 Cowpea area cultivated and production

Cowpeas are mainly produced by small-scale farmers for family consumption and sale. The area planted with cowpea accounts for 1.3 per cent of the world total and is subject to wide variations. The cowpea area is characterized by high variations mainly due to cowpea price changes and climatic conditions. Problems to access improved varieties and pesticides, as well as the high costs of these inputs are also constraints that inhibit expansion of cowpea production in Senegal to reach its full potential.

6.2.1.2 Cowpea market actors and relationships

Even if cowpea is mainly produced by small-scale farmers in Senegal, several intermediaries are involved in cowpea marketing at different levels. Producers, collectors, wholesalers, exporters and retailers are all identified as cowpea

market role-players. Role-players also extend their functions into their non-traditional areas of operations, for example, some successful farmers are acting as traders or even wholesalers. The number of traders tends to decrease as you move from the farm to the urban centers.

The export tax is seen as a barrier to potential smaller exporters who do not have enough capital to finance large-scale cowpea exports. This in turn restricts the number of traders that can export.

It also appears as if the lack of access to credits facilities limits the ability of certain role-players to fully participate in the market.

6.2.1.3 Cowpea marketing margins

The calculated margins show a producer's gross profit of 72 FCFA. For wholesalers and retailers the gross profit is 198 FCFA and 83 FCFA, respectively. Further investigation shows that 31 per cent of the market margin goes to producers, 49 per cent to wholesalers and 20 per cent to retailers.

6.2.1.4 Cowpea price rends

The mean and median prices over the reported period (1998 to 2003) were 321 FCFA per kg and 324 FCFA per kg, respectively, and the maximum and

minimum prices are 700 FCFA per kg and 45 FCFA per kg. Cowpea prices show a relatively high level of deviation from the mean with a standard deviation of 185 FCFA. In addition, while cowpea nominal prices show an increasing trend, real prices have been declining since 2000 due to inflationary pressures.

6.2.2 Characteristics of cowpea demand

6.2.2.1 Cowpea consumption in Senegal

In Senegal, cowpea dry seeds, as well as the green pods are consumed in two main forms: (i)*Thiebou Niebe* which is made of rice, dried fish and cowpea as vegetable and (ii) *Ndambe* made of boiled cowpea cooked with oil, tomatoes and spices and served as dinner or breakfast. Ground cowpea is also used to make snack foods, such as *Accara*, which is a traditional beignet.

Cowpea flour was also used as ingredient in infant food on a small scale, but, a recent study revealed that only one processor out of the previous five is currently producing cowpea flour, whilst none uses cowpea in infant food anymore. Processors and shop owners indicated that cowpea flour did not sell well and deterioration of cowpea flour during storage is also a constraint.

Using the Household Income Expenditure data in Dakar, annual average per capita cowpea consumption was estimated at 1.5 kg in 1997 against 1.2 kg in

1989. Despite the fact that cowpeas are a highly nutritious food, and is also becoming a more valued commodity in urban areas, the overall demand remains low simply because of consumption habits.

6.2.2.2. Cowpea export

Although it is known that Senegal exports cowpea to its neighbouring countries, information on the exact quantities is basically non existent. Information on cowpea exports was mainly sourced from those countries that import cowpeas from Senegal or through oral declarations.

Based on such oral declarations by traders in Banjul (Gambia) the estimated quantity of cowpea imported each year from Senegal is approximately 100 tons. Wholesalers in Sagatta and MPal markets indicated that they export about 10 tons of cowpea per week to Mauritania.

Using available data, it appears that the exports of cowpea to neighbouring countries represent approximately 1 per cent of the total production in Senegal.

6.2.2.3 Cowpea demand relations

An AIDS model was applied to estimate demand relations of cowpeas in Senegal using household expenditure survey data on cowpeas, white beans, green beans and small peas.

Deaton and Muellbauer (1980b) show that the AIDS model satisfies the axioms of choice, aggregates over consumers and has a functional form consistent with known household budget data. The model also allows the restrictions from economic theory to be taken into account during estimation and the cross commodity impact to be captured.

The results show high expenditure share of cowpeas (0.58) and an expenditure elasticity of 0.97, i.e cowpeas are considered as normal necessity. The own price elasticity of cowpea was estimated to be -1.23, which illustrates that cowpea demand is elastic. Cross price elasticities obtained from the model show that cowpea and white bean are substitutes, while cowpeas and green beans appear to be complements. The relationship between cowpeas and small peas was not statistically significant.

