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# Linear programming approach to optimal cowpea marketing in Soroti and Pallisa districts of Uganda

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## Abstract

Cowpea (*Vigna unguiculata* L. Walp) is an economically and nutritionally important grain legume in northern and north eastern Uganda. The crop is grown both for subsistance and as cash crop. However, increased production of cowpea as a cash crop will depend on reliable market information. This study was designed to assess the nature of cowpea marketing and establish how optimally it is marketed within the districts of Pallisa and Soroti. Primary data were collected from 72 traders in rural and urban centers of Pallisa and Soroti districts, using pre-tested structured questionnaires. The data were analysed using descriptive statistics and a linear programming (LP) transportation model. The results indicated that a majority of traders were male and sole proprietors. At both wholesale and retail levels, transport costs accounted for the highest percentage of total marketing costs incurred by traders. Poor storage and seasonal fluctuation in demand were among the leading marketing problem. Farmers generally took the largest share of the consumer price. Use of the LP transportation model showed that traders did not optimally distribute their cowpea. The current level of operation was 10% lower than the optimal level. For optimality, Katakwi zone should supply 1164 kg of cowpea to Soroti market. Similarly, Gweri zone should put on the market 2544 kg of cowpea in Soroti. In Pallisa district, Apopong, Putiputi, Ikiiki and Agule cowpea sources would supply only the Pallisa market. The various problems faced in the marketing system were contributing to the difference between the optimal level of transactions and current level.

Key words: Farmers, markets, optimality, traders, transportation model, *Vigna unguiculata*

## Introduction

Cowpea *(Vigna unguiculata)* is an important staple and cash grain legume crop in north-eastern Uganda grown for its edible leaves and grain (Sabiti *et al.,* 1993). Significant quantities are also used as animal feed mostly in developed countries (FAO, 1994).

However, the overall area cultivated per household in the study area is small (~ 0.5 ha per household) and production is mostly constrained by labour availability, especially without animal traction (Adipala *et al.,* 1997). The situation is worse in Soroti district where nearly all livestock was lost during insurgency and cattle rustling. For the last five years, therefore, Pallisa district has committed more land to cowpea and has in turn produced more grain than Soroti district.

Uganda's grain legumes face growing domestic and regional demands as part of the non traditional export crops whose earnings have continued to grow over the past years. Their marketing and pricing efficiency could be improved if producers and other market participants were better informed of market conditions. However, cowpea marketing in the study area is constrained by several factors. Production of the crop is by small scale farmers on scattered holdings and geographically concentrated in areas that are often found some distance from major consumer markets. The infrastructure in the rural areas is poor and communication networks are not sufficiently developed. This therefore makes

movement of commodities from supply to demand points difficult. The virtual absence of price information system also hinders producers and traders in their transactions. Generally, wholesale traders have greater mobility and are better informed of the market situation. Consequently, they often take advantage of the less informed producers although traders do not often optimally distribute cowpea from producers to consumers. Related studies on other agricultural products have come to similar conclusions. Mugisha (1994) used the transportation model to determine the optimum level of banana distribution in Uganda. He found that the quantity of bananas marketed was not optimal and suggested partial and temporal adjustments in banana distribution for banana traders to increase their profits by 38.47%. Nakachwa (1995) also used the transportation model to determine the optimum level of fresh fish distribution in the central region of Uganda. It was found that the distribution of fresh fish was not optimal and hence suggested that to reduce costs adjustment in fresh fish distribution was necessary so that the fish traders raise their profits by 85.6% from 14.39%.

However, these recommendations have not been adhered to and this has resulted in a situation whereby traders earn low profits, while farmers receive unattractive prices that do not motivate them to produce more for the market. A system allowing a fair play for the marketer, the consumer, and the farmer, therefore, needs to be developed. The principal purpose of this study was to assess the efficiency of the current marketing network of cowpea in Soroti and Pallisa districts, paying particular attention to distribution channels, market structure, conduct and performance. Specific objectives were to 1) estimate the marketing margins of cowpea, 2) identify the major infrastructure, informational, institutional, socio-economic and financial constraints within the cowpea marketing system and propose mitigative measures, and 3) determine the optimum supply points of cowpea to markets to minimize transfer costs.