6.2.3 Market information systems in Senegal

Several market information systems were identified in Senegal. However, few are related to agricultural products. The market information systems closely related to agriculture are:

- The Governmental Market Information System (SIM) that collects data mainly on cereals;
- Manobi a private market information system which gathers information mainly on vegetables;
- Oryza Corporation, an internet based market information system, which focuses on rice information;
- The *Direction de l'Analyse et des Prévisions Statistiques* (DAPS) that collects aggregated data on agriculture; and
- Trade Point, which goal amongst other is, to promote contact between local traders and foreign markets.

Except for the DAPS which collects data on cowpea areas and production, none of the systems collects data on cowpeas. As a consequence, there is a definite gap in terms of market information for cowpeas.

6.2.3.1 Information needs

As far as information needs are concerned, all respondents interviewed indicated that they require the price per kg of cowpea. Price information should be available for local and exports markets. Respondents have indicated a particular need for price information for the Mauritania and Gambia markets where they often export their cowpea.

About one half of the producers interviewed did not see information on quantities as important. This could probably be explained by a combination of several factors, namely, (i) they are focused mainly on providing enough for own consumption with relatively small surpluses sold to collectors, (ii) it is their main source of additional income, and for this reason sell at any prices offered to them, (iii) the lack of understanding of the impact of over-supply in the market and (iv) that such information is in any case not available. Collectors, surprisingly, do not attach much importance to the availability of supply either. The importance exporters attach to availability of supplies is indicative of a more organized marketing chain where exporters stand to lose market share and clients should they not be able to honor export contracts. In the case of buyers' preferences, the results are also mixed. For producers, such information assists them to plant the appropriate varieties and also to sell in appropriate markets. For wholesalers and exporters, this information is important since they need to make the correct purchasing decision for further

distribution and to ensure that they buy from the appropriate production region or producer.

For researchers, the information needed is related to producer variety preferences, to the cost of production, as well as the constraints farmers' face in production.

Institutions dealing with market information systems need to know what information is needed by market actors' and also what is the most appropriate form of disseminating such information. In addition, they need information related to donors who can support the market information systems.

6.2.3.2 Information dissemination channels

To communicate cowpea related market information, the results show different modes depending on their accessibility. These options are the use of radio broadcasting, telephone calls, television, e-mail exchanges, web-pages specialized in cowpea or other agricultural products, reports and daily newspapers.

Radio was mentioned by all the respondents as being the best way of communicating market information to its users. Telephone and cell-phones also appear to be a popular way of receiving information. Television appears to be

the 3rd most favored way to receive information. The other modes of information dissemination appear to be less favored.

6.2.3.3 Market integration

Based on the hypothesis that there is a general lack of market information in the cowpea sector, the hypothesis of no cowpea market integration was investigated.

Instead of relying on only one approach to investigate the degree of cowpea market integration in Senegal, bivariate correlation coefficients, co-integration, Granger-Causality and Ravallion model were used to account for the complex interactions of prices in different markets. Results from these tests show that cowpea markets as a whole are not integrated.

6.2.4 Influence of cowpea characteristics on cowpea prices

In Senegal, very little is known about the willingness of consumers to pay for certain characteristics of cowpea. This state of affairs puts producers, middlemen and other role players in the marketing chain at a disadvantage. Based on the economic principle that product demand stems from the utility provided as a function of its quality characteristics (Berndt, 1991), a hedonic

pricing model was used to investigate the impact of different cowpea characteristics on its price.

The output of the model showed that in terms of grain size (w100) consumers in all markets are willing to pay a premium. For example, in MPal market consumers are willing to pay up to 25 FCFA for each additional unit of grain weight. This can be explained by (i) consumers prefer large seeds for their sauce or rice and (ii) processors are willing to pay a premium for large seeds since it yields a larger amount of flour.

The impact of bruchid holes on cowpea prices is only significant at Tilene market in Dakar where consumers discount price for just 1 FCFA for any additional bruchid hole. The negligible affect of bruchid hole on price can be attributed to the low level of infestation by insects as discussed previously.

The impact of skin color on price is significant in the MPal and Bambey markets. In Tilene market consumers are willing to pay a premium of 15 FCFA for red skin color, but discount price with 30 FCFA for black skin compare to the white skin color, which is the reference. In Bambey, on the other hand, consumers are willing to pay a premium for black speckled skin.