## Methodology

*Research design and sample selection*

This was a descriptive and market diagnostic study conducted in the districts of Pallisa and Soroti on a previous study by Sabiti (1995), which identified these districts as main cowpea production and marketing areas in eastern Uganda. Within the districts, counties that ranked high in cowpea production were chosen. A total of six counties were selected, three per district. Subsequently two markets were selected per county. Thus, a total of thirteen markets were selected , six in Pallisa and seven in Soroti. In total 36 respondents in Pallisa and 36 in Soroti district were selected in each market using the fish bowl method and interviewed with a pre tested questionnaire.

*Data description and sources*

Primary data were collected during the market surveys. During the surveys, data were collected on prices, marketing costs, characteristics of traders, marketing channels, type of marketing problems faced, quantities of cowpea supplied, sources of supply, distribution of demand and respective margins were computed. Problems encountered in marketing cowpea were also recorded and ranked. Also identified were major market participants and services rendered; average costs incurred; size of market margins; price spreads and farmer's share of the consumer's shilling.

*Data Analysis*

Quantitative and descriptive statistics were used to analyze the data collected. To analyse marketing constraints, ranking methods were used. To determine the various margins and shares , the following equations were used.

Share to the farmer = $\frac{Px}{Py} \times 100\%$ ..... 1

Wholesale margin = $\frac{Pw - Px}{Py} \times 100\%$ ..... 2

Retail margin = $\frac{Py - Pw}{Py} \times 100\%$ ..... 3

Where: Px, Py, Pw refer to farmgate price, retail price and wholesale price respectively.

To determine the optimal distribution of cowpea for the two districts, theLinear programming (LP) transportation model was used. The transportation model for this study was specified to determine the amount of cowpea to be delivered from different production sources to major consuming markets with the objective of minimizing costs. The problem was specified in an LP transportation framework using the following standard summation notation:

LetXij = amount of goods transported from source i to destination j.
Cij = cost per unit for transferring goods from source i to destination j.
Assuming also that there are: m = sources and n = destinations
and Si = Quantity of goods available (supply) at source i.
dj = Quantity of goods required (demanded) at destination j.

Then the problem is the following:

$$\text{Min} \sum_{i=1}^{m} \sum_{j=1}^{n} CijXij \quad \text{.....4}$$

The minimization problem is subject to the following critical constraints.

$$\sum_{j=1}^{n} Xij \leq Si \ (i = 1, 2, \ldots, m) \quad \text{..... 5}$$

Meaning amount transferred from source i to all destinations must not exceed the amount available at that source.

$$\sum_{j=1}^{m} Xij \geq dj \ (j = 1, 2, \ldots, n) \quad \text{..... 6}$$

Amount transferred to destination j, from all sources must be at least as great as the requirements at that destination.
The transportation problem is balanced when the total available at the sources equals the total required at the destinations.

$$\text{Thus} \sum_{j=1}^{m} Si = \sum_{j=1}^{n} dj \quad \text{..... 7}$$

Si, dj, Xij ≥ 0 (for all i,j) ..... 8

That is, no negative goods can be transferred from source to destination.

By solving equation (1), the optimal solution to the transportation problem can be determined. Equation 4 is the objective function for minimizing costs. Equations 5, 6, 7 and 8 represent supply constraints, demand constraints and non-negativity of the variables, respectively. Primary data collected from the cowpea sources and study markets during the district market survey (DMS) were incorporated in Table 2, as required by the transportation model for analysis.

The cowpea supply zones included Katakwi, Usuk, Wera, Orungo, Asamuk, Otuboi, Kaberemaido, Kyere, Gweri, Pallisa, Butebo, Kameke, Agule, Ikiiki, Putiputi and Apopong. The selected markets included Orungo, Ocorimongin, Usuk Mission, Soroti, Tubur, Katine, Wera, Palisa, Ikiiki, Kameke, Kanyum and Kamuge.

When formulating the transportation problem, the following assumptions were considered:

(a) Traders were free to purchase cowpea from any source i for sale at any market j
(b) Different sources produced different amounts of cowpea, and different markets have different demand potentials for cowpea.
(c) Transfer costs are functionally related to the quantity of cowpea handled.
(d) There is an even flow of cowpea supply throughout the year between all points of demand. A steady flow can be achieved by holding sufficient stocks at each cowpea supply zone.

Despite the above assumptions, the following restrictions prevailed and were included in the model as the constraints:

(a) The total amount of cowpea supplied to each market could not exceed the potential demand otherwise the problem would have no feasible solution, given non-negative transfer costs (Simmons, 1972).
(b) The amount of cowpea supplied from each source to any of the markets could not be increased given high market demand.

## Results and discussion

*Characteristics of Traders*

The results indicate that generally, cowpea trade is dominated by married males while women played a minimal role. Although many schools of thought believe post primary education as a key to success, primary school leavers accounting for 50 percent of the respondents interviewed dominate the trade in cowpea. The study revealed that cowpea selling generates employment for the unskilled, semi-skilled, and those who do not have enough capital of their own. These types of traders comprised 86 and 94% of the retail traders of cowpea interviewed in Pallisa and Soroti districts, respectively (Table 1). Earlier, Buphal (1994), noted that the existence of petty retailers or vendors in the vegetable trade helped in creating competitive conditions. Cowpea business is largely a retail trade with wholesaling at less than 50%. Majority of traders interviewed ran their own business and sold other products that largely comprised farm produce. In terms of experience in cowpea marketing, on average, traders had spent 6.5 years trading in cowpea with a minimum period of one year and a maximum of 28 years. This is a clear indication that cowpea trade has provided a living for many traders for quite sometime.

*Cowpea distribution channels*

Wholesalers in both districts relied mostly on direct purchase of cowpea from farmers. A similar case was observed with retailers. Other middlemen comprised brokers, agents or "kilograms boys" as referred to in Pallisa district. However, purchases of cowpea were not restricted to one source only. For example, 60% of wholesalers in Pallisa district purchased their cowpea from more than one source (Table 1). The rest purchased directly from the farmers. About 7% of the retailers purchased cowpea from fellow retailers. In both districts, the most important customer to a wholesaler was the retailer. This is usually the case in a normal marketing channel. However, in Pallisa district, middlemen were very important to wholesalers, which was not the case in Soroti district. Overall, the consumer was the most important customer to the retailer. Also, there were indications that inter-trade within channels exists. The results also showed that in either case, traders sold to more than one customer. Also, traders strived to buy from farmers and sell to the consumer. A clearly defined typical food-marketing channel is therefore not evident. It is prompting to suggest that a well-established wholesale structure is not in place under such a marketing arrangement.

According to Singh (1994), wholesale markets play a critical role in efficient allocation of resources, in transmitting price signals to adjust demand and supply, and improving productivity and competitiveness. Additionally, as stated in MAF (1984), an absent wholesale structure prevents the build-up of security and market stabilizing stocks. Such a situation has resulted in supply disruptions and subsequent instability in price as has often occurred in cowpea marketing in the study area.

The cowpea distribution channel was modelled from the results of the district market survey (Fig.1). There was a clear indication that a strong linkage exists between certain sections of the marketing channels, probably because of differences in marketing margins. For example, producers dealt more

*Table 1. Characteristics of cowpea traders.*

| Item | Description | Respondents (%) (n = 72) | |
|---|---|---|---|
| | | Pallisa | Soroti |
| Sex | Male | 97.2 | 80.6 |
| | Female | 2.8 | 19.4 |
| Age | 18 – 25 years | - | 11.1 |
| | 26 – 30 years | 16.7 | 13.9 |
| | > 30 years | 83.3 | 75 |
| Marital status | Single | 5.6 | 2.8 |
| | Married | 94.4 | 94.4 |
| | Divorced | - | 2.8 |
| Education | None | 19.4 | 2.7 |
| | Ended at primary | 50.0 | 50.0 |
| | Secondary | 25.0 | 41.7 |
| | Tertiary | 5.6 | 5.6 |
| Type of traders | Retail | 86.1 | 94.4 |
| | Wholesalers | 11.1 | 16.7 |
| | Dealers | 2.8 | 2.8 |
| Type of business | Sole proprietor | 91.7 | 88.9 |
| | Partnership | 8.3 | 11.1 |
| Type sold | Only cowpea | 19.4 | 5.6 |
| | Also other products | 80.6 | 94.4 |

with retailers who finally sold to consumers. Wholesaler-consumer linkage was also very strong. Sharma and Prihar (1994) observed this kind of relationship between the strength of the linkage in the marketing channels and the marketing margins. Sharma (1994) reported that net margin were highest in the channel where produce was directly sold to the retailer.