With regard to skin texture, consumers discount prices for smooth skin cowpeas in Nioro, MPal and Tilene markets. This discount varies from 20 FCFA at Nioro

to 30 FCFA at Tilene. The reason for this is that cowpea varieties with smooth skin are not easy to cook. Consumers in Bambey and Castors appear to be indifferent to the skin texture of the cowpea but discount price for black eye.

Cooking time has a significant impact on price only at Tilene while the sucrose level tends to provide a premium throughout. This premium is as high as 59 FCFA at Bambey.

6.3 POLICY RECOMMENDATIONS

- In light of the fact that the Senegalese Authorities have been successful in promoting the consumption of local cereals in recent years, similar approaches should be utilized in order to stimulate cowpea consumption by Senegalese households. Such approaches could include:

  - Establish food competitions whereby women's associations should prepare meals with cowpeas as the main ingredient. Similar competitions for other foodstuffs have proved to be relatively successful. In addition, awareness campaigns should be launched that focus on the different uses of cowpeas as source of nutritious meals. In this regard, the different attributes of cowpea should be promoted. Promotion could also make use of television spots and recipe brochures on the different uses of cowpea.

- Producers (as collective group), wholesalers and exporters should attend events and trade shows, such as FIARA that is an annual International Agricultural Fair held in Dakar. The goal of the FIARA is to provide international exposure to small-scale farmers and to showcase agricultural products. Processors, for example, attending this event with value added cowpea based products are still doing it in a very non-organized manner. To promote the sale of cowpeas it is imperative to showcase that the value chain is well organized and consumers' needs are adhered too. If this is not the case, urgent attention in this regard is needed. More specifically, a cowpea forum should be established as overarching body where issues like marketing, research, exports, consumer trends and the like could be critically discussed. Such a forum should be inclusive and act as a lobbying institution for cowpea role-players. If furthermore could provide the necessary impetus for the establishment of sub-organizations that represent role-player groups, e.g. a cowpea producer organization.

- Collectors and retailers appear to be ignorant to what their clients' needs are. This is probably due to a poor communication and the fact that they don't have enough, or any information, that could be used to promote the characteristics of cowpeas as nutritious food. Therefore, it is vitally important to inform collectors and retailers about buyers'

preferences, and the opportunity that conveying such information could actually increase their sales. This could be done through the information channels described, as well as with brochures. The suggested cowpea forum could play a vitally important role to achieve this.

- The importance of the export market should receive more prominence, especially as far as processed cowpea products are concerned. The study has shown a reduction in the number of processors willing to add value to cowpeas due to low local demand for cowpea flour and storage problems. This is notwithstanding the fact that there are clear indications that non-Senegalese buyers do have a preference for cowpea flour. Addressing these problems, i.e. making processors aware of export opportunities and innovative packing could stimulate exports of value added cowpea products. This in turn could benefit local producers. In this regard, a thorough marketing analysis is required to determine the full extent of such an endeavor, and if proven possible, the necessary institutional and functional marketing approaches should be implemented.

- The lack of a proper MIS is severely constraining the efficient marketing of cowpeas. Such information would allow role-players to make better informed production and marketing decisions that will increase efficiency

and hence profitability. Therefore, the implementation of a MIS focusing on cowpea specifically should receive serious consideration. What follows are broad recommendations to establish a cowpea MIS.

- Information on local prices, demand and supply, and buyers preferences should be collected and registered, in collaboration with the cowpea forum, by the Food Security Service (CSA) which has representatives in all the Senegalese regions. In addition, the CSA already has gained invaluable experience in collecting and processing of market data. The CSA could be assisted by the National Agency for Rural Support and Counsel (ANCAR) who has personal in all regions that also interact with rural communities.

- CSA also has links to the West African Market Information System Network and could use this opportunity to also source information on cowpea demand and prices from other West African countries.

- Aggregated statistics on cowpea area and production are being collected by the DAPS on a yearly basis, and such information could be used to forecast supply. DAPS is assisted in its field data collection by the Regional Rural Development Services (DRDR). Hence the DRDR could also assist in gathering up to date, reliable

and relevant information as identified in the study, and pass it on to the CSA.

- Data should be centralized and processed by CSA personal. Price data should be collected from rural and urban markets. It should be processed and disseminated on a daily basis. This may require regional information hubs.