*Cowpea losses*

Poor storage facilities present a significant obstacle to reasonable price and market stability. In Pallisa, 75% of the traders incurred losses in cowpea marketing, while in Soroti district all traders reported losses in cowpea marketing. The losses were mainly incurred in storage and attributed to insect pests (Table 2) but insect problems were less serious in Pallisa compared to Soroti district. Additionally, price flactuations because of over supply was another important factor causing decline in cowpea production in both Pallisa and Soroti districts.

In Pallisa, traders used insecticides to control pests unlike in Soroti. Some traders were, however, unaware of pesticides, and those who were aware of their availability claimed they were too expensive. Fuglie (1995) in a study on potatoes in Tunisia found that improved pest control during storage, significantly reduced variation in market prices and quantities. A similar strategy in the study districts could possibly reap the same benefits, more especially in Soroti where only limited attention is paid to storage pest problems.

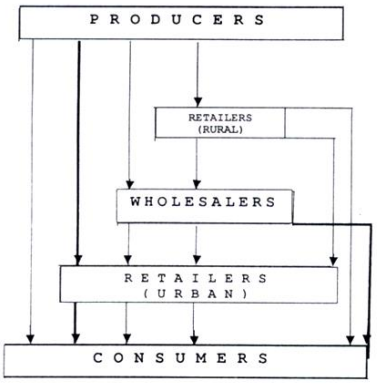


*Figure 1. The generalised cowpea distribution channel.*

*Table 2. Percentage response on cause and frequency of losses in cowpea.*

| Type and cause of loss | | Responses (%) | |
|---|---|---|---|
| Type of loss | Cause | Pallisa | Soroti |
| Storage | Insect pests | 38.9 | 100 |
| Storage | Rodents | 11.1 | 13.9 |
| Storage | Loss in weight | 2.7 | 2.8 |
| Revenue | Drop in prices | 58.3 | 30.6 |

*Marketing problems*

Anumber of marketing constraints were identified and ranked by the respondents as shown in Table 3. In Pallisa, the most important constraint to cowpea trade is fluctuation in demand. This is brought about by the seasonal nature of production. Fluctuation in demand is followed by rapid crop spoilage which leads to losses both in quantity marketed and purchase of agrochemicals. In Soroti, traders considered rapid crop spoilage as the most serious problem in cowpea marketing. As mentioned earlier, traders have not yet entered into the culture of treating grain with pesticides since most of them were not aware or found them expensive. In both districts fluctuating demand and rapid grain spoilage were considered serious problems.

*Marketing information*

A good internal and external market information system is a prerequisite for effective marketing arrangement as it guides efficient production and resource allocation decisions (King, 1995). In Pallisa District 58 percent of the traders had access to market information compared to 30% in Soroti (Table 4). Devine and Marion (1979) stated that lack of price information results in price dispersion across chains. This is probably the reason why the standard deviation of both farm-gate and consumer prices in Pallisa district were (28.9; 49.5, respectively) smaller than in Soroti (54.7; 56.0 respectively). In a homogenous product market, price dispersion represents an undesirable imperfection in that dispersions in price do not reflect accurately the differences in costs and preferences. When the data were disaggregated, according to marketing channels, it was found that in both districts, wholesalers were more informed of the prices than retailers. Wholesalers, because of their greater mobility, had more information about the market used the opportunity to exploit the other traders and producers.

*Means of transport*

In both districts, the most important means of transport used by traders to take produce to the market were bicycles. Nearly 74% of traders in Pallisa and 63% in Soroti used bicycles compared to 21% who used vehicles in both districts. Reliance on bicycles permits movement of only small quantities of produce to the market and therefore limits production to subsistence level.