- Information on foreign prices and demand could be disseminated on a monthly basis and supply forecast on a yearly basis. Information could be disseminated through national radio, as well as through communal radio stations which are very popular in Senegal. Information should be broadcasted in Wolof and French.

Figure 6.1 summarize the proposed cowpea MIS.

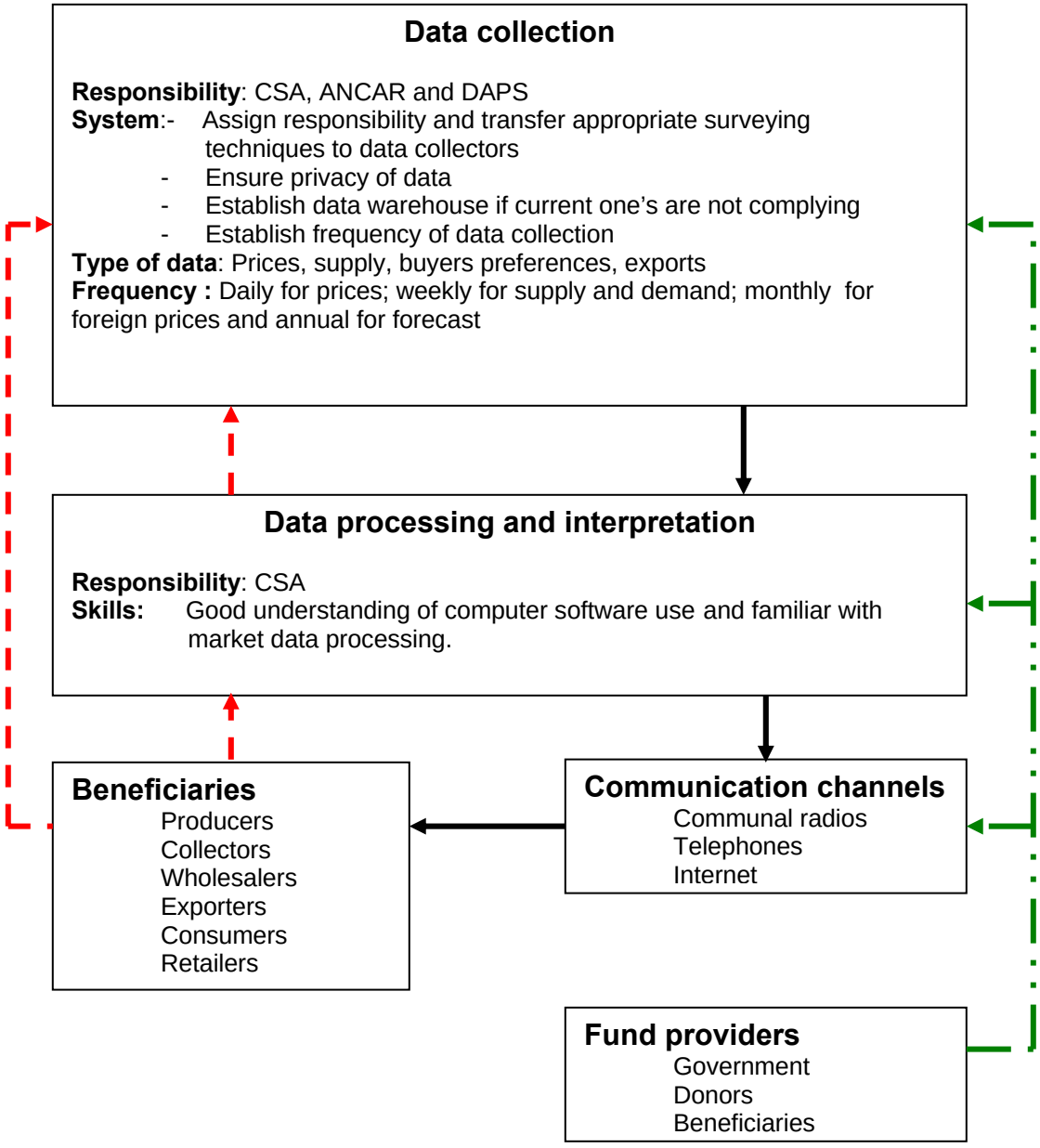

Figure 6.1: Proposed cowpea market information system

Data collection, processing and dissemination
Feed backs
Funds providers

- The study has clearly showed that consumers are willing to pay premiums for grain size and sucrose contents. The implications for cowpea plant breeder would be to focus on a breeding program incorporating large grain size and sucrose contents as main characteristics.