*Table 3. Rating of selected cowpea marketing problems in Pallisa and Soroti districts*

| Marketing problems | Rating (%) | |
|---|---|---|
| | Pallisa | Soroti |
| Fluctuating demand | 75 | 50 |
| Rapid spoilage in store | 66.7 | 77.8 |
| Poor transport | 5.6 | 22.2 |
| Lack of capital | 2.8 | 8.3 |
| High marketing fees | - | 5.6 |

*Table 4. Availability of price information among traders.*

| Market participants | Percentage informed | | Percentage not informed | |
|---|---|---|---|---|
| | Pallisa | Soroti | Pallisa | Soroti |
| Both wholesalers and retailers | 58.3 | 30.6 | 41.7 | 69.4 |
| Wholesaler | 60.0 | 66.6 | 40.0 | 33.3 |
| Retailers | 12.9 | 23.3 | 87.1 | 76.7 |

*Marketing costs, prices and margins*

A number of studies on marketing costs have revealed that transport cost is a major problem in marketing of produce (Mugisha, 1994; Njoku, 1994). Virender and Khatkhar (1994) in their study of marketing of grapes in Haryana observed that transport and packaging material are the major components of the marketing costs. In another study, Sudaryanto (1994) reported that a high marketing margin is primarily due to high transport costs and produce losses. In this study, transport accounted for the highest share of marketing costs followed by storage (Table 5)

*Prices and marketing margins*

On average, cowpea prices were comparatively higher in Soroti district than in Pallisa (Table 6). The average price difference between the two districts at all levels was Shs. 47.72. In Pallisa average farm gate, wholesale and consumer prices were Ug. Shs. 258; 283 and 331 compared to an average of Ug. Shs. 308; 327 and 380, respectively in Soroti district. As shown in Table 6, retail margins were higher than wholesale margins in both districts and producers in Soroti district earned more returns from their produce than farmers in Pallisa. However, in both districts, the producer took more than half of the revenue. This signifies that the marketing system favoured the farmer rather than the trader.

In India, Kumar (1994) reported higher marketing margins for rice retailers than other market intermediaries. In Haryana, India, Chhikara *et al.* (1993) noted that the producer's share in the consumer's price is only 40%. The cowpea producer is therefore comparatively better off and this supports observation by Sabiti (1995) that production of cowpea is profitable in this region.

*Determining the cost-efficient distribution of cowpea using the transportation model*

Traders generally aim to maximise profits by minimising costs while rendering good services. Results showed that in the various markets studied, the urban markets of Pallisa and Soroti were major consumers of cowpea. Data from the two districts were combined and analysed using the transportation

*Table 5. Marketing costs.*

| Type of marketing cost | Pallisa | | Soroti | |
|---|---|---|---|---|
| | Average | % | Average | % |
| Transport | 21.2 | 36.0 | 16.5 | 33.5 |
| Storage | 19.8 | 33.6 | - | 0.0 |
| Produce preparation | 8.0 | 13.7 | 2.8 | 5.7 |
| Handling costs | 3.3 | 5.7 | 14.3 | 29.1 |
| Packaging | 2.7 | 4.6 | 7.4 | 15.0 |
| Marketing fees | 3.8 | 6.4 | 8.3 | 16.7 |
| Total | 58.9 | 100.0 | 49.3 | 100.0 |

*Table 6. Producer shares and marketing margins in cowpea grain trade.*

| Item | Share (%) | |
|---|---|---|
| | Pallisa | Soroti |
| Producer share | 78.1 | 81.0 |
| Wholesale margin | 7.7 | 5.2 |
| Retail margin | 14.3 | 14.0 |

model with the objective function being the minimisation of costs subject to the various structural constraints. The data used are shown in Table 7, and the optimal solution is given in Table 8.

The optimal solution from the model indicates that if distribution is done efficiently, cowpea trade in the region can be achieved at a minimum cost of Ug. Shs. 5,865,416. However, given the prevailing distribution plan used by the cowpea traders, cowpea distribution was done at a cost of Ug. Shs. 6,476,458. This means that the current performance is 10% more costly. Reorganising of the cowpea distribution routes could rectify this difference by minimising distribution cost and addressing other constraints such as high cost of transport, handling, crop spoilage, packaging costs and inadequate infrastructure.

There were significant differences in distribution of cowpea from various sources to destinations. For example, Soroti market received cowpea from eleven sources, yet for cost minimisation, it could be supplied by seven only. On the other hand, two sources from Pallisa district (Pallisa and Butebo), supplied two markets in Soroti District. For optimality, only Butebo could supply the Soroti market. The randomness in the existing distribution pattern can be attributed to the fact that traders mainly deal in small quantities and use own bicycles to transport the produce in which implicit costs are not accounted for by the traders.

The results shown in Table 7 indicate that Katakwi zone supplied 1164 kg of cowpea to four markets, 125 kg to Ocorimongin, 147 kg to Usuk mission, 772 kg Soroti and the rest to Wera. However, based on the model, in order to minimise marketing costs, all the supply from Katakwi should go to Soroti market, which is much further than the rest. This is plausible, since most cowpea from Katakwi reaches Soroti on vehicles, which is comparatively a cheaper means of transport compared to bicycles with small loads that dominate the distribution of cowpea to other markets. On the other hand, Usuk zone supplies 1053 kg to three markets, Ocorimongin 330 kg, Usuk mission 293 kg and the rest to Soroti market. For efficiency, the model suggests that 93% of this should be supplied to Ocorimongin, which is another conduit to the Soroti market and the remainder should be sold at the local market (Usuk mission).

Another important source of cowpea, Orungo zone supplies 1032 kg to six markets Ocorimongin 168 kg, Orungo 235 kg, Soroti 204 kg, Tubur 150 kg, Katine 135 kg and Usuk Mission 140 kg. The model suggests that, two markets should be supplied; 621 kg to Katine and 411 kg to Orungo market. Most of the cowpea is again sent to the furthest market. Similarly, Asamuk zone supplies 1138 kg of cowpea to seven markets, Soroti market receiving 33.7% and the largest share from all the markets. The model again reduces the destinations to only three Soroti markets, furthest away takes the largest share of 51.4%.

Pallisa zone, the biggest supplier of all the sources with 2992 kg, supplies to seven markets, two in Soroti district and five in Pallisa district. In all 36.7% was supplied to Soroti while 63.3% remained in Pallisa district. The model suggests that this zone supplies only four markets and that all cowpea remains in Pallisa district. Another important source of cowpea, Butebo zone supplies 1862 kg to six markets, five in Pallisa district and one in Soroti district. According to the transportation model, this source should supply to only two markets, one in Soroti district (76.7%) and the rest to one market in Pallisa district. The rest of the four supply zones in Pallisa district, Agule, Ikiiki, Putiputi and Apopong supply on average 3 markets in Pallisa district, and should continue supplying only to Pallisa market. This is irrespective of the fact that the costs incurred in supplying these markets are relatively higher.

It is therefore evident according to the model that higher savings from supplying other markets compensate the high costs normally incurred supplying these markets. For example, according to the current distribution network, it costs Ug. Shs. 284,618; 399,080; 287,540 and 405,532 to supply Ikiiki, Kameke, Kanyum and Kamuge markets, respectively. According to the model, costs can be reduced and savings of up to 9% and 4% can be made from supplying Ikiiki and Kameke markets, respectively.

Admittedly, there are various goals in trade in addition to minimising costs/maximising returns such as satisfying consumer utility, and keeping in business even if there are zero profits (Livesey, 1989; Derbertin, 1992). Therefore traders still maintain certain routes although they are making losses as long as they satisfy these other goals.