- The introduction of a sustainable and viable credit system to provide financial support to market actors would be an important way of promoting cowpea marketing due to the fact that there is no formal credit system in the cowpea sector.

6.4 FUTURE STUDIES

Following the investigations described in this study, some aspects merit further exploration and development. These are:

- The consumption patterns described in this study were mainly focused in Dakar, which is an important urban consumption area. However, a more in depth study on cowpea consumption in other urban areas, as well as rural areas, could further enlighten the consumption patterns of cowpeas in Senegal as a whole. The value of such a study is that it will contribute to the understanding of rural versus urban consumption, which in turn will influence how cowpeas are distributed/marketed.

- As mentioned earlier, the export market could play an important role to provide the vehicle for the Senegalese cowpea industry to reach its full potential. In depth analysis, similar to this study, is needed on cowpea consumer preferences in these markets.

- The lack of access to credit facilities appears to be a major limitation for certain role-players to fully participate in the market. It is hence vitally important that mechanisms are found to assist different role-players to get access to credit that suite their specific circumstances. Hence, this issue requires further investigation.

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APPENDIX A

Table A.1: Average areas and production for some cowpea producer countries around the world (1993-2003)

Locations	Areas(ha)	Production (Mt)	% of total area*
Nigeria	4,364,282	1,953,364	49.89
Niger	3,282,314	364,785	37.53
Burkina Faso	306,491	251,832	3.50
Mali	298,605	91,944	3.41
Myanmar	121,317	95,285	1.39
Senegal	115,195	34,916	1.32
Kenya	74,273	28,545	0.85
Haiti	49,818	34,828	0.57
Mauritania	42,134	14,947	0.48
Cameroon	22,591	49,228	0.26
Sri Lanka	15,485	13,989	0.18
South Africa	13,045	6,400	0.15
Australia	6,937	2,919	0.08
United States of America	5,066	5,036	0.06
Madagascar	4,527	3,718	0.05
Bosnia and Herzegovina	1,250	1,755	0.01

Source FAOSTAT, 2004.

Note:

*Cowpea worldwide area and production reported are respectively = 8,746,953 ha and 3,145,285 Mt from 1993 to 2003

Brazil is an important cowpea producer but omitted on this list because data were not available.

APPENDIX B

Survey on market information system in Senegal: Questionnaire

Region…….

Department…….

Rural Community…….

Gender…….

Level of education: **a.** Primary school **b.** Secondary school **c.** University

d. Status in the cowpea supply channel

……..Producer

……..Collector

……..Wholesaler

……..Exporter

1. What type of information do you have access to currently?

Options	Type of Information	source	Access
1	Local cowpea Price		
2	Foreign cowpea price		
3	Area planted		
4	Production		
5	Demand (quantity)		
6	Demand (location)		
7	Consumer preferences		
8	Input prices		
9	Existence of stocks		
10	Transportation costs		
11	Others (cite)		

2. What type of information would you like to have access to?

Options	Type of Information	Frequency*	Rank**	Comments
1	Cowpea Price			
2	Local cowpea Price			
3	Area planted			
4	Production			
5	Demand (quantity)			
6	Demand (location)			
7	Consumer preferences			
8	Input prices			
9	Existence of stocks			
10	Transportation cost			
11	Others (cite)			

* Frequency
daily, weakly,
monthly or yearly

**Rank:
1 = not important
2 = fairly important
3 = important
4 = very important
5 = priority

2. What type of information channel and transmission language would you prefer?

Options	Information channels	Language	Comments
1	Radio		
2	Newspapers		
3	Television		
4	Reports		
5	Telephone		
6	Internet		
7	Email		
	Others (cite)		

3. Are willing to pay for market information

Yes ☐ No ☐

Comments:

APPENDIX C

Cowpea price and grain characteristics survey: Questionnaire

Year	Month	Day	Market	Sample	Price/ kg	Type of measurement	Type of seller	Variety name	W100G (g)	NH100	Skin color	Skin texture	Eye color	CT(mns)	SUC (%)
				1											
				2											
				3											
				4											
				5											

W100G = Weight of 100 grains
NH100 = Number of holes per 100 grains
CT = Cooking time
SUC = Sucrose level

N.B. Measurements regarding W100, NH100, CT and SUC were always done in laboratory.