*Table 7. Raw data for transportation model.*

| Source of cowpea | Orungo | Ocorimongin | Usuk Mission | Soroti market | Tubur | Katine | Wera | Pallisa market | Ikiiki | Kameke | Kanyum | Kamuge | Total supply (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Katakwi | | $125^{381.11}$ | $147^{335.67}$ | $772^{334.24}$ | | | $120^{330.85}$ | | | | | | 1164 |
| Usuk | | $330^{329.14}$ | $293^{342.31}$ | $430^{352.88}$ | | | | | | | | | 1053 |
| Wera | $150^{354.85}$ | $200^{355.00}$ | | $640^{356.23}$ | | $155^{334.55}$ | $300^{307.00}$ | | | | | | 1445 |
| Orungo | $235^{344.67}$ | $168^{370.33}$ | $140^{369.33}$ | $204^{366.53}$ | $150^{365.23}$ | $135^{353.55}$ | | | | | | | 1032 |
| Asamuk | $140^{354.80}$ | $155^{356.60}$ | $80^{357.00}$ | $383^{357.00}$ | $105^{356.74}$ | $125^{355.40}$ | $150^{312.36}$ | | | | | | 1138 |
| Otuboi | $66^{344.95}$ | | | $356^{334.55}$ | $68^{366.08}$ | | | | | | | | 579 |
| Kaberemaido | | | | $565^{265.02}$ | | | | | | | | | 565 |
| Kyere | | | | $327^{394.04}$ | | | | | | | | | 327 |
| Gweri | | | | $2347^{341.84}$ | $50^{343.24}$ | $147^{342.65}$ | | | | | | | 2544 |
| Pallisa | | | | $847^{366.56}$ | | $250^{373.89}$ | | $1056^{312.95}$ | $308^{293.90}$ | $156^{307.90}$ | $150^{309.95}$ | $225^{311.85}$ | 2992 |
| Butebo | | | | $332^{263.88}$ | | | | $477^{322.75}$ | $227^{271.30}$ | $144^{296.88}$ | $350^{293.88}$ | $332^{294.60}$ | 1862 |
| Kameke | | | | | | | | $792^{322.85}$ | | $546^{290.52}$ | $130^{324.40}$ | $175^{323.00}$ | 1643 |
| Agule | | | | | | | | $615^{320.72}$ | | $166^{320.72}$ | $155^{321.80}$ | $135^{320.95}$ | 1071 |
| Ikiiki | | | | | | | | | $220^{379.42}$ | | | | 220 |
| Putiputi | | | | | | | | $470^{319.60}$ | $153^{320.52}$ | $80^{299.90}$ | $126^{294.75}$ | $270^{293.80}$ | 1099 |
| Apopong | | | | | | | | $500^{319.95}$ | | $224^{323.40}$ | | $180^{324.33}$ | 904 |
| Total demand (kg) | 591 | 978 | 660 | 7203 | 373 | 901 | 570 | 3910 | 908 | 1316 | 911 | 1317 | 19638 |

Note: The superscripts represent per unit costs (Ushs) to a given market from the respective source

Overall, the model seems to direct that the marketing of cowpea be confined to the respective districts with minimal inter-region trade although much of it must be taking place alongside the borders. This is logical, because bicycles are the main source of transport, and this is relatively expensive over long distances. Long distance haulage only becomes inexpensive when vehicles are used.

An efficient marketing system for agricultural products is important if a country is to move from a subsistence economy to a commercial based one.

A clear difference was observed between optimal and current level of operation hence the need to reorganize cowpea distribution if traders are to minimize costs. A number of marketing constraints were identified which accounted for the high costs currently incurred. These included high crop spoilage, costly handling and packaging, marketing fees and inadequate infrastructure. These factors could explain the 10% difference between the optimal level and current level of operation. At both wholesale and retail levels transport costs are the major marketing costs. Fluctuating in cowpea supply is also responsible for instability in cost outlays and prices in cowpea marketing. The cowpea marketing structure is generally competitive with many buyers and sellers and a price structure which varies from market to market in the districts. Lack of working capital may explain why most traders handle small amounts of cowpea traded at the markets. Based on the results of this study the following recommendations can be made:

1. Transport costs which are a major handicap to an efficient distribution of cowpea from producers to major markets could be reduced by handling produce in bulk and using vehicles over long distances.

2. Improved storage facilities should be promoted at both producer and trader level in order to increase the shelf life of cowpea and avoid supply disruptions during off-season. Additionally, use of safe pesticides for storage should be encouraged.

3. Policies should be put in place to give credit facilities to support cowpea traders so as to break the working capital constraint. Loan availability should be accompanied by conducive borrowing environment that includes manageable interest rates.

4. Lack of sufficient information about cowpea markets has largely confined the consumption and marketing of this crop to the north and north-east. There is therefore need to collect and disseminate information on cowpea prices, market and costs incurred, demand and potential use.

5. The revelation in this study that cowpea farmers in the study area realised the highest share of the consumer price is a production incentive in itself and should prevail in the search for optimal distribution of cowpea.

## Acknowledgement

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